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RELATING TO THE

FIRST REPORT

OF THE

ROYAL COMMISSION ON SCIENTIFIC INSTRUCTION
AND THE ADVANCEMENT OF SCIENCE,

AND A

MEMORIAL

ADDRESSED TO THE

DEPARTMENT OF SCIENCE AND ART BY THE DIRECTOR OF
THE ROYAL SCHOOL OF MINES.

Presented to both Houses of Parliament by Command of Her Majesty.



LONDON:

PRINTED BY GEORGE EDWARD EYRE AND WILLIAM SPOTTISWOODE,
PRINTERS TO THE QUEEN'S MOST EXCELLENT MAJESTY.
FOR HER MAJESTY'S STATIONERY OFFICE.

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COPIES OF CORRESPONDENCE,

ETC. ETC.

Letter, with enclosures, addressed to the Royal Commissioners.

I.

Science and Art Department, London, W.

May 23, 1871.

SIR,

I AM directed by the Lords of the Committee of Council on Education to forward to you the accompanying copy of a statement of the opinions of some of the professors of the Royal School of Mines on the First Report of the Royal Commission on Scientific Instruction, with a copy of the letter from Sir Roderick Murchison transmitting these to me; and I am to say that their Lordships do not propose to take any steps with respect to these communications until they have heard from the Commissioners.

I am, &c.

NORMAN McLEOD,
Assistant Secretary.

The Secretary,
Royal Commission on Scientific Instruction and the
Advancement of Science, Old Palace Yard.

(Copy.)

Jermyn Street, April 22, 1871.

SIR,

I ENCLOSE, for the consideration of the Lords of the Committee of Council on Education, a statement of the opinions of those professors of the School of Mines whose teachings are most intimately connected with the well-being and efficiency of that establishment.

I have on more than one occasion informed their Lordships that in my opinion it was essential to the success of the School of Mines that it should be ever kept in connexion with the Geological Survey and Museum in Jermyn Street; and I, therefore, entirely approve of the enclosed document, though I beg to state that I have taken no part in its preparation.

Having now presided for very nearly 16 years over the Council of Professors or Teachers of the School of Mines, I am bound to state that we have invariably acted in perfect harmony; and after the proofs we have obtained of the successful labours of the eminent men over whom it has been my pride to preside, it would truly grieve and mortify me to see this compact body, whose duties and objects are so well defined, losing its special *mining* character by being moved from its present central position, and absorbed in a general "college of science."

I am, &c.

(Signed) ROD. I. MURCHISON.

The Secretary,
Department of Science and Art.

(Copy.)

Royal School of Mines,

April 22, 1871.

SIR,

WE, the undersigned officers of the Museum of Practical Geology, and some of us lecturers in the Royal School of Mines from its commencement, having read the "First Report of the Royal Commission on Scientific Instruction, &c.," have the honour to submit to you our opinions on certain recommendations contained therein which affect the Royal School of Mines.

The Commissioners propose to remove the teaching department, termed the "Royal School of Mines," in Jermyn Street, to South Kensington, to be there merged in what they designate a "science school." While we admit that "there is no necessary connexion between the direction of the Geological Survey and of the School of Mines," we nevertheless hold it to be indisputable, that, considering the special object for which that school was established, the direct association of the two institutions has been attended with great practical advantage. The object of the Geological Survey is the investigation of the nature and extent of the mineral resources of the country; and the object of the Royal School of Mines is to teach how those resources may be most scientifically, and, therefore, most efficiently and most economically developed. But in order that the teaching may be as practical as possible, it is not only desirable but essential that the teachers should be able to avail themselves of suitable and extensive collections, such as have been accumulated in the Museum of Practical Geology. And if this be admitted, it follows obviously that the museum and the school should be localized in the same building, and that they should not, as proposed in the First Report of the Royal Commissioners on Scientific Instruction, &c., be separated from each other.

It may here be advisable to state succinctly how the School of Mines originated.

During the execution of the Geological Survey, commenced many years ago by the Government, and still in progress, large and valuable collections have been made, illustrating the nature and extent of the various geological formations, and the methods by which the minerals contained in them may be turned to practical account.

By a parliamentary vote during the administration of the late Sir Robert Peel, strongly advocated by the late Mr. Joseph Hume, it was determined that a suitable building should be erected in which to preserve those collections, and to which there might be free access for examination and study to persons concerned in mining, quarrying, metallurgy, civil engineering, architecture, and agriculture, as well as to the general public. It was further decided by the Treasury, in pursuance of a recommendation of the British Association in 1838, to establish a "national depository for the preservation of documents and records relating to the mining operations of the country," in which to collect plans of existing and of abandoned mines, partly for the preservation of human life, and partly to guard against the waste of capital upon mining enterprises in ground previously exhausted.

Hence the Museum of Practical Geology and a Mining Record Office in association therewith were established.

Such an institution being in existence, it was represented to the Government in numerous memorials from the mining districts, particularly Cornwall, South Wales, Staffordshire, Northumberland, and Durham, that it was desirable further to utilize its collections by the establishment of courses of lectures in the museum, and hence arose, in 1851, the School of Mines. The institution did not conflict with any other, because no school of the kind existed in this country; and it is notorious that students desirous of acquiring a knowledge of the subjects taught in this school were obliged to visit distant foreign academies for the purpose.

We would remind you that there is a wide distinction between a school for preparatory training in the elementary sciences, and a school designed for teaching the application of those sciences to any particular industrial art. The object of the former is general, while that of the latter is special. Excellent instruction in the elementary sciences, such as mathematics, chemistry, physics, &c., a knowledge of which is indispensable to the students of a school of mines, is provided in numerous private institutions, both in the metropolis and in other parts of the kingdom; and some of the students of the Royal School of Mines have received their instruction in those branches of science at such institutions.

We are apprehensive that if the Royal School of Mines be merged in a general science school it may lose its definite and distinctive character, and that the confidence of the mining interest in its value, which we have so long struggled to acquire, may in consequence be severely shaken. We fear, moreover, that the cause of technical instruction

in the mining districts, the subject of so many applications to Government, and of so many observations by Committees of the Houses of Parliament, and by the Government inspectors of mines in their reports on the loss of life in mining operations, would, by such a course as is now proposed, be thrown back for many years.

The value of the juxtaposition of these collections of the geological maps, mining plans, statistical documents, and mining models; and of the metallurgical laboratory, has been attested by the great number of persons, including the present Prime Minister and numerous Members of Parliament, and officers of public departments, who have sought for special information concerning the mineral resources and geological structure of particular districts of the country. It is of no slight importance that these collections are placed in a part of London so easily accessible to official and commercial men.

Amongst the reasons assigned for the recommendation to transfer the Royal School of Mines to South Kensington is that of deficient accommodation in the existing institution. The Keeper of the mining records, whose evidence has not been requested by the Commissioners, asserts that there is ample accommodation for additional records during many years to come, notwithstanding it is alleged by the Commissioners, in their First Report, that "the space allotted to the Mining Record Office is already insufficient for the proper reception and arrangement of the valuable documents accumulated there." The Lecturer on mining and mineralogy declares that he is perfectly satisfied with the space devoted to his department. The Lecturer on geology, as such, requires no increase of space; but, as Director of the Geological Survey, he needs additional room, which might easily be provided, at a comparatively small cost, in the immediate vicinity of the collections which have to be so frequently consulted. The Lecturer on metallurgy thinks it desirable somewhat to increase the dimensions of the metallurgical laboratory for the practical instruction of the students in assaying, as he has been repeatedly obliged to decline the application of students for admission from want of space; but this may be obtained in the existing institution at a very small outlay compared with what would be necessary in the event of removal to South Kensington. With regard to the absence of a biological laboratory we have no observation to offer, because we hold that such a laboratory has no connexion with a school of mines; and there is not a mining school in the world, so far as we are aware, in which biology forms part of the instruction.

With regard to the following paragraph in the First Report of the Commissioners,—
 "The Royal School of Mines and the Royal College of Chemistry, which practically constitute one school of pure and applied science, are not organised in such a manner as to enable them to perform efficiently the work for which they were originally, or are at present, intended,"—we would submit that, as the teachers of subjects which are everywhere considered the essential basis of a mining school, our opinions as to the requirements necessary for efficient teaching are deserving of consideration.

The Royal School of Mines is, we maintain, in a most favourable condition for its effective working. It is in a most convenient and accessible locality; it has at its command copious illustrations of fossils, minerals, ores, rocks, and mining and metallurgical models, many of which are so large as not to admit of occasional removal; it is provided with laboratories for the examination and analysis of mineral products, and for instruction in the art of assaying; a large and valuable collection of mining plans, and an extensive library especially bearing on the subjects of its teaching, are in immediate connexion with it; it is constantly resorted to by persons engaged in mining, metallurgical, and engineering enterprise, its locality is well known throughout the country, and the fact of the public having been accustomed to this locality during more than 20 years is a consideration of importance. Under these circumstances, we are of opinion that if the proposals of the Commissioners respecting it be carried out its utility will be greatly diminished, if, indeed, its existence be not thereby jeopardized. The removal of the school to South Kensington would be attended with considerable expense to the nation, for which we see no justification in the reasons assigned by the Commissioners for their proposals. Having laboured during so many years to render the institution worthy of the confidence of the country, and perceiving, as we think, that at length our labours have not been in vain, we are naturally anxious to act upon the let-well-alone system, especially as the school has never been more prosperous than of late.

In conclusion, we would add that we have reason to know, both from published statements and from personal communications at home and abroad, that the juxtaposition of the various branches of the establishment in Jermyn Street, under your direction, has met with the cordial approval of eminent persons engaged in the teaching and practice of mining, and the allied pursuits, in various parts of Europe and America; and that the institution in its present form has been reported on by them as a classical example,

and a model for the organization of similar schools at Berlin, Vienna, New York, and other places.

(Signed) We have, &c.
 WARINGTON W. SMYTH, M.A., F.R.S.,
 Lecturer on Mining and Mineralogy.
 ANDREW C. RAMSAY, LL.D., F.R.S.,
 Lecturer on Geology, and Director of
 the Geological Survey of England.
 JOHN PERCY, M.D., F.R.S.,
 Lecturer on Metallurgy at the Royal
 School of Mines, and to the Advanced
 Class of Artillery Officers at the Royal
 Artillery Institution, Woolwich.
 ROBERT HUNT, F.R.S.,
 Keeper of Mining Records.

To Sir Roderick L. Murchison, Bart., K.C.B.,
 Director General of the Geological Survey,
 &c. &c. &c.

Reply of Royal Commissioners.

Royal Commission on Scientific Instruction

and the Advancement of Science,

6, Old Palace Yard, S.W., July 19, 1871.

SIR,

In reply to your letter of the 23rd of May last, I am requested by the Duke of Devonshire, the Chairman of this Commission, to transmit herewith the Report of a Committee of this Commission to which the enclosures in your letter were referred.

I am to add that this Report was received and adopted by the Commission at a meeting held yesterday.

I remain, Sir, your obedient servant,
 (Signed) J. NORMAN LOCKYER, Secretary.

The Secretary,
 Department of Science and Art.

Report referred to in the foregoing Letter.

1. In compliance with the reference of the Commission, the Committee appointed on the 3rd of March 1871 have considered the memorial of three Professors of the School of Mines and of the Keeper of Mining Records, and the letter from Sir Roderick I. Murchison, transmitting the same, which have been referred to the Commission by the Lords of the Committee of Council on Education.

2. In the First Report of the Commission (in addition to other recommendations not directly affecting the questions raised in the memorial), it was recommended in effect that the Royal School of Mines and the Royal College of Chemistry should be consolidated, and that the consolidated institution should be accommodated in the new buildings at South Kensington.

3. In connexion with this recommendation it was proposed, That the building in Jermyn Street be given up to the Survey and to the Museum, with the reservation that the lectures to working men be delivered as heretofore in the theatre; that the building in Oxford Street be vacated by the Royal College of Chemistry; that the Mining Record Office be lodged with the Statistical Department of the Board of Trade, or, failing accommodation there, in the building now occupied by the Royal College of Chemistry; and that the theoretical instruction of the Royal School of Naval Architecture and Marine Engineering be in future given in the Science School, the general instruction in mathematics, physical science, and mechanical drawing becoming common to both schools.

4. These recommendations were based on the considerations stated in the First Report of the Commission, and are supported by evidence given before the Commission, before

the Committee of the House of Commons on Scientific Instruction, and by official letters and reports of the Officers of the Geological Survey, and of the Professors of the Royal School of Mines, including some of the memorialists themselves, bearing on the following points :—

- a. The want of room in the existing Government buildings in Jermyn Street and Oxford Street for the various departments established there, even under the present conditions of teaching.
- b. The absence of instruction in pure and applied mathematics in the School of Mines, and the facility afforded for supplying such instruction by connecting it with the Royal School of Naval Architecture and Marine Engineering.
- c. The need of better provision for giving practical instruction in physics, chemistry, and biology.
- d. And the advantage generally of concentrating in one place the several courses of instruction given in the Schools.

5. The memorial on which we have been requested to report objects to these recommendations mainly on the following grounds :—

- I. That they involve great expense to the nation, and that the additional accommodation required can be obtained in Jermyn Street at a moderate cost.

In reply to this the Committee have to state that it is in evidence that the cost of extension in Jermyn Street would be very great, whereas the Government possesses a building at South Kensington affording all necessary accommodation.

- II. That it is not desirable to separate the Mining School proper from the other departments now situated in Jermyn Street.

On this the Committee would observe that it is impossible, without great cost, to retain even this department of the School in immediate contiguity to the Geological Museum and Survey. The consolidation of the School is, moreover, in the opinion of the Committee, of greater importance than such contiguity. The evidence given before the Commission shows more especially that there is a great disadvantage in dissociating the chemical laboratory from the geological and metallurgical work. It has long been felt to be a defect, that the Royal College of Chemistry, though a department of the Royal School of Mines, is not in the same building with the other classes of that school.

- III. That if the Royal School of Mines be merged in a general science school it may lose its definite and distinctive character, and that the confidence of the mining interest in its value, which the professors have so long struggled to acquire, may in consequence be severely shaken.

In reference to this objection the Committee have to state that for the last 18 years the average number of students, who, having been examined in mining or mineralogy, have subsequently been employed in the Geological Survey and in the mines and metal works of the United Kingdom, has, according to a table put in evidence, been less than four per annum; and if, notwithstanding the eminence of the Professors, the mining interest has been very slow to avail itself of the advantages afforded by the School, this may be owing in a great degree to the imperfection of its organization, and to the incompleteness of the preparation which it supplies for the professions of mining and metallurgy, owing to the entire absence of instruction in mathematics, and, as a necessary consequence, imperfect teaching of applied mechanics and machinery. The Committee believe that these defects will be in a great measure remedied by the proposed association of the School of Mines with that of Naval Architecture and Marine Engineering; and that the appreciation of the technical education afforded in the school, far from being diminished, may fairly be expected to increase.

- IV. That “it is not only desirable but essential that the teachers should be able to
“avail themselves of suitable and extensive collections, such as have been
“accumulated in the Museum of Practical Geology.”

The Committee admit the force of this objection, but cannot allow it to outweigh the other considerations referred to above, on which the decision of the Commission has been based. At the same time they have learnt that the specimens belonging to the Museum are very rarely exhibited in the lecture rooms; and they believe that whilst the Museum would still remain accessible for study, one or more collections on a smaller scale, adapted for the illustration of lectures, could without difficulty be provided for the school.

V. That the recommendation as to the removal of the Office of Mining Records is unnecessary and based upon insufficient evidence.

The Committee would state that the removal of the Office of Mining Records is a secondary question. Owing to the illness of the Keeper the Commission was unable to examine him, and its recommendation was based on the evidence of other witnesses holding office in the establishment in Jermyn Street. If arrangements can be made between the Record Office and the Geological Survey for the continued accommodation of the former, without the erection of new premises, there would certainly be considerable convenience in keeping these two departments under the same roof.

6. The Commission will observe, from the annexed letter of Professor Huxley, a member of this Committee, that in consequence of his holding office as a Professor of the Royal School of Mines, he has preferred not to take any part in the deliberations of this Committee on the subject of this Report.

B. SAMUELSON.
W. SHARPEY.
HENRY J. S. SMITH.

J. NORMAN LOCKYER, Secretary.
July 18th, 1871.

APPENDIX.

DEAR MR. SAMUELSON,

As I am a member of the Committee (of which you are Chairman) to which the Aid to Science Commission has referred a letter addressed to the Government by the Director and three of the Professors of the Royal School of Mines, I desire to say that I do not well see how I (as a Professor in the Royal School of Mines) can properly take part in the discussion of that letter by the Committee.

I therefore propose to absent myself from the meetings of the Committee so long as it is occupied with the subject in question.

I am, &c.
T. H. HUXLEY.

June 3rd, 1871.

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ROYAL COMMISSION

ON

SCIENTIFIC INSTRUCTION AND THE ADVANCEMENT OF SCIENCE.

VOL. I.

FIRST, SUPPLEMENTARY, AND SECOND REPORTS,

WITH

MINUTES OF EVIDENCE AND APPENDICES.

Presented to both Houses of Parliament by Command of Her Majesty.



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ROYAL COMMISSION ON SCIENTIFIC INSTRUCTION AND THE
ADVANCEMENT OF SCIENCE.

VICTORIA R.

VICTORIA, by the Grace of God of the United Kingdom of Great Britain and Ireland Queen, Defender of the Faith, To Our Right Trusty and Right Entirely Beloved Cousin William Duke of Devonshire, Knight of Our Most Noble Order of the Garter,—Our Right Trusty and Entirely Beloved Cousin Henry Charles Keith Marquess of Lansdowne,—Our Trusty and Wellbeloved Sir John Lubbock, Baronet,—Our Trusty and Wellbeloved Sir James Phillips Kay-Shuttleworth, Baronet,—Our Trusty and Wellbeloved Bernhard Samuelson, Esquire,—Our Trusty and Wellbeloved William Sharpey, Esquire, Doctor of Medicine,—Our Trusty and Wellbeloved Thomas Henry Huxley, Esquire, Professor of Natural History in the Royal School of Mines,—Our Trusty and Wellbeloved William Allen Miller, Esquire, Doctor of Medicine, Professor of Chemistry in Kings College, London,—and Our Trusty and Wellbeloved George Gabriel Stokes, Esquire, Master of Arts, Lucasian Professor of Mathematics in the University of Cambridge, Greeting :

Whereas We have deemed it expedient for divers good causes and considerations that a Commission should forthwith issue to make Inquiry with regard to Scientific Instruction and the Advancement of Science and to Inquire what aid thereto is derived from Grants voted by Parliament or from Endowments belonging to the several Universities in Great Britain and Ireland and the Colleges thereof and whether such aid could be rendered in a manner more effectual for the purpose.

Now Know Ye that We reposing great Trust and Confidence in your Ability and Discretion have nominated constituted and appointed and do by these Presents nominate constitute and appoint you the said William, Duke of Devonshire—Henry Charles Keith, Marquess of Lansdowne—Sir John Lubbock—Sir James Phillips Kay-Shuttleworth—Bernhard Samuelson—William Sharpey—Thomas Henry Huxley—William Allen Miller—and George Gabriel Stokes—to be Our Commissioners for the purposes of the said Inquiry,

And for the better enabling you to carry Our Royal Intentions into effect We do by these Presents authorize and empower you or any three or more of you to call before you or any three or more of you such persons as you may judge necessary by whom you may be the better informed of the matters herein submitted for your consideration and also to call for and examine all such Books Documents Papers or Records as you shall judge likely to afford you the fullest information on the subject of this Our Commission and to Inquire of and concerning the Premises by all other lawful ways and means whatsoever.

And Our further Will and Pleasure is that you or any three or more of you do Report to Us under your Hands and Seals (with as little delay as may be consistent with a due discharge of the Duties hereby imposed upon you) your opinion on the several matters herein submitted for your consideration, with power to certify unto Us from time to time your several proceedings in respect of any of the matters aforesaid, if it may seem expedient for you so to do.

And We do further Will and Command and by these Presents ordain that this Our Commission shall continue in full force and virtue and that you Our said Commissioners or any three or more of you shall and may from time to time proceed in the

execution thereof and of every matter and thing therein contained although the same be not continued from time to time by adjournment.

And for your assistance in the execution of these Presents We do hereby authorize and empower you to appoint a Secretary to this Our Commission to attend you whose services and assistance we require you to use from time to time as occasion may require.

Given at Our Court at Saint James's, the Eighteenth day of May 1870, in the Thirty-third year of Our Reign.

By Her Majesty's Command,

H. A. BRUCE.

ROYAL COMMISSION ON SCIENTIFIC INSTRUCTION AND THE
ADVANCEMENT OF SCIENCE.

VICTORIA R.

VICTORIA, by the Grace of God of the United Kingdom of Great Britain and Ireland Queen, Defender of the Faith, To Our Trusty and Well-beloved Henry John Stephen Smith, Esquire, Master of Arts, Savilian Professor of Geometry in Our University of Oxford, Greeting :

Whereas We did by Warrant, under Our Royal Sign Manual, bearing date the Eighteenth Day of May, One Thousand Eight Hundred and Seventy, appoint Our Right Trusty and Right Entirely Beloved Cousin, William, Duke of Devonshire, Knight of Our Most Noble Order of the Garter, Our Right Trusty and Entirely Beloved Cousin, Henry Charles Keith, Marquess of Lansdowne, together with the several Gentlemen therein named, to be Our Commissioners to make Inquiry with regard to Scientific Instruction and the Advancement of Science, and to inquire what aid thereto is derived from Grants voted by Parliament, or from Endowments belonging to the several Universities in Great Britain and Ireland, and the Colleges thereof, and whether such aid could be rendered in a manner more effectual for the purpose: And whereas since the issue of the said Warrant William Allen Miller, Doctor of Medicine, one of the Commissioners thereby appointed, hath deceased :

Now Know Ye, that We, reposing great Trust and Confidence in Your Zeal, Discretion, and Integrity, have authorized and appointed, and do by these Presents authorize and appoint you the said Henry John Stephen Smith to be a Commissioner for the purpose aforesaid, in addition to, and together with, the Commissioners now acting under the above-mentioned Royal Warrant.

Given at Our Court at Saint James's the First Day of December 1870, in the Thirty-Fourth Year of Our Reign.

By Her Majesty's Command,
H. A. BRUCE.

Professor Henry John Stephen Smith, M.A.,
To be a Commissioner for inquiring into
Scientific Instruction and the Advancement of Science.

FIRST REPORT

TO THE QUEEN'S MOST EXCELLENT MAJESTY.

MAY IT PLEASE YOUR MAJESTY,

WE, the Commissioners appointed by Your Majesty to make Inquiry with regard to Scientific Instruction and the Advancement of Science, humbly beg leave to present to Your Majesty the following First Report :

1. We have heard the evidence of witnesses in reference to the following subjects, forming part of our inquiry, viz. the Royal School of Mines, the Geological Survey of Great Britain and Ireland, the Mining Record Office, and the Museum of Practical Geology, at present located in Jermyn Street; and also concerning the Royal College of Chemistry, at present lodged in a building in Oxford Street; which institutions are under one head, entitled Director-General of the Geological Survey of Great Britain and Ireland and Director of the Royal School of Mines.

2. There is no necessary connexion between the direction of the Geological Survey of Great Britain and Ireland and the government of the Royal School of Mines.

3. The Royal School of Mines and the Royal College of Chemistry, which practically constitute one School of Pure and Applied Science, are not organized in such a manner as to enable them to perform efficiently the work for which they were originally, or are, at present, intended. We base this conclusion upon three grounds: (*a.*) the absence of a chair of Mathematics, (*b.*) the absence of Physical or Biological Laboratories in which students can receive practical instruction, (*c.*) the insufficiency of accommodation in the Royal College of Chemistry.

4. The Officers of the Geological Survey are greatly hindered in their work by want of accommodation; for although their number has been quintupled during the last 20 years, the space originally allotted to them has not been increased.

5. The space allotted to the Mining Record Office is already insufficient for the proper reception and arrangement of the valuable series of documents accumulated there; and for the accommodation of the public who desire to consult them.

6. The collections in the Museum of Practical Geology require greater space for their proper display than is at present afforded.

7. In order to provide a remedy for the inconveniences which have been enumerated, we recommend: (*a.*) That the Building in Jermyn Street be given up to the Survey and to the Museum, with the reservation that the Lectures to Working Men be delivered as heretofore in the Theatre: (*b.*) That the building in Oxford Street be vacated by the Royal College of Chemistry; and (*c.*) That the Mining Record Office be lodged with the Statistical Department of the Board of Trade; or, failing accommodation there, in the building now occupied by the Royal College of Chemistry.

8. Without expressing any opinion, at present, as to the policy of Government Schools of Science, your Commissioners, having to deal with the Royal School of Mines and the Royal College of Chemistry as Institutions which have existed for 20 years, and which, during that period, have turned out a large number of well-instructed Students, consider that such steps should be taken as may be necessary to render their Teaching thoroughly efficient.

9. With this object we recommend that the two Institutions be consolidated; that Mathematics be added to the Courses of Instruction now given; and that sufficient Laboratories and Assistance for giving Practical Instruction in Physics, Chemistry, and Biology, be provided.

10. The Institution thus formed (herein-after called the "Science School") may be conveniently and efficiently governed by a Council of Professors, one of that body acting as Dean.

11. We have further heard evidence concerning the Buildings at South Kensington, now nearly completed, and intended for the reception of a projected School of Naval Architecture and Science; and we recommend that the Science School should be accommodated in these buildings. We have given careful attention to the considerations in favour of the retention in Jermyn Street of the Technical Instruction in certain Branches, but we are of opinion that these considerations are outweighed by the great advantages to be derived from concentration.

12. We have further heard evidence concerning the Royal School of Naval Architecture and Marine Engineering, now conducted at South Kensington; and we recommend that the theoretical instruction of that school should in future be given in the Science School, the general instruction in Mathematics, Physical Science, and Mechanical Drawing, thus becoming common to both schools. We also recommend that no additional buildings, and no reconstruction of the temporary buildings at present occupied by the Royal School of Naval Architecture and Marine Engineering, should be undertaken, until a Further Report has been received from this Commission.

13. We have further heard evidence concerning the system of teaching Elementary Science under the Science and Art Department; and we are of opinion that the Quality of the Instruction given under this Department would be greatly improved if the teachers received Practical Instruction in Elementary Science. Such instruction has, indeed, already been given with marked advantage, although only to a limited extent. The Science School will be available for the instruction of many Science Teachers throughout the country; but we reserve for a Further Report any expression of opinion as to the precise character of such Instruction, and as to the conditions under which it shall be accessible.

14. The organization of, and accommodation required by the Science School (including its Technical Branches), and the Royal School of Naval Architecture, will be dealt with in detail in a Further Report.

All which we humbly submit for Your Majesty's gracious consideration.

(Signed) DEVONSHIRE.
 LANSDOWNE.
 JOHN LUBBOCK.
 J. P. KAY-SHUTTLEWORTH.
 B. SAMUELSON.
 W. SHARPEY.
 THOMAS H. HUXLEY.
 G. G. STOKES.
 HENRY J. S. SMITH.

J. NORMAN LOCKYER,
 Secretary.
 9th March 1871.

SUPPLEMENTARY REPORT

TO

FIRST REPORT.

TO THE QUEEN'S MOST EXCELLENT MAJESTY.

MAY IT PLEASE YOUR MAJESTY :

WE, the Commissioners appointed by Your Majesty to make inquiry with regard to Scientific Instruction and the Advancement of Science, humbly beg leave to present to Your Majesty the following Report on the Organization of the Science School referred to in our First Report, and on the accommodation of that School in the new buildings at South Kensington.

I. ORGANIZATION.

1. Your Commissioners recommend that the Science School be represented before the Board of the Science and Art Department by its Dean, as the Royal School of Mines has been hitherto represented by its Director.

2. We recommend that the Council of Professors shall have power, subject to the approval of the Board, to provide for the due maintenance of discipline in the general school and technical schools; the discipline of the students of the Royal School of Naval Architecture and Marine Engineering remaining under the Principal of that School.

3. We consider that such modifications as to the conditions of admission to the courses, as well as such re-arrangement of the courses as may be rendered expedient by the consolidation of the Schools recommended in the First Report of the Commission, should be considered and reported on to the Committee of Council on Education by the Council of Professors, due regard being had to the maintenance of its character as a School for Special Scientific Instruction. Such re-arrangement should admit of provision being made for the continuance and extension of the instruction given to Elementary Science Teachers during the summer months.

4. With reference to the assistance required by the Professors, we recommend that this subject should also be considered by the Council of Professors, and reported on by them to the Committee of Council on Education, due regard being had to the necessity of practical instruction, and to the suggestion in the previous paragraph concerning the instruction to be given to Science Teachers.

II. ACCOMMODATION.

5. Your Commissioners find that the new buildings at South Kensington will afford sufficient space as regards lecture theatres, class rooms, and laboratories, for the theoretical and practical instruction of a large accession of students. A Committee of Your Commissioners have inspected the new buildings with special reference to the accommodation that will be afforded, and the Secretary, at their request, has applied to the several Professors for information as to the space that they require.

The Committee having reported the results of their inspection and inquiry, Your Commissioners suggest the following general appropriation, considering that the detailed allotment of rooms had better be left to the Professors themselves :

- Basement - Physics, Metallurgy, Chemistry.
- Ground Floor - School of Naval Architecture, General Lecture Room, Mathematics, Applied Mechanics, &c.
- First Floor - Physics and Chemistry.
- Second Floor - Chemistry.
- Third Floor - Biology, Mineralogy, Mining, Geology, Physics, Chemistry (open air work).

All which we humbly submit for Your Majesty's gracious consideration.

(Signed) DEVONSHIRE
LANSDOWNE.
JOHN LUBBOCK.
J. P. KAY-SHUTTLEWORTH.
B. SAMUELSON.
W. SHARPEY.
G. G. STOKES.
HENRY J. S. SMITH.
*T. H. HUXLEY.

* The Chairman has been authorized by Professor Huxley to affix his name to this Supplementary Report.

J. NORMAN LOCKYER,
Secretary.

28th February 1872.

SECOND REPORT.

TO THE QUEEN'S MOST EXCELLENT MAJESTY.

MAY IT PLEASE YOUR MAJESTY,

WE, the Commissioners appointed by Your Majesty to make inquiry with regard to Scientific Instruction and the Advancement of Science, humbly beg leave to present to Your Majesty the following Report on Scientific Instruction in Training Colleges and Elementary Day Schools under the Education Department, and in Science Classes under the Science and Art Department.

I.—SCIENTIFIC INSTRUCTION IN TRAINING COLLEGES AND ELEMENTARY DAY SCHOOLS.

STATE OF INSTRUCTION PRIOR TO THE INTRODUCTION OF THE REVISED CODE.

1. In dealing with the Scientific Instruction in Training Colleges and Elementary Day Schools, Your Commissioners have, in the first place, enquired what provision was made for such instruction before the introduction of the Revised Code in 1861.

2. With respect to the *Training Colleges*, we find that instruction in the elements of science was given to students in their second year. The Committee of Council on Education made grants in aid of the stipends of masters specially qualified to teach the elements of science. In some training colleges a sound, though limited, instruction in the elements of some branches of physical science was thus added to the usual instruction in elementary mathematics. In the model schools attached to the training colleges the students were practised in teaching the rudiments of science, chiefly, though not exclusively, in illustration of appropriate lessons in reading and geography, with obvious advantage in the increase of the intelligence of the scholars and of their interest in their schoolwork. Such instruction enabled skilful teachers to make the lessons the occasion of conveying important explanations of natural phenomena, and some rudimentary acquaintance with the most easily understood laws of nature; although neither in the training colleges, nor in the model schools attached to them, were the methods of communicating the rudiments of scientific knowledge by means of systematised object lessons always sufficiently cultivated. The scientific instruction received by the teachers in the training colleges was, however, of great value irrespectively of such use in the rudimentary lessons; for all such knowledge tends to enlarge the intelligence of the teacher, and enables him to give better and more interesting instruction.

3. With respect to the *Elementary Schools*, we find, as a consequence also of the instruction thus afforded to the teachers, that it was the practice formerly, more generally than at present, in the best of such schools to give, either in separate oral lessons or as parts of the illustrations of the reading lessons, general outlines of physical geography, some of the more prominent facts in astronomy, and instruction in those parts of domestic and social economy which affect the health of families and communities. In some remarkable schools more extensive instruction of this character was given, just as more advanced literary culture was given in others. Under Professor Henslow, for instance, botany was found an excellent method of training the powers of observation and the intelligence. In like manner, in a school comprising, besides the children of labourers, the children of small farmers and tradesmen, Dean Dawes* gave instruction in applied mathematics and mechanics, as well as in some of the elements of experimental physics.

4. It is, no doubt, true that the success obtained in these schools was due to the guidance and the direct personal teaching of men of superior education, having an earnest and even singular interest in the attainment of this result, and a capacity much beyond the average of that of elementary school teachers. We concur, however, in Canon

* See Canon Moseley's Report on King's Somborne School in the "Minutes of the Committee of Council on Education," for 1847-48, Vol. I., p. 7.

Moseley's opinion that, even without such exceptional advantages, the system pursued in these schools may be conducted by well-trained teachers of average capacity with good effect. Indeed, we have the evidence of highly competent authorities to show that the scientific instruction which was given by ordinary elementary school teachers, before the introduction of the Revised Code in 1861, was in many cases sound and valuable in itself and beneficial to the pupils.

Questions
7903-8031,
pp. 542-551.

Questions
8032-8099,
pp. 551-559.

Qu. 8033.

5. In order to show more distinctly the state of Scientific Instruction in Training Colleges and Elementary Schools before 1861, we proceed to give some extracts from the evidence of the Rev. Dr. Rigg, Principal of the Wesleyan Training College, Westminster, and of the Rev. Canon Cromwell, Principal of St. Mark's College, Chelsea.

Qu. 8033.

6. In the earliest schemes of the Training Colleges, arrangements were made that the students should have such a basis of scientific instruction as, in the words of Dr. Rigg, would enable them to give the children in "elementary schools information on various points of science which at that time were not generally taught in the school reading books, and, therefore, could only be done by oral lessons. The subjects were such as these: the structure and habits of remarkable animals and plants, short explanations of various scientific principles involved in manufacturing processes, as, for instance, the construction of some common machines, involving, of course, the principles of mechanics; together with points in physiology, as bearing on the preservation of health; instruction with regard to our own body and its organs; the atmosphere, and other such topics." In order to prepare the teachers for giving such instruction, the promoters of the Wesleyan Training College at Westminster, at its foundation, spent 200*l.* "in purchasing scientific apparatus." "Pure and mixed mathematics" were, "up to 1862, taught to an extent about equal to that required for a B.A. degree of the London University. One half of the second year's male students received some sort of systematic instruction in the elements of physics, and the other half in mathematics."

Qu. 7904.

7. The Rev. Canon Cromwell states, that, "between 1851 and 1861, there was a very great change both in the amount of assistance that the Government gave, and also in the character of the candidates who came for admission. The Minutes of 1846 began to tell on the Colleges. Those minutes provided for a system of apprenticeships to schoolmasters all over the country. The cleverest boys in the schools were selected to become pupil teachers. They received special instruction at the hands of masters, and for that instruction the masters were paid a certain sum by the Government. The result was, that the schoolmasters were stimulated to give as much instruction as they possibly could to their pupils, and the pupils came up to the College, in 1851 and subsequent years, with a very fair amount of mathematical knowledge. They came with a thorough knowledge of arithmetic, in all its branches, applied as well as theoretical, with a knowledge of algebra as far as simple equations, and sometimes as far as quadratic equations, with a knowledge of the first two books of Euclid, as a necessary condition of admission, and very often they brought up four books of Euclid, and not unfrequently they came up with some knowledge of Latin. There was here a good foundation upon which subsequent knowledge could be built. Such were the qualifications for admission into the college between the years 1851 and 1861; and during that time instruction was given in applied mechanics, in chemistry, in hydrostatics, and in optics. A laboratory was established, and a regularly paid and competent teacher was employed. Models of all the ordinary machines were bought, and the students were instructed in applied mechanics. Drawing was so taught as to be applied to the arts. The drawing master was an engineer of considerable experience, and a perfect enthusiast in the way of practical education." "I should say that in the year 1854, at the representation, I think, of Canon Moseley, who was once Professor of Mathematics at King's College, special encouragement was given to the teaching of applied science in Normal Colleges, by the establishment of lectureships for competent instructors, and those lectureships could not be obtained unless the lecturers passed a special examination before, I think, the Civil Service Commissioners. Every lecturer who did so pass (for instance, in chemistry, or in applied mechanics, or in any other subject of science) received 100*l.* a year from Government, in addition to the salary which he received from the Council or Committee of his College. That grant gave a very great stimulus to scientific instruction in the various Colleges. That 100*l.* a year was not paid, however, unless the lecturer continued to give satisfaction at the annual inspection of the College by one of Her Majesty's Inspectors. One of the Inspectors during a part of that period was Professor Moseley, and during the other part of that period Bishop Temple was Inspector."

These lecturers "taught^a solely in the College, and it was a condition they should^a Qu. 7905. have a fair salary from the College as well as the 100% augmentation from the Government." "A College of 30^b could not have more than one lecturer, and a^b Qu. 7906. College of 100 not more than three lecturers."

INFLUENCE OF THE REVISED CODE UPON SCIENTIFIC INSTRUCTION.

8. We now proceed to consider the influence of the Revised Code of 1861, which introduced the system of individual examination, proposed in the Minute of 1853. While we approve the principle that the grants to schools should be determined to a considerable extent by the results of individual examination, we are of opinion that the limitation of such examination to the subjects of Reading, Writing, and Arithmetic unfortunately narrowed the instruction given in Elementary Schools; and that this change, together with the lower standard adopted in the training and examination of Pupil Teachers, and the curtailment of the Syllabus of the Training Colleges, exercised a prejudicial effect on the education of the country.

9. Dr. Rigg observes that "if the Revised Code is considered to be identified merely Qu. 8083. with the principle of individual examination in schools, I do not doubt that, from the principle of individual examination in schools, very good results have followed; but that principle was recommended before the Revised Code was in existence." It had been previously recommended "that a certain proportion of the grant should be made dependent on individual examination," and a Minute had been drawn for that purpose in 1853, but not carried out; "therefore, I do not consider that the principle of payment after ascertainment of results was really the principle of the Revised Code. I think that the principle of the Revised Code was to restrict education as far as possible within the limits of those particular subjects on which payment was made. That was the governing principle of the Revised Code, especially as originally propounded in Parliament, and to discourage everything in the nature of higher education, and broader education, and deeper education; that it looked, in fact, to mechanical instruction in what are considered the three principal rudimentary branches. I have no doubt at all that many children were more or less neglected, and that in order to cure that, individual examination was necessary; but I believe that individual examination might have been had without the general spirit and scope of the Revised Code."

Dr. Rigg also expresses his opinion that the tendency of the Revised Code was Qu. 8084. "to compress the school age within very narrow limits, to discourage children attending school after 10 or 11 years of age, and to restrict the education of the children within hard and narrow lines."

10. The same witness also states, that though, between 1862 and 1867, scientific Qu. 8034. instruction was never given up in the Training Colleges, "there is no doubt that from 1862 everything suffered; our infant school processes suffered, and everything suffered more or less, perhaps owing as much to panic as to anything else; but many things were sacrificed in, I do not say the majority, but in a considerable proportion, of our schools, to what were considered to be paying results."

11. Canon Cromwell confirms this evidence by stating, "that before 1861 the inspectors Qu. 7930. were called upon to inspect in all the subjects which were taught in a school; but after 1861, as a rule, they did not examine except in those subjects which were prescribed by the Code of 1861 and 1862—reading, writing, and arithmetic, and some religious knowledge. That change caused the schoolmasters to cease from giving instruction in extra subjects."

12. In reference to Pupil Teachers and Training Colleges, Canon Cromwell states:— Qu. 7907. "In the year 1861 a great change took place. The amount of instruction encouraged and paid for in the Training Colleges was very much reduced, and those lectureships to which I have referred were all of them abolished. The Government has, for many years past, been in the habit of drawing up a Syllabus of the course of instruction to be followed in the various Training Colleges. That syllabus was very much curtailed in 1862. The special subjects, such as applied mechanics, physical science, and the higher mathematics, were all struck out, and the syllabus was reduced almost to the level that might be attained by a really clever boy in the first class of a good national school. The students were expected to have a certain amount of religious knowledge, geography, history, arithmetic, and two books of Euclid. At the same time, the amount of instruction given to pupil teachers all over the country was also diminished, because no longer were the masters and mistresses paid for giving instruction to pupil teachers, and the result was, that, in

- “ many cases, scarcely any instruction has since been given. In most of the Normal
 “ Colleges, certainly at St. Mark’s, and at Durham, where I was at the time, we
 “ struggled against that reduction in the subjects of the syllabus. We tried to retain
 “ the higher standard as long as it was possible with the students; we taught more
 “ things in the Colleges than the Government required; but year by year we found
 “ that the pupils who came in were worse and worse prepared, so that, at last, it was
 “ almost impossible to give anything more than the Government syllabus demanded.”
- Qu. 7908. “ The syllabus is almost the same that it has been since 1861. Under it, the pupil
 “ teachers, instead of being required to bring two books of Euclid into the College, are
 “ only expected to bring up one book, and, instead of being expected to go through
 “ simple equations, they are now not expected to have any knowledge of algebra; so
 “ that the whole standard, everywhere, from the National School up to the Training
 “ College, has been reduced in amount, making it extremely difficult for us to continue
 “ the higher style of education in the Training Colleges. The time given to the
 “ instruction of pupil teachers in each week was also reduced. Prior to 1861, the pupil
 “ teachers were to receive one and a half hours’ instruction on five days in the week, or
 “ seven and a half hours’ instruction in each week; but, subsequently to 1861, a pupil
 “ teacher was only required to have one hour a day, or five hours a week. But time
 “ was not the only thing that was reduced; the teachers had not the same interest or
 “ zeal in the matter, because they were no longer paid as before.”
- Qu. 7909. “ The pupil teachers might be instructed in the evening school along with the ordinary
 “ scholars, and that almost reduced the instruction to the level of an ordinary evening
 “ school.”

13. The general apprehension inspired by all these changes, rendered the profession of
 schoolmaster less popular. The education of the pupil teachers was generally impaired,
 fewer candidates were apprenticed, and the number of those who resorted to the Training
 Colleges fell off. So that, Canon Cromwell says, “ in the spring of 1869, instead
 “ of having 50 or 60 candidates for admission, we had, I think, only 34; and the
 “ College, instead of having 104 inmates, had less than 80 inmates. The Highbury
 “ Training College and the Chichester Training College were entirely closed; and the
 “ Colleges at Chester, York, Durham, Culham, Peterborough, and Exeter were scarcely
 “ half full. It was the case almost all over the country. The number of pupil teachers
 “ fell [at one period] from 13,000 to 6,000.”
- Qu. 7978.
- Qu. 7979.

14. It is right, however, to point out that the consequences to which we have referred
 have been in part obviated by the operation of the system introduced by the Science
 and Art Department. So strong was the conviction of the Principals of certain of the
 Training Colleges, that elementary scientific knowledge was of great value to their
 students, that, in the absence of any assistance from the Education Department, they
 prepared their students for the May Examinations of the Science and Art Department,
 and permitted them to attend those examinations, thus qualifying themselves to earn
 grants under that Department.

15. Thus, Dr. Rigg, speaking of the Wesleyan Training College at Westminster, says,
 that “ in 1868, 1869, and 1870, the encouragement given by the Science and Art Depart-
 “ ment had begun to tell so powerfully, that instruction was fully restored in those
 “ scientific subjects, and some classes of students in the Westminster Training College
 “ were presented for the May Examinations of the Science and Art Department, and
 “ there will be a large number of them this year. The subjects selected for such exami-
 “ nations were physical geography, inorganic chemistry, elementary mathematics, and,
 “ in part, theoretical mechanics, and, this year, animal physiology. Those were prepared
 “ as being in some relation to the ordinary course of training presented by the Com-
 “ mittee of Council on Education. The female students attempted nothing more than
 “ physical geography. Of course, that includes some instruction about the habits of
 “ plants, and about geology, and so forth. Some of the male students took four subjects,
 “ but the majority of them took only three.”
- Qu. 8083.

16. Among the impediments to higher instruction in Training Colleges, besides the
 restricted range of the syllabus of studies, the absence of sufficient indication of the
 objects and limits of the examination papers is also the subject of important evidence
 from Dr. Rigg, and Canon Cromwell. Dr. Rigg represents that the Principals or Com-
 mittees of Training Colleges have slender opportunities of making any “ deliberate repre-
 “ sentations upon the subject to the Committee of Council.” We are of opinion that
 “ occasional conferences on the syllabus might be useful, in giving the Department the
 aid of the practical experience of Principals, of Inspectors, and of Men of Science.”
- Qu. 8035.
 Qu. 7951.
 Qu. 8039,
 8040.

THE NEW CODE OF 1871.

17. The New Code of 1871 does not affect the Training Colleges except so far as relates to religious inspection, and, from the evidence we have taken, we fear it will practically have little effect in widening the range of the education in elementary schools; that, as heretofore, the grants will, in future, be almost wholly given for reading, writing, and arithmetic; and that little encouragement will be afforded to the study of other subjects, even of history and geography.

18. It is true that grants of 3*s.* each are offered for proficiency in any two "extra subjects," under which term the Committee of the Privy Council on Education include everything except reading, writing, and arithmetic; but no children can earn these grants unless they are presented for examination in Standards IV.-VI., and pass a satisfactory examination in two out of the three compulsory subjects. Now, no child can be presented in the first standard until it is seven years old, so that the fourth will not be passed before the 11th year. For children of this age, the standards for the extra subjects, as laid down in the schedule of the New Code (p. 19.), seem to us very low. For instance, in geography the requirements are "a knowledge of the chief divisions of the world and of the meaning of a map;" while, in history, the master is instructed to "select some chief event of importance in the history of England since the Conquest, and let the children know something about it in detail." The requirements in the other extra subjects are not more difficult, and we are of opinion that such examinations might easily be passed by children at an earlier age than 11, and that the grants for extra subjects might, therefore, be advantageously thrown open at an earlier period—at any rate, to children who are going in for the third standard. Such a modification in the Code could not interfere with the instruction in reading, writing, and arithmetic, because the grant for extra subjects is contingent on success in two out of the three elementary subjects. As regards the younger children, also, we consider that Her Majesty's Inspectors should be directed to satisfy themselves that such elementary lessons are given as would prepare the minds of the children for the more advanced instruction which will follow.

19. We now come to the case of the elder children. Those who are presented in Standards IV.-VI. may offer themselves for examination, and, if successful, will earn the grants of 3*s.* each offered for proficiency in any two extra subjects. But, on the other hand, it appears to us that the encouragement thus apparently held out is rendered, to a great extent, illusory by the other conditions of the Code. To make this clear, it is necessary to state the manner in which, under the Code, grants are earned. The sum of 6*s.* is granted for each scholar on account of attendance, and 4*s.* each for the three subjects, making 12*s.* for reading, writing, and arithmetic. Thus, each scholar can earn 18*s.*, apart from extra subjects, and as 14*s.* a head (or 15*s.* where music is taught) is the maximum payable, it is evident that schools can earn the whole amount without teaching any of the so-called extra subjects.

20. Indeed, it is obvious that if 75 per cent. of the children pass in reading, writing, and arithmetic, the school will earn the maximum grant, and, in fairly good schools, this amount of success has been, and we doubt not will be, attained without difficulty. Nor do we think it would be desirable that the standards should be raised in such a manner as to reduce the passes below this proportion; such a course would, we think, tend to discourage both the masters and pupils. The last Report of the Education Department shows* that the existing schools did, in fact, earn last year almost the full grant, without any assistance from the extra subjects, and those schools which are unable to pass the children in the elementary subjects are certainly not likely to be successful in others of a more advanced character.

21. We do not wish to underrate, in any way, the necessity of careful instruction in reading, writing, and arithmetic, as the very foundation of education; but we do not believe that the introduction of extra subjects would in any way interfere with it. Mr. Lingen, then Secretary to the Committee of Council on Education, stated before Mr. Samuelson's Committee on Scientific Instruction, in answer to Mr. Dixon,† that those schools in which extra subjects are introduced are most successful in teaching reading and writing; and Mr. Moseley, in his Report on the King's Somborne School, expressed it as his opinion that the slowness with which children in our elementary schools learn to read

* The total number of children qualified to earn grants was 1,090,611 (l. c. p. viii.). The number presented for examination was 887,041, of whom 810,911 passed in reading, 792,480 in writing, and 707,381 in arithmetic.

† *Minutes of Evidence taken before the Committee*, Qu. 756, p. 40.

is in some degree to be attributed to the unwise concentration of the labours of the school on so few subjects. With these opinions we are disposed to concur.

22. Although we are not at present prepared to recommend any change in the existing system under which the number of extra subjects is limited and the choice left to the school managers, we trust that the time may not be far distant when it may be possible to introduce a more systematic programme of instruction in elementary science.

23. Meanwhile, we submit that the scale of payments in boys' and girls' schools might be so arranged as to encourage the regularity of the attendance of the scholars; to promote the employment of a sufficient staff of teachers; and to ensure the success of the teaching of the three elementary subjects, while a sufficient reward was given for proficiency in the extra subjects. Even without altering the maximum of 15s., we conceive that scales of payment might be adopted by which it would be possible to afford adequate encouragement to humble rural schools; to increase the general intelligence of the scholars in all schools, and thus to make success in the teaching of the rudiments more certain, while the range of instruction was enlarged, and the standard raised.

GENERAL OBSERVATIONS.

24. From a consideration of the evidence we are of opinion that instruction in the elements of natural science can be, and eventually ought to be, made an essential part of the course of instruction in every elementary school.

25. The instruction to which we refer, though scientific in substance, should, in form, be devoid of needless technicality, and should be almost wholly confined to such facts as can be brought under the direct observation of the scholar. It should, in fact, be conveyed by object lessons, so arranged and methodized as to give an intelligent idea of those more prominent phenomena which lie around every child, and which he is apt to pass by without notice.

26. A course of object lessons of the nature here indicated could be given even to the junior classes of elementary schools, not only without in any way interfering with the efficiency of other instruction, but with the effect of aiding the general development of the intelligence of the children; and similar advantages would attend teaching of a like kind, but of a somewhat more advanced character, in the senior classes.

27. Canon Cromwell sets forth the nature and extent of rudimentary scientific instruction which can be given in elementary schools with teachers properly trained. Qu. 7982. "I know, by experience, that the elements of physical geography can be very well taught almost throughout the school." "Another subject which I find can be generally taught is drawing." "It is very useful because, as we all know, many boys go from the elementary school to various building trades or designing trades," or to "engineers' and machinists' offices." "I should like also to have mensuration taught generally." Also Qu. 7984. "a certain amount of natural science of an elementary character, remembering that it must always be given in a concrete shape with plenty of illustrations." "I think that Qu. 7985. "boys should be familiar with some of the simple machines and instruments, which could be explained to them by ordinary models, and they should know something of the common properties of matter—chemical attraction, capillary attraction, and so forth."

28. The scientific instruction thus afforded would, within the narrow limits to which it extends, give a sound acquaintance with the elements of physical science. It would, therefore, possess very considerable intrinsic value, especially in localities in which classes under the Science Department have not been established; while in those places in which Science classes are accessible, it would render the additional service of preparing the scholars for them, and thus enable the teachers to raise the standard of their instruction.

29. It is of great importance to remember that in order to render the scientific instruction in elementary schools as successful as possible, the teachers must not only have acquired the needful amount of scientific knowledge, but must also have been carefully trained in the special methods of teaching science.

30. A reasonable hope may be entertained that, as the methods of instruction are improved, and the skill of the principal and assistant teachers increases, the standard reached by very young children in infant schools may be much raised without any undue pressure. Moreover, if some of the principal objects for which the Education Act of 1870 was passed be attained, the greater regularity of the attendance of children at school; the economy of time attained by better teaching, and a larger staff of teachers

and the prolongation of the school age; will afford greater facilities for the introduction of elementary scientific instruction in the sense already explained.

31. In any case, there can be no good reason why such Elementary Scientific Instruction as has long been given in the Primary Schools of Germany and Switzerland should not be bestowed upon English children. The Report of Mr. Samuelson's Committee entirely confirms this opinion.

32. The London* and Liverpool School Boards have recently determined to make elementary physical science and social economy essential subjects in all the schools which they provide, and their example will not improbably be followed by other school boards.

33. While we are clearly of opinion that scientific instruction should form a substantial part of the curriculum of Training Colleges, we feel the great difficulty which arises from the present condition of the general instruction in those Colleges, as disclosed by the Reports of the Inspectors for the years 1870-71, extracts from which we have placed in a foot note.†

* The following is extracted from *The First Report of the Scheme of the Education Committee of the School Board for London*, p. 4.

"JUNIOR AND SENIOR SCHOOLS.

"We recommend that certain kinds of instruction shall form an essential part of the teaching of every elementary school; while others may or may not be added to them, at the discretion of the managers of individual schools, or by the special direction of the Board.

A. ESSENTIAL SUBJECTS :

- a. Morality and Religion.
- b. Reading, writing, and arithmetic; English grammar in senior schools; with mensuration in senior boys' school.
- c. Systematised object lessons, embracing, in the six school years, a course of elementary instruction in physical science, and serving as an introduction to the science examinations which are conducted by the Science and Art Department.
- d. The history of Britain.
- e. Elementary geography.
- f. Elementary social economy.
- g. Elementary drawing, leading up to the examinations in mechanical drawing, and to the art teaching of the Science and Art Department.
- h. In girls' schools, plain needlework and cutting out.

B. DISCRETIONARY SUBJECTS, which may be taught to advanced scholars :

- a. Algebra and geometry.
- b. Latin, or a modern language."

† [Extracts from the *Report of the Committee of Council on Education, 1870-71.*]

Extracts from the Report, for the Year 1870, by Her Majesty's Inspector, the Rev. B. Morgan Cowie, B.D. on the Church of England Training Schools for Schoolmasters:—

Battersea.—"The students of the second year fell below a fair standard of proficiency in grammar and mental arithmetic."

Carmarthen.—"The students of the second year fell below a fair standard in mental arithmetic, English grammar, geography, history, political economy, and Euclid. Their penmanship was also very inferior to what is needed to qualify a good teacher."

Carnarvon.—"The students of the second year did not pass creditably in mental arithmetic, English grammar, geography, history, or school management."

Chelsea—St. Mark's College.—"The students of the second year did not reach a fair standard in mental arithmetic, English grammar, geography, and Euclid. Their penmanship, also, judged by the copy setting, was of very low quality."

Cheltenham Training College.—"The students of the second year did not acquit themselves creditably in English grammar, mental arithmetic, English composition, and geography."

Chester Diocesan Training School.—"The examination at Christmas shows that the students fell below a creditable standard of proficiency in mental arithmetic, English grammar, geography, and economy."

Culham Training School for Masters.—"The students of the second year were below a fair standard in mental arithmetic and English grammar."

Durham Training College for Masters.—"The students of the second year did badly in mental arithmetic, grammar, geography, history, and Euclid."

Exeter Training College for Masters.—"The students of the second year did not reach a fair standard in these subjects: mental arithmetic, English grammar, geography, history, and Euclid. The copy setting (penmanship) of both years was very poor, the second year even being worse than the men in their first year."

Peterborough Training College for Masters.—"The students of the second year did not reach a fair proficiency in mental arithmetic, English grammar, geography, history, or Euclid. In penmanship neither years did as well as they ought to do for schoolmasters; the second year was in this respect inferior to the first."

Saltley Training College for Schoolmasters.—"The students of the second year fell below a fair standard in mental arithmetic, English grammar, geography, history. In penmanship they got a very low mark."

34. We have recorded the evidence which has been given as to the changes in the conditions of the grants of the Committee of Council on Education which interfered with the efficiency of the instruction of Pupil Teachers in Elementary Schools, and caused the colleges to be supplied with students imperfectly prepared, which deprived them of a staff of special teachers, which curtailed the syllabus, and reduced the standard of acquirements in the examination for certificates. In so far as these circumstances affect the preparation of teachers on subjects other than scientific, they fall within our province only because they militate against the introduction of the elementary forms of scientific

Winchester Training College for Schoolmasters. — “The students of the second year fell below a fair standard in mental arithmetic (although in this subject they gained more marks than many colleges), grammar, geography, and Euclid.”

York and Ripon Training College for Masters. — “The students of the second year fell below a fair standard in mental arithmetic, English grammar, geography, history, and Euclid.”

Extracts from a Report, for the Year 1870, by Her Majesty's Inspector, Matthew Arnold, Esq., D.C.L., on the Training Schools of the British and Foreign School Society in the Borough Road for Schoolmasters, and at Stockwell for Schoolmistresses:—

Borough Road College “For the second year students I find that the weak points are geometry, mental arithmetic, geography, and grammar. Less than 27 per cent. reached the mark of *fair* in Euclid, less than 14 per cent. in mental arithmetic, less than 5 per cent. in geography, and less than 3 per cent. in grammar. The results in these matters with the second year students of 1869 were better as regards Euclid and grammar, slightly worse as regards mental arithmetic and geography. Grammar, mental arithmetic, and economy are the weak points with the first year students this time.” “With the *Stockwell* students also mental arithmetic is a weak point.”

Extracts from the Report, for the Year 1870, by Her Majesty's Inspector, Scott Nasmyth Stokes, Esq., on the Roman Catholic Training School at Hammersmith for Schoolmasters:—

“The results of the ordinary examination held in December 1870, show that the second-year students obtained *moderate* marks for history and Euclid; and they were found *imperfect* in mental arithmetic, grammar, and economy, since in those subjects none got even fair marks.”

“The students of the first year were judged to be imperfect in mental arithmetic, grammar, and economy.”

Extract from the Report, for the Year 1870, by Her Majesty's Inspector, James Cumming, Esq., LL.D., on the Free Church Training School, Edinburgh:—

“In considering the tabulated results of the examination in reference to the different subjects of study, the conclusions are partly satisfactory, and partly of a somewhat perplexing if not startling nature. In regard to the most essential subjects, the reading, writing, arithmetic, religious knowledge, and teaching power, the results are generally good, with, perhaps, some deduction in the penmanship of the female students. But according to the table, while in composition 88 per cent. of the senior females, and 84 per cent. of the junior females, as well as 66 per cent. of the junior male students, have passed creditably, not one individual of the senior male students has passed as excellent, as good, or even as fair; the per-centage is an absolute blank. A similar result appears as to geography. Such a result would require very anxious consideration and inquiry on the part of the conductors of the institution, and would no doubt receive it, were it not so very extraordinary as to excite the suspicion that there must be some mistake. I am assured that this is not the case, and I can therefore only direct attention to the striking fact.”

TABULATED RESULTS OF EXAMINATION, CHRISTMAS, 1870.

Per-centage of Candidates examined who obtained Marks of Excellent, Good, or Fair.
Male Students of the Second Year.

Training School.	Mental Arithmetic.	Grammar.	Geography.	Penmanship.	Euclid.
Bangor - - - - -	8·33	—	—	75·00	58·33
Battersea - - - - -	29·73	10·81	43·24	48·65	37·83
Borough Road - - - - -	13·33	2·22	4·44	75·55	26·66
Carmarthen - - - - -	12·50	—	25·00	25·00	25·00
Carnarvon - - - - -	—	—	—	27·27	—
Chelsea - - - - -	6·90	3·45	6·90	31·03	13·79
Cheltenham - - - - -	21·05	—	21·05	63·16	55·55
Chester - - - - -	—	—	—	—	—
Culham - - - - -	8·33	—	25·00	58·33	33·33
Durham - - - - -	16·66	—	—	66·66	—
Edinburgh (Ch. of Scotland)	—	—	—	80·77	30·77
(Free Church) - - - - -	5·26	10·53	—	78·95	26·31
Exeter - - - - -	11·11	—	11·11	22·22	11·11
Glasgow (Ch. of Scotland)	—	4·54	4·54	81·81	40·90
(Free Church) - - - - -	10·00	—	30·00	70·00	30·00
Hammersmith - - - - -	—	—	—	73·33	20·00
Homerton - - - - -	—	—	—	60·00	—
Peterborough - - - - -	9·52	—	—	33·33	19·04
Saltley - - - - -	14·63	2·44	12·19	24·39	39·02
Westminster - - - - -	32·35	8·82	8·82	76·47	23·53
Winchester - - - - -	29·41	—	5·88	35·29	29·41
York - - - - -	8·33	—	—	50·00	8·33
Average per-centage - - - - -	13·41	3·17	10·48	56·09	28·36

instruction into the education of pupil teachers, and the re-establishment of scientific instruction as a part of the curriculum of training colleges.

35. We do not consider that the evidence which we have received is exhaustive or conclusive as to the causes which have led to the results which we have stated; but whatever may have been their origin, we fear that an extension of the curriculum, so as to include elementary science, could not be expected to succeed until the means of scientific instruction for the students are more complete, and until the students enter in a better state of preparation, or remain a longer period.

36. On the other hand, the extension of the time of education in Training Colleges would obviously raise questions of expense both with respect to the buildings and annual outlay. These questions may bring under consideration the expediency of adopting, to a greater or less extent, the alternative of instruction without board.

37. Before we leave this part of the subject, we think it expedient to state that the encouragement of instruction in the rudiments of natural knowledge in elementary schools falls properly within the province of the Education Department, and should be adequately provided for in the regulations of the Code issued under its authority.

Recommendations.

I. We recommend, as regards the elder children in the Elementary Schools, that the teaching of such rudiments of Physical Science as we have previously indicated should receive more substantial encouragement than is given in the Regulations of the New Code.

II. We recommend, as regards the younger children, that Her Majesty's Inspectors should be directed to satisfy themselves that such elementary lessons are given as would prepare these children for the more advanced instruction which will follow.

III. We recommend that the mode of instruction of Pupil Teachers; the conditions of admission to Training Colleges; the duration of the course of study in them; and the syllabus of subjects taught, should be so modified as to provide for the instruction of students in the elements of Physical Science.

II.—SCIENTIFIC INSTRUCTION IN SCIENCE CLASSES UNDER THE SCIENCE AND ART DEPARTMENT.

Origin and growth of the System.

38. Before the year 1859, elementary instruction in science was scarcely attainable by the working classes. Some of the principal mechanics' institutions of great towns had, from time to time, popular lectures on scientific subjects, which were frequently illustrated by experiments, diagrams, or specimens; but these lectures seldom extended to systematic courses. In very few of such institutions did any classes exist for collective instruction; scarcely any had laboratories; and whatever collections of natural objects existed were almost always ill-arranged and incomplete, even for the purposes of very limited instruction. Certain exceptions to this description existed, as, for instance, in Glasgow, Edinburgh, Manchester, Liverpool, and one or two institutions in London. But in smaller towns, and in manufacturing and rural districts, no such instruction was attainable except from one of the better educated schoolmasters, whose time, however, was otherwise sufficiently occupied.

39. The Department of Science and Art was constituted in 1853 by a Minute of the Treasury in consequence of the representations of the Board of Trade (under whose jurisdiction a Department of Practical Art was at that time included), and was placed under the Committee of Council on Education.

40. In 1859, the Department, thus constituted, originated a system of teaching by means of Elementary Science Classes and of payment on the results of the examination of the scholars. Examinations on a somewhat similar plan had been carried on by the Society of Arts, through local agency, in different parts of the kingdom; but, whilst encouragement was given to students by granting prizes for proficiency, the plan did not include any direct aid or encouragement to teachers. The object of the system introduced by the Science and Art Department was more comprehensive, for it proceeded to encourage the formation of a class of teachers of elementary science, and to stimulate and reward their activity by granting a payment, proportionate to attainments, for every pupil who passed an examination in one of certain successive stages of proficiency.

41. This system has given a remarkable impulse to elementary scientific teaching throughout the United Kingdom, some indication of which will be gathered from the

following table, showing the number of schools and persons under instruction in successive years:—

			Number of Schools.			Number under Instruction.
1860	-	-	9	-	-	500
1862	-	-	70	-	-	2,543
1864	-	-	91	-	-	4,666
1866	-	-	153	-	-	6,835
1867	-	-	212	-	-	10,230
1868	-	-	300	-	-	15,010
1869	-	-	523	-	-	24,865
1870	-	-	799	-	-	34,283

Teachers.

42. As the introduction of the system coincided with the period in which the masters of elementary schools were under great apprehension as to the reduction of their emoluments, and did often actually suffer considerable loss, they naturally availed themselves of the opportunity offered by a Department of the Government to increase their income by teaching science classes in the evening. This course was open to them if, either by their own unaided personal exertions and private studies, or by attendance on elementary science classes, they could acquire sufficient knowledge to enable them to pass whatever examination was required.

43. A special examination was originally instituted for teachers, and a certificate was issued recognising the amount of knowledge which they had obtained. But, subsequently, the Department relied to such an extent upon the examination of the papers of the pupils in the several classes as to regard the special examination of the teachers as, "to a great extent, unnecessary." Any student of an elementary science class recognised by the Department, if he pass in the advanced classes of the annual May examination, is now deemed to be qualified to teach, and may, by presenting pupils at a subsequent examination, earn by their success the grants given by the Department.

44. Under these conditions an elementary schoolmaster could, with the consent of his school committee, open his schoolroom in the evening for the instruction of the youth and adults of the working classes in his vicinity. Many scholars in his own more advanced classes passed from the elementary school at once into the evening school, and he gathered about him others who had been his pupils in previous years. The knowledge of the existence of such a class spread to others whose education had been neglected; and some who were desirous to fit themselves for positions in manufactures or trade requiring some elementary scientific knowledge, resorted to these classes as a first step towards the attainment of that object.

45. The number of teachers in March 1871 was 957. From a return made at a somewhat earlier period to a circular issued by the Science and Art Department at the suggestion of this Commission,* it appears that, of the 867 qualified science teachers employed at the date of the return, 556 were day-school teachers. Of these, 429 were certified as elementary school teachers by the Education Department in Whitehall or in Dublin, and 112 possessed no such certificates. One large section of the masters of day-schools who conduct science classes in Great Britain has passed through the Training Colleges, and, up to 1861, as we have already observed, had in many of those colleges an opportunity of obtaining an elementary knowledge of one or two branches of science. Such masters have had experience in teaching, and possess considerable knowledge of the organisation, discipline, and methods of instruction adopted in elementary schools. The masters who have left the Training Colleges since 1863 have passed through a more limited course of study, but they have recently been stimulated to acquire some knowledge of science in the elementary classes under the Science and Art Department.

46. We feel that the experience and skill of even an uncertificated teacher, and the previous literary training of certificated teachers, qualify them to acquire an elementary knowledge in the existing elementary science classes with a greater degree of success than inexperienced students. When they take charge of science classes, the skill they have acquired in giving instruction cannot fail to increase their success as teachers, especially in promoting the development of the intelligence of the pupils.

* See Appendix XII., p. 44.

47. There remain, according to this return, 311 private teachers, who are not day school teachers, of whom 259 are persons having other employments in the daytime. These occupations are commonly those of tradesmen's clerks, surveyors' assistants, draughtsmen, mechanics, or handicraftsmen, or persons employed in such trades as dyeing or calico printing. In these last, the work affords some opportunities for acquiring skill in chemical manipulation. It is probable that, notwithstanding the want of training in the management of classes, and in teaching, and the occasional want of literary qualifications, many of these teachers have rendered valuable service. We are also informed that 79 hold honorary science certificates; that 33 of them obtained certificates according to the method of examination in use previously to 1867; and 176 have qualified according to the system now in use by passing in the advanced classes at the May examinations, while 23 hold the certificates awarded in consequence of the examination previously to 1867 in some subjects, and have qualified in other subjects at the present May examinations by passing in the advanced classes. We have no information as to what is the relative scientific knowledge of the several classes of teachers.

48. The steadily increasing stringency of the examination, ensured both by the character of the questions and the requirements of the examiners as to the answers, has doubtless had considerable influence on the qualifications of the teachers. The operation of the system has been marked by a progressive improvement in the answers to the examination papers.

49. While the increased stringency of the examinations to which we have already referred supplies a powerful motive to the teachers to improve themselves, an important opportunity of such improvement is afforded by the system recently introduced by the Department of supplying courses of lectures in the metropolis, with opportunities of practical instruction, which science teachers are aided in attending by a grant towards their expenses. The initiation of this system is thus described :

“ In accordance with the terms of the Minute of 11th March 1869, two courses of six lectures each to science teachers were delivered : one of them, on *Light*, by Professor Guthrie, was given at the Royal School of Mines, Jermyn Street, on the evenings of the week ending the 3rd July; the other, on *Animal Physiology*, by Dr. Michael Foster, prefaced with an introduction by Professor Huxley, in the Lecture Theatre of the South Kensington Museum, during the following week.

“ These lectures were specially meant to instruct teachers in the art of teaching, making their experiments, &c.; and special pecuniary assistance was given to enable teachers generally to avail themselves of the opportunity, which 253 did. Of these 169 attended both courses, 35 that on *Light* only, and 49 that on *Physiology* only. The total numbers attending the two courses were, therefore—*Light*, 204; *Physiology*, 218. Admission to the lectures was also given to various other persons connected with education, including several Principals and Tutors of Training Colleges who made application for it.

“ Simultaneously with the delivery of these lectures a short course of practical instruction in the laboratory of the Royal College of Chemistry was given by Dr. Frankland and Mr. Valentin, permission to avail themselves of which was given to 153 teachers.”

50. In 1870 short courses of lectures, of a similar character, upon chemistry and experimental physics were delivered by Dr. Frankland and Professor Guthrie, and were accompanied by six days' work in the chemical laboratory for each teacher who came up for instruction.

51. In the year 1871, the Lords of the Committee of Council on Education, “ finding “ that the special courses of lectures on teaching science have been very successful, and “ highly appreciated by the masters for whose benefit they were instituted,” provided for an extension of this kind of instruction in biology and in experimental physics.

52. The course on *Biology* was commenced by Professor Huxley on the 14th of June; and the course on *Experimental Physics* by Professor Guthrie on the 5th of July. Each course lasted six weeks, and was attended by between forty and fifty persons.

53. Oral instruction was given by the Professors in the form of lectures or otherwise; but the most important feature of the course was the practical work through which every one under instruction was made to pass, and which occupied four or five hours of each working day.

54. In giving this practical instruction, each Professor was aided by several highly competent Demonstrators.

55. We are of opinion that the arrangements for the instruction of teachers, thus briefly described, have already been of material benefit, though, as yet, they have been attended by no great number of teachers; and that they may be continued and extended with every prospect of advantage.

Buildings and Apparatus for Teaching.

56. Excepting when building grants are given, no restriction is placed upon the character of the room or building in which the class may be held. To quote the words of Mr. Cole, "it might be held in a garret or in a cellar." Neither is it required that a typical collection of specimens, apparatus for the illustration of instruction, or for acquiring skill in the use of instruments, or a laboratory for practice in manipulation, should be attached to an elementary science class. Such requirements would obviously, at the origin of the system, have proved insurmountable hindrances to the formation of these classes in the great majority of instances.

57. Science classes conducted by certificated and uncertificated day-school teachers are commonly held in day schoolrooms, which are generally sufficiently commodious, and are frequently furnished with well-arranged desks and benches, with black-boards, and easels, and the other ordinary apparatus of elementary instruction.

Subjects Taught.

58. The subjects taught are as follows :

Subject	1. Practical Plane and Solid Geometry.	Subject	13. Mineralogy.
	2. Machine Construction and Drawing.		14. Animal Physiology.
	3. Building Construction.		15. Zoology.
	4. Naval Architecture and Drawing.		16. Vegetable Anatomy and Physiology.
	5. Pure Mathematics.		17. Systematic and Economic Botany.
	6. Theoretical Mechanics.		18. Principles of Mining.
	7. Applied Mechanics.		19. Metallurgy.
	8. Acoustics, Light, and Heat.		20. Navigation.
	9. Magnetism and Electricity.		21. Nautical Astronomy.
	10. Inorganic Chemistry.		22. Steam.
	11. Organic Chemistry.		23. Physical Geography.
	12. Geology.		

59. The teachers in the several schools are aided in their course of instruction by a Syllabus carefully prepared by the eminent scientific men who act as examiners, setting forth the range of study required, so as to enable the pupils to prepare for examination.

60. The syllabus is, in fact, a valuable outline of a course of elementary scientific instruction, suitable to the working classes. It is the result of the experience of men who have devoted themselves for many years to the teaching of science.

Examinations.

61. From the memorandum printed in our Appendix III. (*p. 6.*), with regard to the preparation of the papers for the science examinations of May 1870, it appears that there are three papers in each subject: A., an elementary or first stage paper; B., an advanced or second stage paper; and C., an honours paper. The examiners frame their papers with a view to discourage and detect mere cramming.

62. The examination is conducted under the superintendence of local committees.

63. All students in the science classes are required to present themselves for examination in the elementary stage before they come up in the second or advanced stage. The elementary paper is intended to meet what may be expected to be the reasonable results of one or two years' instruction of lads of from 13 to 14, and artizans who attend classes during the winter evenings. The paper, however, covers a wide range, so as not only to reward the teachers who, by careful instruction of the duller pupils, enable them to pass in the lowest class, but, likewise, in the case of the better informed and more intelligent pupils, to secure the higher grants to the teacher where they pass in the first class.

The advanced paper is intended to test what may be regarded as a reasonable amount of progress in knowledge after another year's instruction.

The honours paper requires for success more efficient means of instruction than are commonly afforded by the elementary science classes, and is adapted to the acquirements of highly advanced students, teachers, and candidates for the Whitworth and other scholarships.

64. The examination papers are privately printed, and are distributed by post in sealed packets addressed to the proper officers of the several committees of elementary science schools throughout the country.

65. On the evening of an appointed day, the seal of this packet is broken in the presence of at least three members of the committee, and the papers are distributed to the several candidates assembled. The papers are worked in the presence of three selected members of the committee, in order to prevent any assistance being given to any student. The examination, excepting in two subjects, lasts three hours—from 7 till 10. The written answers are collected, sealed in the presence of the Committee, and returned by post to the office of the Department. The duties of the committee may

extend over eight or ten successive evenings, when several separate subjects have been taught. The mode of appointment of the committees from which these members are selected, is obviously important as a means of preventing any breach of rules in the conduct of the examination. The regulations of the Department, as to the constitution of the committees, are carefully drawn, and, if carried out in the letter and in the spirit, would ensure an occasional visitation of the classes while under instruction, and would effectually prevent any unfair proceedings at the examinations.

66. The Department acknowledges the attention of the Local Committees at the period of examination. "It is through their agency that more than 2,000 examinations were held in all parts of the country in 1869. Mistakes and irregularities have in some cases occurred, as might be expected, from the novel nature of the duties to some gentlemen." The employment of 60 or 70 officers of the Corps of Royal Engineers as Local Inspectors has, as in the previous year, been of great service in assisting the Local Committees, and seeing that the rules were strictly adhered to. In this way about 500 of the examinations were visited.* "By these means several cases of irregularity were" (as Mr. Iselin reports) "brought to the knowledge of the Department."

67. Mr. Iselin remarks that "a periodical inspection of the science schools and classes has always been found useful in preventing the spread of irregularities, and in controlling the appointment and action of the Local Committees, over whom, otherwise, the Department, from want of special local knowledge, could exercise no authority."†

68. We are informed that the Department has had under its consideration the question whether School Boards established under the Education Act, 1870, might not be of service in the appointment of Committees, and in the selection of the members to be present at the examinations, as well as by the attendance of their own officers.

69. The same scientific men who prepare the syllabus of studies and the examination papers, are likewise charged with the duty of reporting on the results. They nominate, for appointment by the Department, assistant examiners, and their suggestions in this respect are in practice adopted. As in eight of the subjects above 2,000 papers have to pass under their scrutiny, these papers are divided by the chief examiner among his assistants. As the papers are distinguished only by numbers, the examiners have no knowledge of the classes or schools from which the papers come. The assistants receive instructions from the chief examiners as to the mode of conducting their work, so as to secure uniformity. Certain of the papers are taken as examples, and the amount of marks to be allotted is determined in a preliminary conference between the chief examiner and his assistants. When each assistant has completed his work, it is reviewed in all special cases by the examiner. The honours papers are read, and the marks for these are awarded by the chief examiner himself.

70. Out of 29,928 elementary and advanced stage papers examined in 1870 (*Eighteenth Report of the Department*, 1871, p. 57.), 25,200 were presented in the elementary stage, and of these 11,835 failed. Of 4,728 papers examined for the advanced stage, 1,723 failed. The per-centage of failures in the elementary stage was 46·96, and in the advanced stage, 36·44. The proportion in successive years is indicated in the following table, extracted from the 17th and 18th Reports of the Science and Art Department for 1870, 1871 (p. viii. in both).

	Number of individual Candidates who presented themselves for Examination.	No. of Papers worked.	No. of Papers passed.	Prizes.
1867	4,520	8,213	6,013	3,453
1868	7,092	13,112	8,649	5,246
1869	13,234	24,085	14,550	1,969
1870	16,515	34,413	18,690	3,108

71. The prizes consist of four medals (one gold, one silver, and two bronze); Queen's prizes (books or instruments); scholarships of 5*l.* (to assist in the instruction of deserving students); local exhibitions—grants of 25*l.* per annum for one, two, or three years, where the locality raises a like sum by voluntary subscriptions (to enable students to complete their education at some college or school where scientific instruction of an advanced character may be obtained); and Royal exhibitions (tenable for three years) to the Royal School of Mines, London, and the Royal College of Science, Dublin. Free admissions to the last-named institutions are also given to all gold medallists.

72. A table communicated by Captain Donnelly gives the ages of 34,336 students examined in 1870, and the number who passed at each age.

* *Seventeenth Report of the Department* (1870), p. x.

† *Seventeenth Report of the Department* (1870), p. 53.

73. Of those examined 4,739 were under 13, the age to which day-school attendance is required under the Factory Acts, and 7,746 were under 14, the age to which efforts have been made to extend the operation of those Acts.

74. Among these 7,746, there were 5,027 unsuccessful candidates. In considering this proportion due allowance must be made for age, but it would probably be improper to regard this result as a measure of the capacity for scientific instruction of boys up to this age. It must be taken into account that, for the most part, the scientific instruction received by the teachers themselves was elementary, their training imperfect, and that their classes were conducted without the aid of experimental or other illustrations.

75. An inspection of the table will show that the per-centage of success increases in each year up to candidates who were 20 years old, when it was 62·5, having been 62·3 in the preceding year. Between 12 and 13, one-third of the candidates were successful, and a somewhat greater proportion between 13 and 14.

AGES OF CANDIDATES who presented themselves for Examination, May 1870.

Ages.	Number of Papers handed in by Candidates of the respective Ages.	Number successful.	Per-centage of Successes in Nos. examined.
60	2	—	—
59	—	—	—
58	2	1	50·
57	—	—	—
56	—	—	—
55	4	—	—
54	4	3	75·
53	6	2	33·3
52	5	1	20·
51	5	2	40·
50	12	7	58·2
49	13	9	69·3
48	6	3	50·
47	21	12	57·1
46	18	13	72·2
45	30	14	46·6
44	31	15	48·3
43	33	19	57·5
42	48	26	54·1
41	34	20	58·8
40	58	31	53·4
39	63	41	65·07
38	86	39	45·3
37	93	49	52·6
36	128	61	47·6
35	127	75	59·0
34	172	93	54·0
33	157	84	53·5
32	209	127	60·7
31	268	148	55·2
30	393	218	55·4
29	350	203	58·
28	425	262	61·6
27	400	234	58·5
26	512	305	59·5
25	738	438	59·3
24	832	479	57·5
23	1,016	579	56·9
22	1,104	660	59·7
21	1,476	909	61·5
20	2,103	1,315	62·5
19	2,682	1,672	62·3
18	2,684	1,530	57·
17	2,270	1,175	51·7
16	2,440	1,251	51·2
15	2,654	1,277	48·1
14	2,876	1,274	44·2
13	3,007	1,164	38·7
12	2,572	890	34·6
11	1,397	451	30·9
10	599	175	29·2
9	142	34	23·9
8	29	5	17·2
Total	34,336*	17,395	50·6

* The discrepancy between this and the number given in p. 19 arises from an occasional double counting of papers, which cannot be detected at the time.

76. We have had before us certain of the Examiners: from them we have derived the impression already recorded, that substantial advantages result from the system of instruction pursued, but from the considerable proportion of failures which occur, as well as from the character of the answers given, the examiners are under the impression that a very large part of the instruction is derived from books, tested and aided by the class examinations of the teachers; and that it is not often illustrated by specimens or experiments, the use of apparatus, or the out-door study of nature. One of the examiners even complains that it is clear that the common expedient of the black-board and chalk is not used to illustrate instruction in geology. We have it in evidence that not only is scientific apparatus wanting, but that too often the teachers confine their instruction to the same routine of book learning and class questioning with which alone they were made familiar in the rudimentary classes in which they received their own imperfect elementary knowledge.

77. The examiners conclude that when there is a great preponderance of failures in any school, the teacher has systematically endeavoured to prepare his students by an almost exclusive exercise of the memory. Mr. Iselin confirms this impression by reporting that "this defect is most observable in science classes established in connexion with, and for the pupils of elementary schools, where the students are more immediately under the control of the teacher. In order to produce good results, the youth, and often the deficiency in primary education of his pupils, compels the teacher to cultivate their memory rather than their intelligence."* Teachers of elementary day schools are, as we have already observed, under strong inducements to found evening science classes, and the transfer of scholars immediately from the day to the evening schools is one chief means of filling those classes.

Inspection.

78. There are only two permanent Inspectors of Local Schools of Science and Art, and as their inspection extends to the Art as well as to the Science Classes, it is obvious that their supervision must be inadequate to provide any important check against irregularities, or to greatly influence the methods and means of instruction.

79. The Engineer Officers before referred to are employed as local inspectors, their only duty being to see that the regulations of the Department are complied with. They are not charged to report upon the methods of instruction adopted by the teachers, as to the degree in which that instruction is limited to text-books, and to class examinations, founded upon such book instruction, nor as to the comparative skill and knowledge of method, or assistance from apparatus or specimens, by which the success of the teaching may be promoted. But a system of inspection embracing these objects, yet without proceeding to systematic individual or class examination, would be of great value as a supplement to the May examination of the papers of the pupils.

80. Practical instruction in the science classes would be greatly promoted by more frequent inspection, followed by reports on the methods and apparatus employed, and the number of pupils receiving such practical instruction.

Payments on Results.

81. Payments are made by the Department on account of each successful student of the industrial classes,† at the rate of 1*l.* for every second class, in either the elementary or the advanced stage; of 2*l.* for a first class in either of these stages, or for

* *Seventeenth Report of the Science and Art Department* (1870), p. 57.

† The following definition of these classes is thus given in the 24th edition of *The Directory of the Science and Art Department*:

"Under 'Students of the Industrial Classes' are included:—

- a. Artisans or operatives in the receipt of weekly wages.
- b. Coastguards, policemen, and others who, though in receipt of weekly wages, do not support themselves by manual labour.
- c. Teachers of elementary schools in connexion with the Education Department, Whitehall, or the National Board of Education, Ireland. (*See exceptions in § XLVII., p. 17, and in the special rules applying to Irish National School Teachers, see p. 32.*)
- d. Persons in the receipt of salaries not large enough to render them liable to the income tax, as some descriptions of clerks, shopmen, &c.
- e. Small shopkeepers employing no one but members of their own family and not assessed to the income tax.
- f. Tradesmen and manufacturers on their own account, supporting themselves by their own manual labour, not employing apprentices, journeymen, &c., and not assessed to the income tax.
- g. The children (not gaining their own livelihood) of all such persons above mentioned.

No payments are made on account of any other students."

a second class in honours; and of 4*l.* for a first class in honours. "The payments to teachers on the results of the instruction of the artisan classes, as tested by these examinations, amounted in the year 1869, to 17,015*l.* 15*s.*, being at the rate of about 13*s.* 7*d.* for each person under instruction. In the previous year the rate paid was about 17*s.* 5*d.*."* In this way teachers were sometimes enabled to earn considerable sums, and in the 17th Report, 1870, the average payment to the teachers is stated to be 35*l.* a year, while one earned as much as 227*l.* 10*s.*, and the Bristol Trade School, with three teachers, earned, in 1869, 653*l.* Although we do not think that either the times of attendance, or the amount and sources of contributions in elementary schools can be strictly compared with those in science classes, it may be worthy of observation that the elementary schools are required to be open 400 times, and no grant is made for the elementary instruction of any boy or girl who has not attended 250 morning or afternoon meetings of the school, whereas the science classes are only required to be open 25 times in the year. The cost per head of teaching each scholar in an elementary school, calculated on the average attendance, ranges from 21*s.* to 30*s.*; but the average rate of grant was reduced by the operation of the Revised Code from 12*s.* 3*d.* to 8*s.* 6*d.* or 9*s.* per scholar, and the maximum grant attainable under the New Code cannot exceed 15*s.*, nor can it exceed one half the sum raised by fees and subscriptions.

82. The expenses are defrayed by school pence and contributions. We have grave doubts whether equivalent subscriptions could, at an early period, have been raised in support of the most improved forms of teaching in the elementary science classes. Nevertheless, we think it worthy of the consideration of the Department whether means could not be adopted to increase the resources of the elementary science classes by greater payments from the pupils, and by local contributions. This will become necessary in proportion as practical instruction is introduced. Though, in the earliest period, to have required local contributions, bearing some proportion to the grants, might have prevented the establishment of the classes, that danger ought, if the instruction is valued, gradually to cease to exist.

General Remarks.

83. The efficiency of the instruction given in the science classes has been diminished, on the one hand, by the imperfect organization of the classes, whether considered separately or in groups, and the absence of practical teaching; and, on the other, by the irregular and unsystematic manner in which scholars have taken up the subjects taught.

84. As an example of the efficiency of scientific instruction as an instrument in the education of boys belonging to the humbler middle classes, and from 12 to 15 year of age, we think it desirable to describe the Bristol Trade School, which was successfully developed under the guidance of the late Canon Moseley, who, both as a Professor at King's College, London, and, subsequently, as an Inspector of Training Colleges, has prolonged experience of such instruction.

Qu. 6338. 85. This school was designed for boys intended for "trades chiefly connected with the construction of machinery and building," or for general commercial pursuits.

Qu. 6338. 86. The school now contains 160 boys, who belong chiefly "to the manufacturing and mechanical trades." It comprises an elementary department of 100 boys, from 1 to 12 years old, who learn "nothing of science" "except a little practical geometry. These elementary classes are introductory to the science department, which is attended by 60 boys, who "pass from the elementary part of the school into the science part at about 12, and remain until the age of 15." "There are four masters" to the school, "each of whom takes his share in the general literary work." "There is on one master who is not engaged in both divisions." "One master devotes himself more especially to mathematics, another to descriptive geometry and its application to machinery and building structures, and to applied mechanics;" and the headmaster "to chemistry and experimental physics."

Qu. 6329. 87. The head master (Mr. Thomas Coomber) gives the following account of the instruction in the Upper Department: "We teach mathematics and the application of mathematics to mechanics and mechanism, descriptive geometry, and the application of descriptive geometry to machine drawing and building construction." "In addition

* *Seventeenth and Eighteenth Reports of the Science and Art Department of the Committee of Council on Education* (1870 and 1871), p. viii. in both.

“ to that, we teach chemistry, both inorganic and organic, and experimental physics, “ which includes electricity, magnetism, light, and heat.” Nothing systematic has yet been effected in the day school in the practical scientific instruction of boys in the laboratory. This, “as far as the day school is concerned,” is confined “to several “ boys who have been withdrawn from the school, and have become apprentices as “ chemists.” A mining school is connected with the trade school, and contains six Qu. 6334-6. pupils, who have the advantage of attending the scientific classes. A fifth master Qu. 6353. superintends this school. Considerable opportunities are afforded for practical observation, and for manipulation in the laboratory, in connection with the mining school. “ The boys who are educated” in the day school, “and leave at ages varying from 14 Qu. 6339. “ to 15, continue their education, after their day’s work, in the evening school.” Free exhibitions to the lectures of the Royal School of Mines in Jermyn Street have been Qu. 6342. awarded to three of the scholars, to enable them to pursue the scientific study of mining. One of the former mining scholars is “the manager of a colliery in South Wales; another “ is now engaged in the development of a coalfield at Natal; and the third used the Qu. 6343. “ education which he acquired at the Royal School of Mines in London to obtain a “ science scholarship at Cambridge, and is still at Cambridge.” The boys educated in Qu. 6349. the trade school “are, as a rule, doing very well indeed;” but so short a time has elapsed since the commencement of the school that instances of remarkable success can scarcely yet be expected.

88. The charges and resources of the school are thus described: “ Our fee is 3*l.* per year in the trade school, and in the mining school an additional 7*l.*, in all 10*l.* [in the Qu. 6355. “ mining school], so that our income for the past year will be very nearly 450*l.* from “ fees in the trade school only.” This is increased by subscriptions, and by the rent Qu. 6356. of the cellar, to a little more than 500*l.* a year, independently of the grants of the Science and Art Department. Out of the grants to science classes in this school in 1871 240*l.* 15*s.* were for the day school.

89. As an example of the grouping of classes for the purpose of introducing the services of more efficient teachers, we proceed to give a brief sketch of the organization of a group of evening classes formed in East Lancashire. These classes were in the first instance assembled for the purposes of elementary literary instruction, either in day school-rooms or in the rooms of literary and mechanics’ institutions. They were conducted at one period by three kinds of teachers. Besides the principal teacher, one of the most successful students of former years was appointed a local assistant teacher. These local teachers were for a time encouraged by a grant of 10*l.* annually from the Committee of Council on Education. They were aided by a pupil fulfilling the function in the evening school which a pupil teacher does in the day school. Such teachers were paid 5*l.* annually from a local subscription. We may remark, incidentally, that the training of such assistants in elementary science schools would greatly facilitate the introduction of practical instruction by the aid which they would give to the master in all mechanical details; while, on the other hand, such assistance would insensibly, but surely, impart such skill and knowledge as would give an impulse to the career of the pupil so employed.

90. The class, organized as we have described, was visited on one or two evenings in the week by a highly-instructed certificated master, qualified also to give elementary instruction in science under the Science and Art Department. A class in the ordinary rudiments of literary instruction, and another in the elements of science, were conducted by him at successive periods of the same evening, and the youths who had entered in the literary class, commonly, after having passed through that, proceeded to receive instruction in the science class, and became candidates in the science examination. By these expedients the services of a master of much greater experience, skill, and knowledge, were obtained for the entire group of science classes. Boxes of apparatus were provided by subscription aided by the grants of the Education Department, or the Science and Art Department, and the instruction by these means assumed a more practical form. The master of this group of schools gave, in the daytime, scientific instruction in a grammar school, and, on Saturdays, to a class for elementary day-school teachers, as well as in a private school. Efforts have been made to introduce a similar system into a few other districts.

91. As a remedy for the irregular and unsystematic manner in which students take up subjects for the study of which they are unprepared, the Science and Art Department on

the 24th November 1871, issued a Minute* suggesting the adoption of definitely arranged courses of instruction, and offering encouragement in the form of extra payments to the schools in which such courses are adopted. This minute will be of especial service to the teachers themselves, who have hitherto been in the habit of qualifying themselves successively in different subjects without sufficient regard to their connection.

92. In the preceding outline of the system of elementary scientific instruction which has rapidly sprung into existence under the Science and Art Department, we have recognised the high value of the schemes of instruction prepared for each branch of study by the examiners, as well as the skill and care with which they have superintended the examination of the papers by which the distribution of the grants has been determined, and have been enabled year by year to raise the standard of instruction. On the other hand, we have not concealed the imperfections, either of the organization or the working of this system, or of its results.

93. These imperfections seem to have been the unavoidable incidents of the mode in which these classes came into existence, and of their very rapid extension, notwithstanding many difficulties and obstacles. The undeveloped state of elementary education, and the defects of the only machinery available for the establishment of these classes, rendered necessary the experiment of employing whatever rooms and teachers were at hand. The degree of success attained in the enterprise of thus boldly opening, in spite of all obstacles, a path for the introduction of a system of elementary scientific instruction, is greatly due to the vigorous and able administration of the Department, and to the efficiency with which the examinations have been conducted.

94. The ground thus prepared may hereafter be occupied, step by step, with elementary science schools in well-constructed buildings, supplied with proper apparatus, and a sufficient staff of trained teachers. These schools may train assistant teachers, may group around them humbler classes, and aid them with apparatus and superintendence or instruction.

95. The first steps have been taken with such vigour, and the result has been to such an extent successful, that we confidently expect that, with needful guidance and encouragement, a thoroughly efficient system of elementary scientific instruction for the working classes may, ere long, be founded on this basis. Our recommendations show in what way, in our judgment, the existing system should be further developed.

Recommendations.

IV. We recommend that the instruction in elementary science classes under the Science and Art Department, be so arranged as to work in complete harmony with the general system of public elementary education, but, at the same time, we consider it important that the Education Department and the Department charged with Instruction in Science shall continue to be co-ordinate.

V. We recommend that a more efficient inspection of Elementary Science Classes be organized, and that the Inspectors should advise the Local Committees and report on :—

- (a.) The apparatus of instruction.
- (b.) The state of the discipline and methods.
- (c.) The general efficiency of the arrangements.

VI. We recommend that teachers who have already qualified by passing the May examination in either of the advanced classes shall continue to be recognised as qualified to conduct Elementary Science Classes, with the title of *Elementary Science-Teacher*, and to earn the grants awarded by the Department of Science and Art on the results of the examination of their scholars; but that this qualification and title shall in future only be attainable by passing in the first of the advanced classes.

VII. We recommend that should such arrangements as are herein-after set forth for conducting the practical instruction of teachers, and for providing for them practical examination at several centres, be adopted, all elementary science teachers shall, after such practical instruction, be admissible to a further examination, which, in all suitable subjects, shall be practical. We recommend that success in this examination shall entitle a teacher to a certificate of *Second Grade Science Master*.

* See Appendix XIX., p. 57.

VIII. We recommend that, as an inducement to teachers to prepare for and pass this further examination, payment for results in the case of a Second Grade Science Master be made at a somewhat higher rate than in that of the Elementary Science Teacher.

IX. We recommend that an examination, both by papers and by practical tests, in any group of allied subjects defined by the Department which the candidate may select, shall be open to all those teachers who have passed in the advanced classes, or who have been otherwise admitted as Science Teachers; and that success in this examination shall entitle the candidate to receive a certificate of *First Grade Science Master* in that group.

X. We recommend that a greater capitation grant be payable in respect of the scholars of a First Grade Science Master teaching in any group of allied subjects with or without assistance, than in respect of the scholars of a Second Grade Science Master, provided that the Inspector report that the apparatus is sufficient, and that practical instruction has been given in each suitable subject.

XI. We recommend that, with a view of maintaining uniformity of standard in these examinations, they shall be conducted at the several local centres by the staff of Examiners acting under the Science and Art Department.

XII. We recommend that the more systematic training of the teachers of science referred to, be provided for—

- (a.) By the adoption of special arrangements for this purpose in the Science School which has been referred to in our First Report; and by the recognition by the Department of similar arrangements for the instruction of this class of students in any University or College, and in Science Schools as herein-after described.
- (b.) By giving to the students of Training Colleges the opportunity of remaining a third year, during which scientific instruction may either form a principal part of the curriculum of such Colleges or be accessible in some adjacent College or School of Science approved as efficient for that purpose.

XIII. We recommend that the Science and Art Department be at liberty to dispense with the preceding examinations and to accord the privilege of First and Second Grade Science Masters in consideration of University Examinations in Science, or of a satisfactory course of study in Colleges in which Science is taught, as well as in other cases of obvious scientific qualification.

XIV. We recommend that in schools recognised as Science Schools, as herein-after set forth, facilities for the employment of Assistant Teachers be afforded as an experiment on a limited scale, some addition being made to the emoluments of the teacher in consideration of the instruction afforded; provided the Department be satisfied, on the report of an Inspector, that such assistant teacher has received practical instruction in subjects in which it is prescribed, and that he has been actively engaged in teaching.

To encourage the more advanced scholars to become assistant teachers under first grade masters in such schools, a small stipend, rising in successive years, might be granted on condition that a like sum was raised locally, subject to such conditions as the Department might deem expedient. The proportion of assistant teachers should not exceed one for every 15 successful scholars in any science school, and no scholar should be recognised as an assistant teacher until he has passed in the first division of the elementary class in the May examination.

XV. We recommend that, with a view of training First Grade Science Teachers, exhibitions of sufficient value and in sufficient numbers be offered to elementary science teachers and to assistant teachers who have served three years, and passed in the first division of the advanced class in the May examinations; and that such exhibitions should be tenable in any University, College, or Science School recognised in Recommendation XII.

XVI. We recommend that the grants made by the Science and Art Department for buildings be extended, under sufficient guarantees, so as to embrace institutions for scientific instruction, although they may not be built under the Public Libraries Act, or be in connexion with a School of Art.

XVII. We recommend that grants similar to those now made for apparatus be given for laboratory and museum fittings under proper guarantees.

XVIII. We recommend that whenever the arrangements for scientific teaching in any institution shall have attained a considerable degree of completeness and efficiency, such institution be recognized as a Science School, and be so organized as to become the centre of a group of elementary science classes; and to provide the assistance of First Grade Science Masters, the loan of apparatus and specimens, and the means of instruction in the laboratories and museums to the more advanced students of the group.

XIX. We recommend that assistance be given for the formation and maintenance of such Science Schools by special grants, the conditions of which shall be determined by regulations to be framed by the Science and Art Department.

XX. We recommend that when laboratories are attached to second grade grammar schools in the schemes issued by the Endowed Schools' Commissioners, the Trustees of such schools be encouraged and enabled to invite the formation of elementary science classes, to be taught therein.

All of which we humbly beg leave to submit for Your Majesty's gracious consideration.

(Signed) DEVONSHIRE.
 LANSDOWNE.
 JOHN LUBBOCK.
 J. P. KAY-SHUTTLEWORTH.
 BERNHARD SAMUELSON.
 W. SHARPEY.
 G. G. STOKES.
 HENRY J. S. SMITH.
 * T. H. HUXLEY.

* The Chairman has been authorized by Professor Huxley to affix his signature to this Report.

J. NORMAN LOCKYER,
 Secretary.

March 22nd, 1872.

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APPENDICES.

APPENDIX I. (See Question 2.)

PROPOSED MATERIALS for the SEVENTEENTH REPORT of the Science and Art Department of the Committee of Council on Education.

I.—AID GIVEN TOWARDS THE PROMOTION OF INSTRUCTION IN SCIENCE.

(a.) *Elementary Scientific Instruction.*

Extension of elementary scientific instruction.

1. A satisfactory increase continues to be maintained in the number both of the Science schools and of the students under instruction in them from year to year, as will be seen from the following table of the returns from 1865 to 1869:—

	No. of Schools.	No. under Instruction.
1865	120	5,479
1866	153	6,835
1867	212	10,230
1868	300	15,010
1869	516	21,500

In this table every institution in which scientific instruction is given is counted as a school, though the subjects taught and the number of classes in them vary much. In some instances a school consists of but one class, in which only one subject is taught, while in others there are 10 or more classes in different subjects. The 516 schools in 1869 comprised about 1,456 different classes. 12,988 students of these classes came up for examination in May, besides 246 self-taught students and pupils of classes not under certificated teachers. The results, as compared with those of the two previous years, are given below.

	No. examined.	No. of Papers worked.	No. of Papers passed.	Prizes.
1867	4,520	8,213	6,013	3,453
1868	7,092	13,112	8,649	5,246
1869	13,234	24,085	14,550	1,969

At the examinations for seafaring men, held in March, September, and December, about 50 persons were examined in addition to the above.

Examination.

2. The examinations were held in May at 437 centres, 389 provincial and 48 metropolitan. The payments to teachers on the results of instruction of the artisan classes, as tested by these examinations, amounted for the year 1869 to 17,015*l.* 15*s.*, being at the rate of 15*s.* 9*d.* for each person under instruction. In the previous year the rate was about 17*s.* 5*d.* The number of teachers paid was 486, the payments varying from 1*l.* to 236*l.* 10*s.*, the average being about 35*l.* per teacher. Grants were also made towards the purchase of apparatus, diagrams, and examples, amounting in the year to 357*l.* 15*s.* 5*d.*, being an increase of 21*l.* 13*s.* 0*d.* on the year 1868, when they amounted to 336*l.* 2*s.* 5*d.* Prizes and medals to the value of 711*l.* 18*s.* 8*d.* were awarded on the results of this examination.

Number of Science Classes.

3. The latest returns, March 1870, show that the number of Science Schools had increased to 810; of these, 561 were in England, 45 in Scotland, and 204 in Ireland. There were 2,204 classes in these schools, and the number of students taught in them was 29,956. This is an increase of 296 schools and about 9,000 students over the corresponding returns for the preceding year, and is irrespective of the Navigation Schools, which do not send up pupils for examination, and, therefore, receive no payments on results of instruction from the Parliamentary vote.

Whitworth Scholarships.

4. The first competition for the *Whitworth Scholarships* took place last May, and 106 candidates competed in the theoretical examination. Of these, 52 passed the qualifying examination, and 46 competed in the practical examination, which was held partly in London and partly in Manchester. In London, Messrs. Geo. Smith and Co., the eminent contractors, obligingly placed a portion of their workshops at our disposal for the practical examination; and in Manchester it was conducted at the works of the Whitworth Company. Sir Joseph Whitworth, Bart., under whose immediate superintendence the practical examination was conducted, expressed himself well pleased with the result.

Practical examination.

26060.

Col. Rich, R.E., one of the Inspectors of Railways for the Board of Trade, Mr. W. P. Marshall, Secretary of the Institute of Mechanical Engineers, and Mr. W. J. Hoyle, Secretary of the Whitworth Company, were the examiners appointed, on Sir Joseph's nomination, for the practical examination. The rules adopted for the practical examination in 1869, having been found rather cumbersome and expensive, we have, with Sir Joseph Whitworth's concurrence, made some changes in the method of procedure, the details of which will be found at page 24 of the Appendix to the 17th Annual Report.

5. It is satisfactory to find that the Minute providing for the establishment of local exhibitions, elementary school scholarships, and science and art scholarships, is being largely taken advantage of, notwithstanding that a local contribution is now, in all cases, required as an absolute condition of aid from the Department. Towards a local exhibition the locality and the State contributes each 25*l.* Three local exhibitions were competed for last year, and 10 have been applied for, and will be competed for at the present examinations. Towards the Elementary School and the Science and Art Scholarships the locality contributes 5*l.*, which is supplemented in the former case by 5*l.*, and in the latter by 10*l.* Of the Elementary School Scholarships, 29 were competed for last May, and 65 will be competed for this May. Of the Science and Art Scholarships, 47 were competed for in 1869, and 62 will now be competed for. These several exhibitions and scholarships, which enable the poor student to remain at school and pursue his or her education, will no doubt have a good effect.

Local Exhibitions, and Elementary and Science and Art Scholarships.

6. We think it only right to call attention to the great exertions of the Local Committees, on whose zeal in the carrying out of the system of State aid to science instruction so much depends. It is through their agency that the examinations are held in all parts of the country. More than 2,000 examinations were so held in 1869. When it is remembered that each examination entails the presence, generally, of three members of the committee from 7 p.m. till 10 or 11 p.m., and that the examinations take place in many districts night after night for eight or ten nights, and in some even oftener, the zeal and attention of the Local Committees will be appreciated. Mistakes and irregularities have in some cases occurred, as might be expected, from the novel nature of the duties to some of the gentlemen. The employment, however, of a large number of Officers of Royal Engineers as local inspectors has, as in the previous year, been of great service in assisting the Local Committees and seeing that the rules were strictly adhered to. In this way about 500 of the examinations were visited. Engineer Officers have also been this year employed in the preliminary inspection of Science Schools. Through their agency nearly the whole of the schools have been inspected and reported on. Besides enabling the Department to keep a check on the instruction given, the information contained in these reports has been of great service in facilitating the amalgamation of committees and schools for examination. This will effect a great saving, both in work and expense, to the central administration, and also diminish the calls upon the time of the members of the Committee.

Effective co-operation of Local Committees

Inspection by Officers of Royal Engineers.

7. In accordance with the provisions of the Minute of 11th March 1869 (see Appendix A., p. 27), advantage was taken of the teachers' visits to London to give them special instruction in the methods of teaching certain branches of Science. The instruction consisted of a course of lectures on the method of teaching Physiology in classes, by Dr. Michael Foster; a course on Light, by Dr. Guthrie; and one lecture and a short course of Laboratory practice by Dr. Frankland, at the Royal College of Chemistry in Oxford Street. Dr. Guthrie gave his course at the Royal School of Mines in Jermyn Street; Dr. Michael Foster, in the Lecture Theatre of the South Kensington Museum. The object of these courses was more especially to show easy and cheap methods of experimental demonstrations to classes. 253 students availed themselves of the lectures, 169 attended both courses; besides which, 35 attended the course on

Teachers visits to London.

Light only, 49 that on Physiology only, and 153 attended the College of Chemistry.

8. Building grants were first extended to Science Schools in 1868. They have during the past year been sanctioned to Keighley and Burslem, and applications for grants to Lambeth, Southampton, Portsmouth, and Kendal are under consideration.

9. The appointment of special Local Secretaries for towns where there are many examinations appears to be working well. We trust by some further changes next year to reduce the labour of the Committees still more. Further details with respect to the Science Division will be found in the Report of the Official Inspector for Science, Captain Donnelly, R.E., at p. 45.

(b.) *Advanced Scientific Instruction.*

10. *The Royal School of Mines.*—The number of students attending the entire course of instruction for the diploma of Associate during the session 1868-69 has been 17, inclusive of the Royal Exhibitioners. This was an increase of five on the number in the previous session. Occasional students, to the number of 93, have attended one or more of the courses, the number in the session 1867-68 having been 102. The details of the attendance are reported by Sir Roderick I. Murchison, Bart., K.C.B., the Director, at page 463 of the Appendix.

11. *The Royal College of Chemistry* continues to be overcrowded, and suffers much from want of space. Dr. Frankland reports that he has been compelled to refuse admission to many applicants. The students' laboratory contains accommodation for only 40, at the most; but arrangements having been made for receiving into the Laboratory of Research some few of the additional candidates for admission, the return of the number of students for the three terms of 1869 presents an increase of 20 on the attendance in 1868; the respective totals being 116 and 136.

12. *The Metallurgical Laboratory* in Jermyn Street, under the direction of Dr. Percy, has been attended by 35 students during the session 1868-69, as against 29 in the preceding session; but the attendance at this Laboratory also is restricted by the want of adequate accommodation. The Reports of Dr. Percy and Dr. Frankland are embodied in that of the Director at pp. 464 and 466 of the Appendix.

13. *The Evening Lectures* to working men, at the Royal School of Mines, have been attended by as many persons, as the Lecture Theatre will conveniently accommodate; the number of School Teachers attending the courses on Chemistry and Physics, specially intended for them, was 417, or 76 more than in the previous year.

14. *Royal College of Science of Ireland.*—The courses of systematic instruction in this College have been conducted, by the several Professors, in accordance with the programme appended to the annual report of the Dean of Faculty for the year 1868 (see 16th Report, p. 422). The Programme for the present session of 1869-70 (see App. p. 486) is the first in which the arrangements for the complete three years' course of instruction have been shown. The curriculum of study includes 14 subjects, and the total number of lectures delivered during the session ending June 1869 was 1,125. The number of individual students was 32, showing the material increase of 14 on that of the preceding session. The number of students pursuing the full three years' course for the diploma of Associate was the same as in the previous year, namely, 13. The results of the sessional examinations in 1869 are satisfactory; and one of the students subsequently gained a Whitworth Scholarship. Further information on this subject, and also respecting the museum of the College,—which has been visited during the year by 6,901 persons,—the Library, and the general administration of the Royal College of Science, will be found in the Report of Dr. Sidney, the Secretary, at page 497 of the Appendix. The Council express their confidence that, as the advantages of the technical training given in the Royal College of Science become more generally understood, the Institution will steadily progress in usefulness and popularity. (The Report of the Council will be found at page 485 of the Appendix.)

15. Courses of *Evening Popular Lectures on Science* were delivered by the Dean of Faculty and five of the Professors, at a fee of 6d. for each course. These lectures, which are entirely voluntary on the part of the lecturers, continue to be well attended; the total number of tickets taken in the past session have been 969 for the six courses. The evening course of Laboratory demonstrations in Practical Chemistry, intended for artisans and others employed during the daytime, was attended by 36 students.

16. *Royal School of Naval Architecture and Marine Engineering.*—The fifth session terminated on 30th April

1869. In consequence of the extension of the time for the course, as mentioned in our last report, from three to four years, there were few candidates for the Fellowship and Associateship among the students, and one candidate for the latter was admitted on the conditions laid down for those who wish to compete being already employed in the profession of Naval Architecture, or Engineering. No certificate was awarded. It appears from the report of the Inspector-General, the Rev. Joseph Woolley, LL.D., that sufficient time had not elapsed since this change to judge of its effect in improving the general character and amount of the knowledge of the students.

17. The privilege of attending the royal dockyards and factories was, as usual, accorded by the Lords Commissioners of the Admiralty to the private students during the four summer months from June to September, inclusive, with excellent results. The number of students during the session 1868-69 was 40, viz., 26 sent by the Admiralty and 14 private. The session 1869-70 commenced with 40 students, namely, 30 Admiralty and 10 private.

II.—MEMORANDUM of SUGGESTIONS for enlarging the System of State Aid to Scientific Instruction, drawn up in accordance with the Instructions of the Lords of the Committee of Council on Education prepared in 1867.

I.—The system and rules of the Science and Art Department for administering the grant for scientific instruction appear fairly to meet the requirements of one large class of persons. Sufficient aid is afforded, and encouragement thereby given to the elementary instruction in Science of the adult artisan class.*

II.—The development that this system has at present taken has been almost entirely in creating evening classes.† Being a pure system of payment on results, however, it is quite possible under it for schools for boys of 10 to 15 years of age to flourish, and to earn large payments, as, for instance, the Bristol Diocesan Trade School, the Bethnal Green Burbeck School, and the Glasgow Secular School do; but, as yet, few such schools have sought this aid. The reason is obvious. Schools cannot combine State aid to elementary and science instruction. It is only in large towns, and under peculiar circumstances, that day schools wholly devoted to secondary instruction can exist. Their establishment must be a work of time. The action of the Department has, therefore, been principally confined to promoting evening instruction in Mechanics' Institutions, and such places. Though payments are not made for the instruction of middle-class students, their instruction has incidentally been aided and encouraged by the establishment and existence of these classes affording them opportunities of instruction which did not exist before. Between 12 and 13 per cent. of the students in science classes, at present, are middle-class students.

III.—There remain two—as far as the machinery of education is concerned—broad classes but slightly affected by the present system of State aid to instruction in science. These are the younger artisan class—broadly the children of the weekly wage class—before they leave school, say of from 10 to 14 years of age; and the younger middle classes—the sons of the employers of labour and so forth, who are eventually to have the management and direction of works—before they leave school.

IV.—There can be no doubt that to meet the requirements of the day it is essential that there should be a more or less general diffusion among all classes engaged in productive industry of scientific, or, as it is sometimes loosely called, technical instruction—scientific instruction, that is; taken up from the point of view of its future application to industry, and not as a purely educational system.

V.—To meet the wants of the younger artisan class it appears to be only necessary to remove some existing restrictions‡ which prevent payments being earned for instruction in science given during the three attendances of

* The progress of the Science Schools since the passing of the general Science Minute, June 1859, is shown in the following table:—

Year	No. of Schools.	No. under instruction.
1860	9	500
1862	70	2,543
1864	91	4,666
1866	153	6,835
1867	213	10,230
1868	300	15,010
1869	516	21,500
1870	810	29,956

† The 213 schools in 1867 had 560 classes in different subjects. Of the 10,230 persons under instruction, 4,520 came up for examination, besides 400 persons not taught in classes aided by the Department, 8,37 papers were worked; 6,120 were passed.

‡ During the last two years, the training colleges have availed themselves pretty freely of the aid offered by the Department. The payments to them last year (1869) were 1,889. This year the amount will probably be greater.

§ Section XLIV. of the Science Directory.

Building grants.

Special Local Secretaries.

Royal School of Mines.

Royal College of Chemistry.

Metallurgical Laboratory.

Popular Lectures.

Royal College of Science of Ireland.

Increased number of students.

Museum and Library.

Progress of the College.

Evening Lectures.

Royal School of Naval Architecture.

an elementary school receiving aid. This restriction was imposed when the schools were aided under the old system, which; it was considered, justified and required some check of this kind. If teachers of elementary schools were permitted to earn payments for the instruction in science, as in drawing, of the more advanced students in these schools, the results of the present science system show conclusively that they would very soon form such classes, and would induce a considerable per-centage of the parents to allow their children to remain longer at school.

VI.—Probably, it would be advisable that the payments should be made through the Education Department, who would then have full control of the matter. The Science and Art Department, acting according to its present system, would simply have to make a return of the results of the examinations to the Education Office.

VII.—To meet the requirements of these schools, it would be advisable to have a sixth standard of examination above the present fifth class, and to make a payment of 10s. on passing it. Whether it would be advisable to make any restriction as to the subjects of instruction, or not, is doubtful. It is generally better to leave this to work itself out.

VIII.—It has not been the policy of the State in this country to aid or interfere with the education of the middle classes, except to some slight extent, and that indirectly, by State endowments in colleges.* The general opinion of the country, working through the Schools' Enquiry Commission and such agencies, can alone be looked to to make any important change in the way of introducing the study of science. Nothing, however, can have much effect on the grammar schools and middle-class schools of the country generally, until the Universities, which give the key of education in the country, allocate a fair proportion of their endowments to the reward of scientific studies. Till such knowledge "pays" at the Universities, the middle-class schools, which look more or less to them, cannot be expected to change their courses of instruction.

IX.—Should it, however, be considered good policy for the State to intervene more than it does at present in furthering scientific instruction among the middle classes, it would appear far more judicious to use existing machinery than to establish new. Money granted as endowments among the Universities and Colleges of the country would be more economically and effectively expended than in the creation of special State institutions.

X.—The instruction in the primary schools can, of course, only be of an elementary character. That in the adult night classes, though in some cases carried a little further, for want of time, means, and apparatus, cannot go to any depth. Such instruction, generally diffused, is of the greatest use; but it only goes far enough to warn people of the mistake they may fall into from sheer ignorance; to teach them not to be satisfied with mere empiricism; to show them how science may be applied to their work; and to induce them to follow it up.

XI.—The question then arises of providing instruction of a far more advanced character. The application of science to the arts can only be made by those who have a thorough knowledge of special branches. The masters, foremen, and others, who will take it up in this way, are necessarily but a small per-centage of those engaged in industry. Any of the poorer classes who show a special ability and aptitude for science can only follow it out if supported while pursuing their study. The richer classes can pay for their instruction. It is only necessary to provide the opportunity. Whatever the Universities and higher educational establishments of the country may do to afford instruction in science, the science will only form one portion of a general course of education. It would be foreign to their objects to afford advanced instruction in one special branch of science, and to grant diplomas to men who had not time or did not wish to pursue other studies, and whose general education was possibly very slight.

XII.—It is not, in the least, necessary that the institutions for giving this instruction should be spread about in country towns. The schools and classes attended by artisans at work, and boys living at home, can only be effective according as they are widely spread. But when it comes to the student's devoting his whole time, and being supported, it may as well be done in London as in Manchester, or Birmingham; and, besides the advantages of accessibility, etc., the best instruction can only be obtained in the capitals.

XIII.—A College of Science has lately been created in Ireland. The course of instruction, which lasts three years, is general, during the first two years, for all the students. During the third year it is specialized under the heads of

Agriculture, Mining, Engineering, and Manufactures. In England the only public institution, besides the Royal School of Naval Architecture, for advanced scientific instruction, is the Royal School of Mines in Jermyn Street. It has not quite as large a staff of professors as the College of Science in Dublin.

XIV. There are now eighteen Royal Exhibitions to these institutions competed for at the May examinations of the Department. They are of the value of 50*l.* per annum, and are tenable for three years. Six, therefore, become vacant every year. The fees are remitted, and the 50*l.* goes to support the student. They are most eagerly competed for. The number might with advantage be increased, at all events in a few years.

XV. *A very simple and, probably, effective extension of this action would be to allow that, wherever a locality raised funds to establish exhibitions to support deserving students in London or Dublin, the fees for instruction should be remitted for those students, and, perhaps, the local funds supplemented. Any place, Leeds for instance, organizing its system of elementary science classes in any way that suited its requirements, could then, for a few hundreds a year, support several of the most promising students here in London, where they would receive the best scientific instruction to be had anywhere.

XVI. The present constitution and the name, "School of Mines," prevent that institution from filling the position of an advanced school of general science effectually. At the same time, by far the larger portion of the scientific instruction given in it is general, and would form a course applicable to any industry. This is not known, and a proposition to send students there would, unless they were intended for mining, not be understood. The Royal School of Naval Architecture and Marine Engineering has not, as yet, any staff for instruction in Experimental Science. This instruction is given by lecturers appointed from year to year, and in a small temporary Chemical Laboratory. It is, therefore, most advisable that a College of General Science should be organized or constituted in London, on the plan of the Irish College of Science, to meet the requirements here indicated.

XVII. A change is most desirable in every way. It is greatly to be regretted that the admirable courses of lectures of the Professors at the Royal School of Mines are attended by so few students. Though the separate courses are in some cases fairly attended, there are only some five or six students entered, besides the Royal Exhibitioners, for the full course of the School, that is, for the Associateship. This must always be so. The field that a School of Mines applies to is but limited. It does not get known in the country, and even the separate courses are not taken, that advantage of which one would suppose.

XVIII. In time it may be found desirable to establish a third College of Science in Edinburgh, and, perhaps, a fourth in the North of England. There is no call for these, however, at present.

XIX. Much is said about the necessity for technical instruction, and efforts will, no doubt, be made to induce the State to supply it. It becomes, therefore, necessary to consider how far, if at all, the State can take this up advantageously, as distinct from the general scientific instruction previously considered.

XX. This action is proposed from two rather different points of view. The one proposal is to have a technical school adapted to the staple industry of a place; the other, apparently, to teach trades which do not exist there, with the idea of their introduction.

XXI. Real technical instruction—the teaching of a trade or art itself on scientific principles—necessarily entails workshops for practice. It would be scarcely possible to devise a more effectual blow to the manufacturers of a place than for the State to establish a really technical school for their trade, with its workshop, under no constraint to pay its expenses, underselling them and interfering with their market. A State pottery school and Messrs. Minton could not exist side by side. On the other hand, for the State to teach trades, where they do not exist, with the view of introducing them, and thereby most probably tempting them away from where they have established themselves, could, at the most, only be innocuous so long as it was ineffectual.

XXII. If, then, it were possible to keep pace with trade, the more efficient the schools were, the more injuriously would they affect private enterprise. It is, therefore, not necessary to dwell on the constant shiftings of trade,

* This suggestion has since been carried out by the Minute of the 21st December 1867. See end.

† A Commission, consisting of Lord Granville, Sir C. E. Trevelyan, and Mr. Lowe, decided, in 1868, that the instruction in the Royal School of Mines should embrace only those branches of general science which are applicable to Mining, and that it should be a special Mining School, similar to those on the Continent.

* Payments to Professors and Examiners, Exhibitions, Scholarships, Medals, and Prizes in the University of London, the Universities of Scotland, and the Queen's University and Colleges in Ireland.

ROYAL COMMISSION ON SCIENTIFIC INSTRUCTION, ETC. :—APPENDIX I.

according to the labour market, the difficulty of determining what was and what should be the staple industry of a place, and many other such points, which would render the administration of a system of technical schools an impossibility in this country.

XXIII. The only technical schools which the State can advantageously deal with are such as the Military Schools, the School of Naval Architecture and Marine Engineering, &c.—that is, where it may be said to be instructing apprentices for the purpose of itself employing them partially or wholly.

XXIV. With regard to general industry, it may be taken that the action of the State cannot safely go further than by aiding and encouraging instruction in general science,—of such applied science as Mining and Metallurgy. The Commission for the College of Science for Ireland laid down that its aim should be to impart a sound and thorough knowledge of those branches of science which may be applied to industry, leaving it to the student subsequently to specialise his knowledge, and turn his attention in the direction he may find most suitable.

XXV. The system of payment on results is so well established, permits of such complete freedom of action, is applicable to such a variety of *circumstances* of schools, and has borne such good fruit, that I take it for granted it will not be proposed to alter it.

XXVI. As much pressure may, however, be brought to bear on the Government, it is, perhaps, right to point out, that the experience of this Department has proved nothing more decisively than that, in the conduct of science or art schools, any general joint action between the State and the locality is sure to lead to difficulties. Whatever system of guarantees for salary, &c., may be invented, the fact that the liability is really limited to one of the partners is sure to have its effect. It is impossible for the State to withhold the whole grant, and close up the establishment, after it has been in operation a few years, because the locality does not comply with every tittle of its contract; and so matters go getting worse from year to year. If pure payments on results cannot be wholly adhered to, care should be taken that the Department is only committed to some definite piece of work when the locality has fulfilled its portion, and that no continuous partnership is entered into.

XXVII. In conclusion, it is only necessary to point out that aiding instruction in science on the plan now being followed, with the proposed extension, can and will aid pure technical instruction in the very best way. That is to say, if the masters of works will either separately or in combination establish schools for the instruction of their employes, the State, by paying on the results of elementary and scientific instruction, would assist in the instruction of the students just up to the point of their learning the absolute trade. There is nothing to prevent manufacturers, with energy and public spirit, establishing as good schools as those of M. Schneider at Creuzot, and obtaining as much Government aid towards them.

J. F. D. DONNELLY, Captain R.E.

12th November 1867.

III. SCIENCE INSTRUCTION.

- 1853. Department of Practical Art enlarged to Department of Science and Art.
- 1854. Science Schools proposed in Birmingham and Aberdeen. Teachers guaranteed Salaries.
- 1856. Commencement in Aberdeen, Bristol, Leeds, London, Newcastle, and Waterford, of Science and Navigation Schools. Examinations held and prizes awarded.
- 1859. Minute of 2nd June passed and first examination held in November for Science Teachers' Certificates. The only Science Schools existing at this time were at Aberdeen and Bristol, and these not largely attended; a few Navigation Schools were in operation.
- 1860. Nine Science Classes and 500 students under instruction.
- 1861. First May Examination held. Teachers paid on certificate allowance earned by results, with extra payments on all prizes awarded. 980 papers worked, about 650 individuals examined, and 1,330 under instruction in 38 schools.
- 1862. 70 Science Schools, and 2,543 under instruction.
- 1863. 75 Science Schools, and 3,111 under instruction. Payments on certificate allowance partially abolished.
- 1864. 91 Science Schools, and 4,666 under instruction. Payments on certificate allowance wholly abolished.
- 1865. 120 Science Schools, and 5,479 under instruction.
- 1866. 153 Science Schools, and 6,835 under instruction.
- 1867. November examination, or certificates as teacher

abolished, first and second class in May being taken to qualify for earning payments on results. 212 Schools examined, and 10,230 individuals under instruction. Minute Establishing Local Exhibitions and Scholarships passed.

- 1868. Building grants to be made to Science Schools. Grants made to teachers visiting London. 300 Schools examined, and 15,010 individuals under instruction.
- 1869. Courses of Lectures and practical instruction given to Science Teachers by Prof. Huxley, Frankland, Guthrie, and Foster. First examination for Whitworth Scholarships. 523 Schools examined, and 21,500 individuals under instruction.
- 1870. 810 Schools examined, and 29,956 individuals under instruction.

IV.—SCIENTIFIC INSTRUCTION.*

LOCAL AND CENTRAL SCHOLARSHIPS.

At Whitehall, the 21st day of December 1867.

By the Right Honourable the Lords of the Committee of Her Majesty's Most Honourable Privy Council on Education.

Present.—His Grace the Duke of Marlborough, Lord President of the Council. The Right Hon. The Lord Robert Montagu, M.P., Vice-President of the Committee of Council on Education.

My Lords consider the subject of scientific instruction with a view to its further encouragement and diffusion.

1. They refer to the Science Directory of the Science and Art Department, and to the Minute of the Education Department of the 20th February 1867, making additional grants for secular instruction to elementary schools.

2. In order to assist the artisan classes who may show an aptitude for scientific instruction, my Lords resolve to aid local efforts in founding Scholarships and Exhibitions. The Scholarship is intended to maintain the student while remaining at the elementary school, and the Exhibition to support him while pursuing his studies at some central institution where the instruction is of a high grade.

3. *Local Scholarships.* These are of two kinds, the Elementary School Scholarship and the Science and Art Scholarship.

4. *Elementary School Scholarships.* The Science and Art Department will make a grant of 5*l.* towards the maintenance of a deserving student to the managers of any elementary school who undertake to support him for one year, and subscribe also at least 5*l.* for that purpose.

5. *Conditions.*—

- a. With any number of scholars up to 100 on the register of the school there can be but one such Scholarship; above 100 and up to 200 two Scholarships, and so on for each 100.
- b. The Scholarship or Scholarships must be awarded in competition to the most successful student or students in some examination of the school. The absolute terms of the competition and the award of the Scholarship will be left to the managers of the school, subject to the approval of the Science and Art Department.
- c. The scholar must be an artisan or poor student as defined by the Science Directory, and be between 12 and 16 years of age.
- d. He must not be the teacher, pupil teacher, or other paid servant of a school.
- e. He must continue regularly to attend the day school, and—
- f. Pass in some one or more branches of Science at the succeeding May examination of the Science and Art Department, after which the Department grant of 5*l.* will be paid.

6. These grants will be made from year to year on the condition that the student each year passes in a new subject, or in a higher grade of the same subject in which he first passed. It will be for the locality to determine for how many years the student may hold the scholarship, but in no case can he be allowed to hold it for more than three years.

7. The Science and Art Department will hereafter consider such alterations in these conditions as appear necessary.

8. *The Science and Art Scholarships.* The Science and Art Department will make a grant of 10*l.* towards the maintenance of a student at an elementary school who has taken a first grade in Freehand or Model Drawing and Elementary Geometry (see Art Directory), and passed in one of the subjects of Science (see Science Directory).

9. *Conditions.*—

- a. With any number of scholars up to 100 on the register of the school there can be but one such

* Science Form, No. 275. South Kensington, December 1867.

- scholarship, above 100 and up to 200, two scholarships, and so on for each 100 scholars.
- b. The scholarship or scholarships will be awarded to the most successful student or students in the school.
 - c. The scholar must be an artisan or poor student, as defined by the Science Directory, of between 12 and 16 years of age.
 - d. He must not be the holder of an Elementary School Scholarship, the teacher, pupil teacher, or other paid servant of a school.
 - e. He must continue regularly to attend the day school, and—
 - f. Obtain at least a third class in the subject of Science in which he has already passed, or pass in some other subject.
 - g. In each year of holding the Scholarship he must pass either in a higher grade of the same subject, or in a new subject.
10. *Local Exhibitions.* The Science and Art Department will make a grant of 25*l.* per annum to the managers of any school or educational institution, or any local committee formed for the purpose, who will raise the like sum by voluntary contribution for the maintenance of a student at some college or school where scientific instruction of an advanced character may be obtained. The exhibition may last for one, two, or three years.

11. *Conditions.*—
- a. The exhibition must be awarded in competition in one or more branches of science at the May examination of the Science and Art Department. The managers may select any branch or branches of science for the competition, and if more than one be taken they may fix any relative amount of marks they consider best to assign to them.
 - b. The place where the student is to pursue his studies may be fixed by the managers, subject to the approval of the Science and Art Department. If a Government institution be selected, such as the Royal School of Mines or Royal College of Chemistry, London, or the Royal College of Science, Dublin, the fees of the student will be remitted.
 - c. The exhibitor must be of the artisan class, or a poor student as defined by the Science Directory.
 - d. The grant of the Department will be paid from year to year, on condition that a like payment has been made by the managers or local committee, and that the student has pursued his studies satisfactorily according to regulations fixed by the Department.
12. Transmit a copy to the Treasury, and request sanction to provide in the estimate for the increased expenditure likely to be occasioned by this Minute.

Note.—By elementary school is understood any school where elementary instruction is given, whether aided by the State or not.

APPENDIX II. (See Question 115.)

PARLIAMENTARY VOTES FOR SCIENCE for the Middle and Upper Classes in 1867–8, exclusive of the cost of the Queen's Colleges, Ireland.

UNIVERSITY OF LONDON.		£	s.	d.	£	s.	d.
Two examiners in Mathematics and Natural Philosophy, 200 <i>l.</i> each	-	400	0	0			
Two assistant examiners in Mathematics, 50 <i>l.</i> each	-	100	0	0			
Two examiners in Chemistry, 175 <i>l.</i> each	-	350	0	0			
Two assistant examiners in Chemistry, 25 <i>l.</i> each	-	50	0	0			
Two examiners in Experimental Philosophy	200	0	0				
" " Botany, 75 <i>l.</i> each	-	150	0	0			
" " Geology, 75 <i>l.</i> each	-	150	0	0			
" " Physiology and Zoology, 150 <i>l.</i> each	-	300	0	0			
					1,700	0	0
UNIVERSITY OF ST. ANDREW'S.							
Professor of Natural Philosophy	150	0	0				
" Mathematics	109	0	0				
" Chemistry	125	0	0				
					384	0	0
UNIVERSITY OF ABERDEEN.							
Professor of Chemistry	40	8	8				
Assistants	150	0	0				
Professor of Botany	300	0	0				
					490	8	8
UNIVERSITY OF GLASGOW.							
Professor of Mathematics	62	0	0				
Assistant	100	0	0				
Professor of Natural Philosophy	21	0	0				
Assistant	100	0	0				
Professor of Natural History	200	0	0				
" Chemistry	200	0	0				
Two assistants	200	0	0				
Professor of Botany	100	0	0				
" Civil Engineering and Mechanics	275	0	0				
					1,258	0	0
UNIVERSITY OF EDINBURGH.							
Professor of Mathematics	80	0	0				
Assistant	100	0	0				
Professor of Natural Philosophy	180	0	0				
Assistant	100	0	0				
Professor of Natural History	160	0	0				
" Botany	160	0	0				
" Chemistry	200	0	0				
					980	0	0
					£4,812	8	8

The amounts to each class of subjects were as follows:—

MATHEMATICS.		£	s.	d.	£	s.	d.
University of London	-	500	0	0			
" St. Andrew's	-	109	0	0			
" Glasgow	-	162	0	0			
" Edinburgh	-	180	0	0			
					951	0	0
CHEMISTRY.							
University of London	-	400	0	0			
" St. Andrew's	-	125	0	0			
" Aberdeen	-	190	8	8			
" Glasgow	-	400	0	0			
" Edinburgh	-	200	0	0			
					1,315	8	8
NATURAL AND EXPERIMENTAL PHILOSOPHY.							
University of London	-	200	0	0			
" St. Andrew's	-	150	0	0			
" Glasgow	-	121	0	0			
" Edinburgh	-	280	0	0			
					751	0	0
BOTANY.							
University of London	-	150	0	0			
" Aberdeen	-	300	0	0			
" Glasgow	-	100	0	0			
" Edinburgh	-	160	0	0			
					710	0	0
GEOLOGY.							
University of London	-	150	0	0			
PHYSIOLOGY, ZOOLOGY, AND NATURAL HISTORY.							
University of London	-	300	0	0			
" Glasgow	-	200	0	0			
" Edinburgh	-	160	0	0			
					660	0	0
MECHANICS AND CIVIL ENGINEERING.							
University of Glasgow	-	275	0	0			
					£4,812	8	8

No annual reports are made to Parliament of the results of this expenditure. Mathematics, natural philosophy, natural history, chemistry, mineralogy and geology, engineering, agriculture, anatomy and physiology, and political economy, are taught in the Queen's Colleges of Belfast, Cork, and Galway.

APPENDIX III. (See Question 152.)

CONFIDENTIAL MEMORANDUM with regard to the Preparation of the Papers for the Science Examinations, May 1870.

Prepared for the use of the Examiners.

I. There are to be three papers in each subject.*

- a. An elementary or first stage paper.
- b. An advanced or second stage paper.
- c. An honours paper.

The examination—except in subjects II. and III.—lasts three hours, from 7 p.m. till 10 p.m.

II. The successful candidates in the elementary paper, and the successful candidates in the advanced paper, are each divided into 1st and 2nd class, for which the teacher receives 1*l.* and 2*l.* respectively.

III. The honours paper is for highly advanced students—teachers and candidates for the Whitworth and other scholarships. The course of instruction may be considered beyond that of the science classes generally. Payments of 4*l.* and 2*l.* are made on account of students taking honours. The successful candidates are divided into 1st and 2nd class, and ranged in the order of merit.

IV. It is intended that all students shall come up in the elementary paper, before they come up in the advanced. It is not possible to enforce this rule universally, as it would interfere with the competition for the Whitworth and other scholarships by outsiders. But everything is done to induce, if not to compel, students to take the elementary stage first. No prizes are given to a student, however well he may do in the advanced paper, unless he have previously passed in the elementary paper, and the teacher loses a chance of further payment. Therefore, it may be taken for granted that the great bulk of the candidates—all the students of science classes—will come up in the elementary paper first.

V. The elementary paper is, then, for first year, and second year, and possibly some third year students—lads of 13 and 14, and artisans who attend classes during the winter evenings.

VI. A teacher should be certain of passing a fair, even a large, proportion of moderately stupid students whom he had taught well during the winter (say giving them 30 or 40 lessons), in the 2nd class. The 1st class should be within the reach of a well-taught, clever, first year student, or an average second year student.

VII. The elementary paper will, therefore, have to cover a wide range, and, while it is in parts so easy as to give a student with a small amount of knowledge a chance of showing it, it will have to be sufficiently difficult in other parts to prevent the higher candidates from thinking that they can take the difficult paper the first year.

VIII. It must be remembered that the main object of this examination is to award the payments to the teacher on his year's work, by finding out the amount of really sound instruction he has given to each pupil. It is, in fact, not so much to find out what a pupil does not know as what he does know, by giving him every opportunity of showing it. The examination is, therefore, of a different nature to the ordinary examination of a school or class, all the pupils of which have had the same instruction, when the object is simply to find out those who have profited most. It is, therefore, advisable to set more questions in the paper than the student can, or is called upon to, answer, so as to give him a choice. Thus, supposing eight questions is the number a candidate may fairly answer in three hours, to set twelve, restricting the candidate from attempting more than eight.

IX. If questions of varying degrees of difficulty be given, as will probably be the case, and if different values be attached to them, it is essential the student should know these relative values; otherwise, by taking the wrong questions, he may, however well informed, not do himself justice. There are no doubt objections to this arrangement, as tempting the student to try questions beyond his power. But it is so desirable, in order to assist teachers who are bringing up students year after year, to indicate, by marks, the questions which the higher students should take, that it is necessary to disregard these objections. It is of more consequence to enable a good student to make certain of a first class, than to protect a foolish one from his own ignorance in attempting questions beyond his knowledge.

X. The following arrangement is not applicable to all subjects, but, where it is applicable, it is of great use in preventing cramming, viz., to set a few, say three, questions in the fundamental portions of a subject which all candidates must attempt, and to set a certain number of others from

which they may make a selection; to lay down, in fact, that of the eight questions which a candidate may attempt, three must be the first three in the paper, while the other five may be selected from the remaining questions.

XI. The same forms cannot, however, be equally applicable to all the subjects, and each examiner can modify the general instructions sent herewith.

XII. The advanced paper should be, if I may so say, a year in advance of the elementary paper, and a power of selection of questions is, perhaps, not so necessary.

XIII. The honours paper should certainly be a very "stiff" one.

XIV. It has been decided, in future, to count the absolute marks obtained by a student in the examination in the various competitions for Royal Exhibitions, Whitworth scholarships, &c.; and the following scale has been published:—

The maximum number of marks obtainable in each subject, except Mathematics, will be, in the—

Elementary stage	-	-	100
Advanced stage	-	-	200
Honours	-	-	400

In Mathematics the numbers will be, in the—

1st stage	-	100	
2nd "	-	200	
3rd "	-	300	Honours 500
4th "	-	150	
5th "	-	300	Honours 500
6th "	-	200	
7th "	-	400	Honours 600

But, in each case, the number of marks gained in the elementary stage (or in the 1st stage in Mathematics) will be diminished by the minimum number required to pass in that stage, and the number of marks gained in the other stages will be diminished by 20 per cent. of the marks obtainable in that stage. The remainder will then be added together to determine the candidate's position.

XV. In order to carry out this plan, it is absolutely necessary that the same form of paper should be adopted by all the examiners: that in each stage—Elementary, Advanced, and Honours—the candidate should be restricted to a certain number (*n*) of questions, as many as can be fairly answered in the time; and that to the (*n*) highest questions a maximum of 100 marks should be assigned. It is essential to limit the number of questions to be answered, otherwise a few quick students make a large number of marks and render it impossible to take a regular per-centage scale.

J. F. D. DONNELLY,
Capt. R.E.

8th March 1870.

N.B.—It is, I am afraid, becoming the practice with some teachers to make a careful study of the examiner's manner and previous papers, and then to teach candidates the answers to certain questions, they think will be asked, by rote. I point this out, because, I believe, if warned, examiners may, by taking great care and varying the form of their questions, to some extent, check this most objectionable practice, without at the same time making their questions too difficult or "catchy." It would also, I think, conduce much to this end if in those cases where examiners have assistants, they consulted one or two of them on the subject when preparing their papers.

Science Form, No. 341.

SCIENCE AND ART DEPARTMENT of the COMMITTEE OF COUNCIL ON EDUCATION, South Kensington.

SCIENCE EXAMINATIONS.

CONFIDENTIAL MEMORANDUM on the appointment of Assistant Examiners, distribution of work, and examination of papers, prepared from Minutes of the Lords of the Committee of Council on Education, and other documents, for the use of the Examiners and Assistant Examiners for the Examination of 1870.

1. The result of each examination, however large, should be published not later than one month after its completion.

* Except in Mathematics, in which subject there are seven stages.

The revision of the papers by the examiners, therefore, should be completed in *three weeks*, at the most, as a full week must be allowed for transcribing, revising, and printing the lists.

2. To enable them to carry this out, the examiners, in those subjects in which there are many papers, have been requested to nominate, for their Lordships' approval, one assistant for every 1,000 written, or 1,300 *drawn*, papers.

3. The assistants to examine and work the papers allotted to them in 15 or 16 clear days, *at the outside*.

4. When the papers are ready for them, the examiners to meet their assistants at South Kensington, and to give precise instructions as to the scale of marks to be adopted, the kind of answering required, &c. The papers to be then divided amongst them in the proportion indicated in § 2.

5. When there are several assistants in a subject, a second meeting to be held, at the end of the first week after the examination, for the purpose of revising and comparing work, and of enabling each assistant to see the marks awarded by his colleagues, so that uniformity of marking may be maintained throughout the entire series of papers.

6. The examiner to be generally responsible for the whole examination, to examine all the *honours* papers himself, and to revise say 20 per cent. of the papers examined by his assistants, so as to keep a general check on the scale of awards and mode of working.

7. There are to be three papers in each subject.*

- a. An elementary or first stage paper.
- b. An advanced or second stage paper.
- c. An *honours* paper.

The examination—except in subjects II. and III.—lasts three hours, from 7 p.m. till 10 p.m.

8. The successful candidates in the *elementary* paper, and the successful candidates in the *advanced* paper, are each divided into 1st and 2nd class, for which the teacher receives 1*l.* and 2*l.* respectively.

9. The *honours* paper is for highly advanced students, teachers, and candidates for the Whitworth and other scholarships. The course of instruction may be considered beyond that of the science classes generally. Payments of 4*l.* and 2*l.* are made on account of students taking *honours*. The successful candidates are divided into 1st and 2nd class, and their names are printed *in the order of merit*.

10. It is intended that all students shall come up in the elementary paper before they come up in the advanced. It is not possible to enforce this rule universally, as it would interfere with the competition for the Whitworth and other scholarships by "outsiders." But everything is done to induce, if not to compel, students to take the elementary stage first. No prizes are given to a student, however well he may do in the advanced paper, unless he have previously passed in the elementary paper, and the teacher loses a chance of further payment. Therefore, it may be taken for granted that the great bulk of the candidates—all the regular students of science classes—will come up in the elementary paper first.

11. The *elementary paper* is for first year, and second year, and possibly some third year students—lads of 13 and

14, and artisans who attend classes during the winter evenings.

12. A teacher should be certain of passing a fair, even a large, proportion of moderately stupid students whom he has taught well during the winter (say, giving them 30 or 40 lessons), in the 2nd class. The 1st class should be within the reach of a well-taught, clever, first year student, or an average second year student.

13. The *advanced* stage is intended to be a year in advance of the elementary stage.

14. The *honours* examination should be very "stiff."

15. The *absolute scale of marks to be taken for each class must depend on the amount of the parliamentary vote for "payment on results," and must be finally decided by the Committee of Council. But, at all events, at present, it will probably be taken as follows:—*

In the advanced stage, above 74 per cent. 1st class.

" " " " 39 " " 2nd "

In the elementary stage, above 69 per cent. 1st class.

" " " " 29 " " 2nd "

It is hoped that this scale will, in fairly taught subjects, give, on an average, in the elementary stage, a first class to about one third of those who pass, and, in the advanced stage, a first class to about one fourth, or, perhaps, rather more, say two sevenths, of those who pass in that stage. The examiners are, therefore, requested to mark the papers so that, taking this scale, the result may, as far as possible, correspond with the intentions of §§ 12 and 13. The information at the head of the students' paper is to assist them in determining this.

The examiner need only write the total marks on each paper in the top right-hand corner.

16. As the award of the Royal Exhibitions and of the Whitworth scholarships, as well as of numerous local prizes, exhibitions, and scholarships, depends on the results of this examination, it is absolutely necessary that the numerical value of each candidate's paper should be carefully given.

17. In computing the marks for the competitions, the maximum obtainable in the *elementary* stage has been fixed at 100; in the *advanced* stage, at 200; and in *honours*, at 400,—except in mathematics, for which there is a special scale.

It will be seen from §LV. p. 20 of the Science Directory, that, in the *advanced* stage, and in *honours*, a candidate may count marks, though he fail in securing a class, if he obtain more than 20 per cent. of the marks awarded for that stage. Whilst, therefore, the examiners can cut out all such papers as are evident failures, and such as, for gross faults, ought to be cancelled, they should carefully mark those in the *advanced* stage, or in *honours*, which get more than 40 and 80 marks respectively.

18. There is a disposition on the part of some teachers to make a careful study of the examiner's manner of questioning, and of the papers of previous years, and then to teach their pupils, by rote, the answers to questions which they think will be asked. It is very desirable that the examiners should, as far as possible, check this objectionable practice, by rejecting all such papers as are unmistakeably the result of mere "cram."

19. A general report on the system of teaching, its faults, &c., from each Examiner would be of great use to the teachers.

May 1870.

J. F. D. DONNELLY,
Capt. R.E.

APPENDIX IV. (See Question 239.)

Science Form, No. 331.

South Kensington, March 1869.

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF COUNCIL ON EDUCATION, SOUTH KENSINGTON.

At South Kensington, the 10th day of March 1869. By the Right Honourable the Lords of the Committee of Her Majesty's Most Honourable Privy Council on Education.

Read the following memorandum prepared by Captain Donnelly, R.E., in accordance with the instructions of My Lords:—

SCIENCE EXAMINATIONS. MEMORANDUM.

1. The great increase in the numbers examined in May, renders a better organization than obtains at present necessary for looking over the papers, not only to ensure this being done in time, but also to reduce the expense. The large sum taken for examination in the estimates was commented on last year in the House of Commons.

2. By a proper organization of assistants both objects

* Except in Mathematics, in which subject there are seven stages.

may, I believe, be attained without sacrificing efficiency. Many of the subjects have been, for several years, so large that the examiners have had to employ assistants, with whom they have made their own arrangements. In future, in these large subjects, it would be better that the examiners should nominate their assistants for the approval of My Lords, and that they should be paid directly by this Department. It would, I believe, be more agreeable to the examiners, and would enable the Department to have a more definite organization.

3. The results of the examination in each subject should be published not later than a month after the examination, however large the subject may be.

4. To enable this to be done, the examiners must complete their work in three weeks at the outside, as one week is the least that can be allowed for transcribing, sorting, revising, and printing the lists.

5. From the inquiries I have made, I believe 70 written (three hour) papers are all that can be examined satisfactorily by one person in a day, or in six hours' work, and this only when many of them are short. In the drawing subjects, probably a third more can be done in the same time.

6. There should, then, be an assistant for every 1,000 written, or 1,300 drawn, papers; for, deducting the time required for comparison, revision, &c., he would have to look through them in 14 or 15 days.

7. I would propose, then, that when the papers were ready, the examiner should come here and meet his assistants; that he should give them precise instructions as to the scale of marks to be given, the kind of answering required, &c.; and that, then, the papers should be divided amongst them, a record being kept of the papers that each takes away.

8. In a week, there should be a second meeting for revision and comparison, each assistant looking at the marks that the others were awarding, so that the same scale might be maintained, as far as possible, throughout.

9. At the end of a fortnight, a third meeting would be necessary for a general revision, and for making up the papers.

10. The examiner should *roughly* examine (say) 20 per cent. of the papers looked over by his assistants, so as to keep a general check on the scale of awards and way of working. This might be done by the assistants sending him their papers, through the Science and Art Department, as they went on.

11. The examiner should also look over all the *honours* papers himself, and be generally responsible for the whole examination.

12. I do not propose any change in the present system as regards the smaller subjects, nor to the examiners being, as now, appointed, or rather asked to act, from year to year.

13. The remuneration might be managed as follows:

- a. The examiner in one subject to receive a retaining fee of 50 guineas, in two or more subjects 100 guineas.

[This fee is not only for the work connected with the examination, but as a general retaining fee for the year; for it must be remembered that the examiner is constantly called on to attend meetings, write reports, and give his advice and opinion on a variety of subjects; in fact, to act as referee for the Department in the subjects in which he examines.]

b. For the preparation in May of the three papers in each subject—*honours, advanced, and elementary*—to receive 10 guineas.

c. For the examination of the *honours* papers to be paid, as now, at the rate of 30 shillings for 10 papers.

d. For each day's attendance here to meet the assistants, 3 guineas.

e. For the revision of assistants' work, at the rate of 11. per 20 papers looked over.

14. The assistants' remuneration to be at the rate of 11. 10s. and 11. per 20 of the *advanced* and *elementary* papers respectively, and in the *drawing* subjects 11. and 15s; and 2 guineas a day for the days they attend here to receive their instructions, &c.

15. Though the payments may, at first sight, appear large, I would beg leave to point out that it is of the highest importance, both as regards the success of the teaching and the position of the Department, that the very best men should be employed in this work, which is of a very laborious and repulsive nature, and that the teachers, whose pay depends entirely on the examination, have a right to expect that it should be very well and very carefully done.

J. F. D. DONNELLY,
Capt. R.E.

6th March 1869.

My Lords approve the same.

HENRY COLE.

APPENDIX V. (See Mr. Cole's Evidence, pp. 1 to 18.)

EXTRACTS FROM NOTES ON PUBLIC EDUCATION, prepared at the desire of the Right Hon. Lord Robert Montagu, M.P., Vice-President of the Committee of Council on Education, South Kensington Museum, 28th November 1867.

II. SECONDARY OR TECHNICAL INSTRUCTION.

10. I concur generally in the paper of 12th November 1867, which Capt. Donnelly has prepared on this subject.

Elementary
schools and
science.

11. I recommend that the managers of elementary schools be free to establish classes for teaching science through certificated teachers, and that payments on results be made to them, and that all fears of competition with elementary education be ignored. (See Education Minute of 20th February 1867.)

Free and
grammar
schools.

12. If effective measures can be taken to deal with the funds and management of the old Free and Common Grammar Schools, the teaching of art and science might be largely introduced into them without increased charge on Parliamentary funds.

Upper
grammar
schools.
Universities.

13. I consider that the State might usefully establish professorships, with prizes and, perhaps, scholarships for science, at Eton, Harrow, Rugby, &c., as well as at the Universities. A very few thousand pounds expended annually in this direction would, I conceive, be the most efficient means of aiding technical instruction. Such an expenditure would act in increasing the public revenue in a few years. Until increased honours are awarded at the Universities for acquiring experimental science, and the knowledge is felt to be remunerative, experimental science will stand no chance with the study of classical learning; and the industrial position of this country, in comparison with other countries generally, will get from bad to worse. (Some parliamentary votes are already made to Universities for Science, see Estimates, Class IV.)* The address of Mr. J. S. Mill, Rector of St. Andrew's, whilst fully estimating the great value of classical knowledge, shows the necessity for scientific teaching, in the most eloquent terms. It is a text book on the subject. (See also Mr. Lowe's address to the Philosophical Institution at Edinburgh.)

14. Four establishments should be formed in the nature of Training Colleges for teaching practical science. There is already one at Dublin. The School of Navigation and Science, now building at South Kensington, might be readily enlarged into such a college. Arrangements, I believe, might be made for a third, either in connexion with the University at Edinburgh, or at Glasgow. And a fourth might be created in the midland counties. The latter college, as well as that for Scotland, might be located in that place which offered to endow the greatest number of scholarships in it.

15. Capt. Donnelly's paper fully states the objections to state "trade" schools, so I do not repeat them.

* Vide ut infra.

III. PUBLIC LIBRARIES AND MUSEUMS.

16. Public Libraries, Galleries, and Museums should be viewed as the highest instruments of public instruction, and be rendered as effective as possible to that end. Full titles, inventories, and catalogues should be prepared, as well for the learned as the unlearned visitor. The superior manners and general culture of the mass of the people, especially in art and science, in many parts of Europe, are to be attributed to the influence of the greater number of public libraries and museums than with us, and to the facilities offered to all classes to study them.* The British Museum, which possesses treasures of the greatest instructional value, is still somewhat treated in its management and purpose only as a collection of things "rare and curious," as they were defined by Sir Hans Sloane a century ago, and not as a great public educational institution, which it might be made.

Public li-
braries and
museums
necessary to
public in-
struction.

17. I strongly recommend, both on religious and moral grounds, that arrangements be made, as at Kew Gardens and Museum, Hampton Court and Greenwich Picture Galleries, &c., to admit the public to National Institutions on Sunday afternoons. A more elevating measure could not be devised.

Sunday
opening.

18. To render public libraries and museums, which are supported in the main by public funds, proper instruments of public instruction, and to manage them effectively and economically, it seems to me indispensable that they be placed under the sole responsibility of a Minister of the Crown. Numerous boards render executive management impotent, and are quite incompetent to deal with the proper expenditure of public funds. Boards are useful for counsel, but obstructive for action. On this subject, as well as on a better administration of public museums, public opinion has been maturing for more than thirty years. (See especially "Quarterly Review," No. 175; Dec. 1850; "Edinburgh Review," January 1866.)

Minister of
Public In-
struction.

19. The greater number of such public institutions of science and art are already under a ministerial authority. It would be of great public benefit, in every way, to subject the remainder to the same authority. (See Estimates, Class IV., Learned Societies.) But I allude especially to the British Museum, the National Gallery, the National Portrait Gallery, and the Patent Museum in London, also to the National Gallery and Royal Irish Academy in Dublin, and the National Gallery, Edinburgh.

Public
museums
under mi-
nister of
public in-
struction.

* See list of such institutions in France, &c., printed by the Department.

IV. GENERAL PRINCIPLES OF ADMINISTRATION.

General principles of administration.

20. I consider it necessary that elementary education, secondary or technical instruction, the management of public libraries, galleries, and museums, and all the votes given for education, science, and art, should be concentrated in their administration of them, so far as the expenditure of public funds at least is concerned, under the sole authority of the same Minister of the Crown.

21. This Minister of Public Instruction ought not, I venture to think, to be the Lord President of the Council. The work appears to me ample enough to engage the sole attention of a Minister, who, I also venture to think, ought to rank as a Secretary of State. He would sit in either House, according to the circumstances of the Cabinet. There should be an Under Secretary also in Parliament.

22. In my opinion, the present work at the Privy Council Office, with all the calls for charters, health,

cattle plague, quarantine, &c., made upon the attention of the Lord President, make it impossible for that high functionary to devote sufficient time to numerous questions involved in public instruction, viewed comprehensively.

23. To enlarge elementary education, making it truly national;—to reform the educational charities;—to increase technical instruction throughout the United Kingdom;—to reorganize the British Museum,* the National Gallery, the National Portrait Gallery, &c., so as to make them work efficiently and harmoniously together, are functions which ought not, I conceive, to be treated as of secondary importance to any others.

(Signed) HENRY COLE.

* In doing this, the Family Trustees should be kept, of course, but they should revert to their original functions: there should be no further elections of "elected trustees," and the "official trustees" would at once give way to a single responsible Minister.

APPENDIX VI.

CORRESPONDENCE between HER MAJESTY'S COMMISSIONERS and the HEADS of COLLEGES and HALLS in the UNIVERSITIES of OXFORD and CAMBRIDGE.

I. Endowments and Parliamentary Grants.

The following letter was addressed on the 13th June 1870 to the Heads of Colleges and Halls at Oxford and Cambridge:

Royal Commission on Scientific Instruction and the Advancement of Science,

6, Old Palace Yard, Westminster, S.W.
June 13th, 1870.

I HAVE the honour to inform you that Her Majesty has appointed Commissioners to make inquiry with regard to Scientific Instruction and the Advancement of Science, and to inquire what aid thereto is derived from grants voted by Parliament, or from endowments belonging to the several Universities in Great Britain and Ireland and the Colleges thereof, and whether such aid could be rendered in a manner more effectual for the purpose.

The Royal Commissioners are of opinion that the inquiry with which they are charged will be much facilitated by their being speedily placed in possession of authoritative statements, on behalf of the several Universities and Colleges indicated in their Commission, of the aid to scientific instruction and the advancement of science derived from Parliamentary grants and from endowments which they enjoy.

I am, therefore, directed to request that you will have the goodness to furnish the Commissioners with a statement of all sums applied to the advancement of science or to scientific instruction, in the University of

College, which are derived from endowments or from Parliamentary grants.

This information will be useful to the Commissioners in proportion as these endowments and grants and their applications are specified in detail.

I am further to state that the Commissioners will be glad to receive suggestions or to hear evidence from you in respect of the matters into which they are commanded to make inquiry.

I have the honour to be, sir,
Your obedient servant,
J. NORMAN LOCKYER,
Secretary to the Commission.

The following replies were received:—

UNIVERSITY OF OXFORD.

20, Dean's Yard, Westminster,
July 27th, 1870.

THE Vice-Chancellor of Oxford has the honour of forwarding the accompanying return in compliance with the request of Her Majesty's Commissioners appointed "to make inquiry with regard to Scientific Instruction and the Advancement of Science," and regrets that unavoidable circumstances have caused so much delay in preparing the return:—

26060.

RETURN of ANNUAL PAYMENTS for the ADVANCEMENT of SCIENCE in the UNIVERSITY of OXFORD.

Estimated from Amounts actually paid in the University Year 1868-9.

Professoriate

Professors.	Amount arising from Endowments.	Amount paid by the University.
Astronomy, Savilian Professor of	£ 272 12 2	£ 162 19 0
Botany (Crown Grant)*	97 12 1	—
Ditto, Sherard's Professor	78 12 10	—
Ditto, Rural Economy, Sibthorp's Professor.	196 4 2	—
Chemistry, Waynflete Professor -	—	—
Chemistry, Prælector of (Crown Grant)*	97 18 4	—
Ditto, Aldrichian Demonstrator of Geology -	126 8 0	—
Geometry, Savilian Professor of	272 12 2	390 16 8
Medicine, Regius Professor of	—	162 19 0
		Fees on Presentations
Ditto, Aldrichian Professor of Practice of	126 8 0	—
Mineralogy -	—	97 12 1
Natural Philosophy, Sedleian -	125 1 9	167 16 6
Physiology, Linacre Professor of	—	—
Ditto, Aldrichian Professor of Anatomy.	126 8 0	—
Ditto, Tomlin's Prælector of do.	88 4 8	—
Physics, Experimental -	30 0 0	263 17 6
Zoology, Hope's Professor	390 16 8	—
	£2,028 18 10	£1,246 0 9

* Paid by the University by composition with the Crown.

Demonstrators' Assistants, &c.

Chemistry, Waynflete Professor of, for a Demonstrator.	—	146 11 3
Ditto, for an Assistant -	—	97 14 2
Physics, Experimental Professor of, for an Assistant.	—	107 8 0
Zoology, Hope Professor of, for a Servant.	—	15 0 0
Observatory, Radcliffe, for an Assistant.	117 7 6	—
	£117 7 6	£366 13 5

Examiners.

Natural Science, Examiners in -	—	146 11 3
Medicine, Examiners in -	—	78 0 0
	—	£224 11 3

4 M

Scholars, &c.		
	Amount arising from Endowments.	Amount paid by the University.
Geology, Burdett-Coutts -	165 12 5	—
Meteorology, Johnson Prize -	9 18 0	—
	£175 10 5	—

University Museum.		
	£ s. d.	£ s. d.
Museum Annuity - - -	—	645 0 0
Ditto, extra Grant - - -	—	250 0 0
MUSEUM :		
Chemistry, Department of, for Apparatus.	—	150 0 0
Physics, Department of, for Apparatus.	—	250 0 0
Zoology, Department of, for the Collection.	48 17 1	—
Ditto, and garden rates and taxes	—	49 12 0
	£48 17 1	£1,344 12 0

Botanic Garden.		
	£ s. d.	£ s. d.
Botanic Garden, for repairs, &c. -	100 0 0	—
Ditto, for maintenance, &c. (Dr. Sherard)*	150 0 0	—
Ditto, ditto, Crown Grant*	82 0 0	—
Fielding Herbarium - - -	—	58 10 0
	£332 0 0	£58 10 0

* Paid by the University by composition with the Founders.

NOTE.—No account is taken in this return of stipends or augmentations of stipend paid to Professors by several Colleges, or of the emoluments received by the Regius Professor of Medicine from Ewelme Hospital, or of payments from the Radcliffe Trust.

SUMMARY of ANNUAL PAYMENTS for the ADVANCEMENT of SCIENCE in the UNIVERSITY of OXFORD.

Departments of Scientific Instruction, &c.	Amount arising from Endowments.	Amount paid by the University.
	£ s. d.	£ s. d.
Professors - - -	2,028 18 10	1,246 0 9
Demonstrators' Assistants, &c. -	117 7 6	366 13 5
Examiners - - -	—	224 11 3
Scholars - - -	175 10 5	—
University Museum - - -	48 17 1	1,344 12 0
Botanic Garden - - -	332 0 0	58 10 0
Total - - -	£2,702 18 10	£3,240 7 5
Grand total - - -	£5,943 1 3	

NOTE.—Pure mathematics are not included in this return.

F. K. LEIGHTON, Vice-Chancellor.
E. T. TURNER, Registrar of the University.

COLLEGES:

1. University College.

SIR,
University College, Oxford,
August 6th, 1870.
In reply to your communication of the 5th inst., I beg to say that only one student of this College has attended the classes in which natural science is taught in the University during the session of 1869-1870, and that he obtained a place in the first class on the public examination in natural science in the Trinity term 1870.
I may add, that we have two or more scholarships in this College, which are given for proficiency in mathematics.
I shall be ready to give any further information which may be desired, if a communication is made to me in November or December next.

I am, Sir,
Your obedient servant,
F. C. PLUMPTRE, D.D.,
Master.
J. Norman Lockyer, Esq.,
Secretary.

2. Balliol College.

Balliol College, Oxford,
June 14th, 1870.
SIR,
I HAVE the honour to acknowledge a letter from the Royal Commissioners on Scientific Instruction and the Advancement of Science, inquiring what sums are applied to the advancement of science or to scientific instruction in Balliol College, Oxford, which are derived from endowments or parliamentary grants.

From parliamentary grants we have none.
But Miss Hannah Brakenbury, of Adelaide Crescent, Brighton (who is still living), founded and endowed three scholarships at Balliol College a few years ago, which, in alternate years, are filled up by a competitive examination in natural science. The scholarships are tenable for three years. In the alternate years they are filled up by a competitive examination in law and modern history. The value of each of these scholarships is 70l. per annum, less income tax.

I have the honour to be, Sir,
Your obedient servant,
ROBERT SCOTT,
Master of Balliol.
Norman Lockyer, Esq.,
Secretary, &c.

3. Merton College.

Caversfield, Bicester,
August 8th, 1870.
SIR,
I HAVE the honour to acknowledge the receipt of letters from you dated the 4th and 5th inst., the former containing a copy of the Aid to Science Commission, and inquiring whether I have any facts or suggestions to lay before the Commissioners with regard to Merton College, and asking if I would be prepared to aid the Commissioners in the prosecution of their inquiry by attending to give evidence in November or December next; the latter requesting a return of the number of students attending any classes in which science was taught during the session 1869-1870.

With regard to facts, I have to say that there is connected with Merton College an endowment by Linacre for 18 lectures in medicine and surgery annually, in respect of which a professorship, with a salary of 800l. per annum paid by the college, was established by an ordinance of the Commissioners in 1854, and that the college has lately promoted physical science by giving a preference to proficients in that science to candidates for fellowships and scholarships in some instances.

As to suggestions, none occur to me at present; and I regret to say that, in consequence of the absence of the Tutors of the College, during the long vacation, I am unable to state the number of students attending classes in which science was taught during the session 1869-1870.

I shall have pleasure in furnishing the Commissioners with any further information in my possession, and in waiting on them in November or December, if required.

I have the honour to be, Sir,
Your obedient servant,
R. BULLOCK-MARSHAM,
Warden of Merton.

4. Exeter College.

Exeter College, Oxford,
June 27th, 1870.
SIR,
No money derived from parliamentary grants or from special endowments is applied to the advancement of science or scientific instruction by Exeter College, save, at least, under the following statutable direction:—
"Preference shall be given to those candidates in whom shall be found the highest moral and intellectual qualifications, such intellectual qualifications having been tested by an examination in such subjects as the College from time to time shall determine."

One out of 15 fellows has been elected for mathematical knowledge, and another is to be elected for mathematical knowledge next week.

The College might, it will be seen, have elected for knowledge in natural science; and the subject of such an election was discussed, but a second mathematician seemed at the present moment more desirable.

I have the honour to be
Your obedient servant,
J. P. LIGHTFOOT,
Rector of Exeter College.
Norman Lockyer, Esq.,
Secretary, &c.

5. *Oriel College.*

[See p. 20.]

6. *The Queen's College.*

Lowther Rectory, near Penrith,
August 10th, 1870.

SIR, I HAVE the honour to acknowledge the receipt of your letter of the 4th inst., which has been forwarded to me from Oxford.

In reply to your inquiry, whether I have any facts or suggestions to lay before the Commissioners with regard to Queen's College, I beg to state that I have no facts besides such as I believe are already before the Commissioners. The facts that I refer to are, that the only money payment out of the revenues of the College towards the advancement of science is 270*l.* paid yearly, as an addition to the salary of the Sedleian Professor of Natural Philosophy. This, however, although the only money payment, is not all that is done by the College for the advancement of science. The College statutes direct that the system of examination for fellowships shall be such as to render the fellowships accessible from time to time to excellence in every branch of knowledge recognized in the schools of the University, and we are in the habit of allowing candidates to choose the subjects in which they desire to be examined. The same rule, with respect to the choice of subjects, is observed in the examination for our open scholarships, so that, although no fellowship or scholarship is specially or exclusively set apart for any one subject, all our (19) fellowships and (15) scholarships may be said to be open to proficiency in science. One of our present fellows and one of our scholars were elected for proficiency in natural science; and I observe, that in the University examination for the degree of B.A., the first class, at the examination in Michaelmas term 1869, contained a greater number of names in the school of natural science than in any other school.

After this statement, perhaps the Commissioners may agree with me in thinking I could not be of any use in giving evidence; if, however, they think otherwise, I wish to put myself entirely into their hands, and will consider it my bounden duty to attend to any summons they may send me.

I have also before me your letter of the 5th. I am sorry I cannot return a strictly exact account of the number of students attending any science classes at one time during the last academical year, without reference to some papers which are in the hands of one of my College Tutors. I have written for the papers, and will send the information required as soon as I can. Begging you to excuse the unavoidable delay,

I have the honour to remain, Sir,

Your faithful and obedient humble servant,

WM. JACKSON,

Provost.

J. Norman Lockyer, Esq.

7. *New College.*

New College, Oxford,
June 14th, 1870.

SIR, In reply to your letter, I beg leave to inform you that there are no special endowments in this College for the advancement of science, or for scientific instruction, nor does the College receive any parliamentary grants for such purposes.

I have the honour to remain.

Your's faithfully,

J. E. SEWELL, Warden.

J. Norman Lockyer, Esq.,
Secretary, &c.

New College, Oxford,
August 2nd, 1870.

SIR, ON considering again the inquiry made in your letter of the 13th of June, on behalf of "the Commission of Scientific Instruction and the Advancement of Science," I think it necessary to state that, although there are no special endowments in this College by original benefactors for such objects, yet the general endowments of the College are charged with a payment of 600*l.* a year viz., 300*l.* to the Savilian Professor of Astronomy, and 300*l.* to the Savilian Professor of Geometry, by virtue of an ordinance framed by the Oxford University Commissioners in 1857.

At present half only of this sum is paid to each professor, under the terms of the ordinance. The other half will become payable in five years from Lady-day last.

I am, Sir,

Your's faithfully,

J. E. SEWELL,

Warden of New College.

8. *Lincoln College.*

[See p. 20.]

9. *All Souls' College.*

SIR, All Souls' College, Oxford.
In reply to your printed circular of the 13th inst., I have the honour to inform Her Majesty's Commissioners that we have no endowments or parliamentary grants in this College restricted to the advancement of science, or to scientific instruction, though such is occasionally given from the College funds, for the assistance of Bible clerks who wish to devote themselves to that branch of education.

I have the honour to be, Sir,

Your obedient servant,

F. K. LAUGHTON,

J. Norman Lockyer, Esq.,
Secretary, &c.

10. *Magdalen College.*

[See p. 20.]

11. *The King's Hall and College of Brasenose.*

[See p. 21.]

12. *Corpus Christi College.*

Corpus Christi College, Oxford,
June 24th, 1870.

SIR, In reply to your inquiry, under date June 13th, I beg to inform you that in this College there is no endowment specially appointed for the advancement of science, and that no aid is here derived for that object from any parliamentary grant.

I have the honour to be

Your obedient servant,

JAMES NORRIS,

President of C. C. C.

J. Norman Lockyer, Esq.,
Secretary, &c.

13. *Christ Church.*

A STATEMENT of the Means provided at Christ Church, Oxford, for the Advancement of Science and for Scientific Instruction.

1. The main sources from which the endowments devoted to natural science at Christ Church are derived, are the estates bequeathed in trust to the Dean and Chapter by Matthew Lee, M.D., by his will, bearing date August 27th, 1755. A copy of the provisions of the will, so far as they relate to this part of the subject, will be found printed in the report of the Royal Commission appointed to inquire into the state, &c., of the University of Oxford (1852), at p. 282 of the Evidence.

2. The provisions of the will are various. The rental of the estates has increased to a considerable sum, and the net income may be taken at about 2,650*l.* a year. Several decrees in Chancery have been obtained by the Dean and Chapter for extending the powers granted to them under Dr. Lee's will. Considerable modifications of these powers were also introduced by the ordinance or statutes framed by the University Commission in 1858, and by subsequent alterations in that ordinance made by the governing body of Christ Church in virtue of powers conferred by the ordinance itself, no alteration being valid till it has received the sanction of Her Majesty in Council.

3. It may be as well to explain here that the government of Christ Church and the administration of its funds, trust as well as corporate, were transferred from the Dean and Chapter by an Act passed in 1867 to a new governing body, consisting of the Dean, the Canons, and the Senior Students of Christ Church. The Senior Students are equivalent to

the fellows in other colleges, and the junior students, it may be added, are equivalent to the scholars in other colleges.

4. Of the augmented revenues of Dr. Lee's estates, the sum of 1,260*l.* a year is at present devoted by the ordinance above named to the payment of junior students elected from Westminster School. It rests with the governing body to determine what portion of the remaining revenues is to be applied to the purposes of advancing science and providing scientific instruction for the young men. What has been already done in this direction shall here be stated.

5. By Dr. Lee's will a lecturer in anatomy was to be maintained, with a salary of 100*l.* a year, and an allowance of 40*l.* for providing human subjects and anatomical preparations for the purpose of his lectures. This lecturer was to hold the position of a University Teacher; he was to admit all applicants to his lectures, and was authorised to take fees from all who attended each course, with the exception of a fixed number of Christ Church undergraduates, who were to be taught without fee or reward.

6. Dr. Acland was appointed to the office in 1845, under the provisions of the will, except that the Reader's salary had before his appointment been raised to 200*l.* He applied himself with great zeal and energy to bringing the department abreast with the requirements of modern science, and gave lectures, which were well attended. In particular, he obtained from the Dean and Chapter grants of money, averaging about 500*l.* a year, to assist him in retaining the services of an assistant, and in making preparations for the use of students. But he expended much, not only of his time, but of his own money in the same work, and succeeded in forming an excellent series of preparations, chiefly osteological and physiological, arranged and catalogued after the Catalogue of the Hunterian Museum. His own account of the collection as it was in 1852 will be found in the evidence he gave to the first University Commission. (Evidence, p. 283.)

7. Dr. Rolleston succeeded Dr. Acland in 1858, and zealously carried on the work of his predecessor, both in lecturing and in enlarging the collections. He resigned the Readership in 1860, when he was elected to the Linacre Professorship of Physiology, then newly created and endowed by Merton College in pursuance of an ordinance made by the second University Commission.

8. Meantime, the Lee's Readership in Anatomy had been, by an order of the same Commission, constituted as a Senior Studentship of Christ Church, and with it a second readership (in chemistry) was founded, both being endowed out of the Lee's fund. These two Readers take rank with the other members of the governing body, according to seniority.

9. The new Linacre Professor was attached to the University Museum, which had been recently erected and endowed out of the University chest at a very large expense. About the time of Dr. Rolleston's appointment, the Dean and Chapter (who then still retained the government of Christ Church) had to consider whether they would continue to keep up the anatomical and physiological collections. It was plain that the Linacre Professor must have collections for his own use in the new museum; and the question was whether it was worth while, in one small town, to have two collections of this kind, one in the museum and one at Christ Church, when it appeared certain that one collection would be all that would be required for purposes of study and instruction. The Dean and Chapter considered that, by retaining their collections, they would be obliging the University to incur a large outlay, and would be compelled themselves to spend a considerable sum annually in keeping up their own collections, which sum might be more usefully employed in promoting other scientific studies. They determined, therefore, to transfer their collections, as a loan to be reclaimed at any time that might be thought expedient, to the University museum. The Lee's Reader in Anatomy has a room assigned him at that museum; he retains the right of making full use of the Lee's collections, and he is also enabled to lecture in the physiological lecture room of the museum, by arrangement with the Linacre Professor; so that while Christ Church men receive his instruction, as before, he strengthens the teaching staff at the museum in no inconsiderable degree.

10. Dr. Acland resigned the Lee's Readership on being appointed Regius Professor of Medicine in the University. The University had in the department of medicine no collections whatever. The Dean and Chapter, acting as they had done in respect of the physiological collection, presented to Dr. Acland, as the foundation of a pathological collection in the museum, those specimens of morbid anatomy which he had deposited in the Christ Church building. They considered this due to the professor, in acknowledgment of the expenditure, both of time, labour, and money, which he had made in their service. These pathological specimens might

in fact have been regarded as his own property, though he had left them at Christ Church. He has now presented them to the University.

11. In 1866, the Christ Church building, being thus left vacant by the transfer of the several collections above-named to the University museum, was fitted up as a chemical laboratory and lecture room, by payments out of the balance on the Lee's fund to the amount of more than 500*l.* The expense of maintaining the laboratory, chiefly for the use of young men, amounts to about 100*l.* a year; and a grant of 60*l.* a year is made to the Reader in Chemistry to enable him to secure the services of an assistant.

12. In 1869, a third Readership was created by the governing body, under powers conferred by a new statute, framed by them, and confirmed by Her Majesty in Council. This Reader is to study and teach mathematical and experimental physics. A grant of 100*l.* has recently been made for the purchase of physical apparatus of an elementary kind. For the present, this Reader shares the lecture room of the chemical reader. More advanced instruction in physics will have to be sought in the Hyde Institute, just erected as an adjunct to the University museum.

13. One of the rooms in Dr. Lee's building at Christ Church has been fitted up as a library and reading room for the use of the Lee's Readers and of undergraduates engaged in the study of physical science. The sum of 100*l.* has been granted for the purchase of standard works; and it is intended to provide scientific periodicals and other additions to the library as they may be needed.

14. By successive alterations of the Lee's trust, made partly under the authority of the Court of Chancery, partly by the University Commissioners, and partly by the governing body under the sanction of Her Majesty in Council, the present state of the Lee's trust fund, so far as it is annually expended upon scientific objects, is this;

	£	s.	d.
Three Readers (in anatomy, chemistry, and physics) receive each 300 <i>l.</i>	900	0	0
Chemical laboratory expenses (about)	100	0	0
Chemical assistant	60	0	0
Mathematical teachers	250	0	0
Other expenses (about)	50	0	0
	<u>£1,360</u>	<u>0</u>	<u>0</u>

15. The Lee's Readers also receive 250*l.* from the fees paid by the undergraduates for tuition, and the mathematical Tutors receive 450*l.*, so that the whole salary

of the Chemical Reader is	450
" Anatomical Reader	350
" Physical Reader	350
" Mathematical Teachers	700
Total expended in salaries to teachers	<u>£1,850</u>

16. It appears, therefore, that during the last 25 years, a large and increasing sum has been set apart by Christ Church, out of funds at the command of the corporate body, for encouraging scientific study and providing scientific instruction for young men.

17. It should be added, that by alterations of the ordinance, made in 1868 and 1869, with the sanction of Her Majesty in Council, the Lee's Readers are, with the consent of the Dean and two-thirds of the governing body, permitted to marry, and to hold property beyond the amount to which other Senior Students are restricted. Their income also is allowed, with the same consent, to be raised to any sum exceeding 200*l.* a year; this sum of 200*l.* being taken as the minimum.

18. What has been said relates chiefly to the Lee's Readers, and the department connected with the higher studies and teaching. It must be added, that, by the ordinance of the Commissioners, made in 1858, it was provided that "in elections to one in every three open junior studentships, the subjects of competitive examination shall be alternately mathematics and physical science." These junior students receive 75*l.* in money, exclusively of rooms rent free, so that the value of a junior studentship may be taken at nearly 90*l.* a year. These studentships are tenable for five years from the day of election. On the 1st of January 1870, out of 30 open junior studentships, there were five mathematical, and five in physical science. But it should be remarked that the governing body, acting as electors, are not restricted to the minimum fixed by the Commissioners of one in every three for mathematics and physical science alternately. Hitherto the number of competitors for each physical science studentship has been very small; but, doubtless, as the teaching of these subjects increases and is improved in schools, so the number of com-

petitors will increase also; and the electors will (I feel sure) promptly consider it their duty to augment the number of studentships appropriated to scientific studies.

(Signed) H. G. LIDDELL,
Dean of Christ Church, Oxford.
July 19, 1870.

14. Trinity College.

Trinity College, Oxford,
August 5th, 1870.
SIR, In answer to your circular of the 13th June, I beg to state that no sums derived from endowments or from parliamentary grants are applied to the advancement of science or to scientific instruction in this College.

The tuition fund of this College is to some extent employed in providing scientific instruction for members of the College, but this does not proceed from endowments. No parliamentary grants of any kind are received by the College.

In answer to the circular of the 4th inst., I beg to state that, considering the circumstances of Trinity College, I have no facts or suggestions to lay before the Aid to Science Commission.

I have the honour to be, Sir,
Your obedient servant,
S. W. WAYTE,
President of Trinity College.
J. Norman Lockyer, Esq., Secretary,
Aid to Science Commission.

15. St. John's College.

[No answer received.]

16. Jesus College.

[No answer received.]

17. Wadham College.

Wadham College, Oxford,
June 17th, 1870.
SIR, I HAVE the honour, in answer to your letter of the 13th inst., to inform the Royal Commissioners on Scientific Instruction that Wadham College has received no aid by parliamentary grant for scientific instruction or advancement of science, but that it has received some endowments, as follow:—

1. An exhibition of 10*l.* yearly for the study of botany.
2. Do. of 90*l.* yearly to a Fellow of the College for the study and practice of medicine.
3. Do. of 18*l.* yearly to a Scholar of the College for the study of chemistry, anatomy, and medicine (if no fellow or scholar competent, to be otherwise appropriated).

The College pays out of its own funds 200*l.* annually towards the salary of a Professor of Experimental Philosophy in the University of Oxford. Further instruction is given within the College, or provided therein, for its own students in chemistry, physiology, and physics.

I am, Sir,
Your faithful servant,
B. P. SYMONS,
Warden of Wadham College.
J. Norman Lockyer, Esq.,
Secretary, &c.

18. Pembroke College.

Pembroke College, Oxford,
June 23rd, 1870.
SIR, In reply to your inquiry as to "what sums are applied to the advancement of science, or to scientific instruction in this College, which are derived from endowments or parliamentary grants," I beg to inform you that the only endowment in this College which comes within the above designation is a medical fellowship founded by the late Mrs. Sheppard, in the examination for which, on the last occasion, natural science (*viz.*, chemistry and physiology) was included, and formed a very important part; and in all probability the same rule will be observed on all future occasions. The value of the fellowship is 200*l.* a year.

I have the honour to be
Yours faithfully,
E. EVANS,
Master of Pembroke College.
J. Norman Lockyer, Esq.,
Secretary, &c.

19. Worcester College.

Worcester College,
June 16th, 1870.
SIR, I HAVE the honour to inform you that Worcester College has no surplus funds to apply for the advancement of science. Our fellowships are under 200*l.* per annum, almost, if not quite, the lowest in the University, and the tutors are paid solely by the fees of the undergraduates.
I have the honour to be, Sir,
Your obedient servant,
R. L. COTTON,
Provost of Worcester College.
J. Norman Lockyer, Esq.,
Secretary, &c.

HALLS.

1. St. Mary Hall.

St. Mary Hall, Oxford,
June 20th, 1870.
DEAR MR. VICE-CHANCELLOR,
MY answer, unfortunately, is very short.
1. This Hall has no endowment or parliamentary grant for the advancement of science or for scientific instruction.
2. I am not able to make suggestions, or to give evidence to Her Majesty's Commissioners on this matter.
I am, dear Mr. Vice-Chancellor,
Yours very faithfully,
D. P. CHASE, Principal.
The Rev. the Vice-Chancellor.

2. Magdalen Hall.

Magdalen College, Oxford,
June 29th, 1870.
SIR, I HAVE the honour to assure you that Magdalen Hall enjoys no endowment or parliamentary grant whatever for the cultivation or aid of scientific instruction of any sort.
Your obedient servant,
R. MICHELL, D.D.,
Principal of Magdalen Hall.
J. N. Lockyer, Esq.
(Endorsed) F. K. LEIGHTON,
Vice-Chancellor,
All Souls' College,
July 2nd, 1870.

3. New Inn Hall.

New Inn Hall,
June 23rd, 1870.
DEAR MR. VICE-CHANCELLOR,
IN reply to the inquiries made through you by the Secretary to the Royal Commission of Scientific Instruction and the Advancement of Science, I beg to state that New Inn Hall neither derives any aid from parliamentary grant, nor enjoys any endowment for the advancement of science or scientific instruction. I beg to remain
Very faithfully yours,
H. H. CORNISH, Principal.
The Rev. the Vice-Chancellor of Oxford,
All Souls'.
(Endorsed) F. K. LEIGHTON,
Vice-Chancellor.

4. St. Alban Hall.

St. Alban Hall,
June 20th, 1870.
MY DEAR MR. VICE-CHANCELLOR,
THE statement which I have to make to the Royal Commissioners is a very simple one.
St. Alban Hall derives nothing from endowment or parliamentary grant, or any other external source whatever.
I am, dear Mr. Vice-Chancellor,
Very truly yours,
W. C. SALTER,
Principal.
The Rev. the Vice-Chancellor.
(Endorsed) F. K. LEIGHTON,
Vice-Chancellor.

5. *St. Edmund Hall.*

There are no such endowments or grants at St. Edmund Hall.

(Signed) EDW. MOORE, B.D.,
Principal.

(Endorsed) F. K. LEIGHTON,
Vice-Chancellor.

UNIVERSITY OF CAMBRIDGE.

Clare College Lodge, Cambridge,

SIR,

July 7th, 1870.

IN reply to the letter of the 13th of June last, addressed to me as Vice-Chancellor of this University, I have the honour to send, for the information of the Royal Commission on Scientific Instruction and the Advancement of Science, the following statement:—

No sums whatever, which are applied to the advancement of science and scientific instruction in the University of Cambridge, are derived in the proper sense of the words from parliamentary grants. Before the year 1858, when the stamp duties formerly payable on matriculation and degrees in the University of Cambridge were repealed, the following salaries and allowances to scientific professors were annually voted by Parliament:—

	£
To the Professor of Chemistry -	100
To the Professor of Anatomy -	100
To the Professor of Botany -	182
To the Jacksonian Professor -	100
To the Professor of Mineralogy -	100

The Act for the repeal of the stamp duties provides that none of the above salaries or allowances, which the University had previously undertaken by grace to pay annually out of its common chest, shall be discontinued or reduced without the consent of the Commissioners of Her Majesty's Treasury.

The salaries of all the above professors are now made up to 300*l.* per annum out of the University chest, none having any independent endowment except the Jacksonian Professor, who receives 160*l.* per annum from the endowment of his professorship, and 140*l.* only from the University chest.

The other professorships which have to do with some branch or other of science are the following, which I give in the order of their establishment:—

1. The Regius Professorship of Physic founded in 1540, the original endowment of which, 40*l.* per annum, has been reduced by government fees to 34*l.* To this is now added the annual rent of a house left to the professor in 1651 by Mr. Crane, which amounts to 150*l.* per annum.

2. The Lucasian Professorship of Mathematics, founded 1663, is endowed with an estate of which the value now is about 150*l.* per annum. This endowment has been recently augmented by the assignment of three-eighths of the net income of the Sadlerian Trust, which three-eighths amount to about 415*l.* per annum.

3. The Plumian Professorship of Astronomy and Experimental Philosophy, founded in 1704, was endowed with an estate, now of the value of about 260*l.* per annum. This was increased by a bequest of about 46*l.* per annum from Dr. Robert Smith in 1768, and has been recently further increased by the assignment of one-eighth part (amounting to about 138*l.* per annum) of the net income of the Sadlerian Trust.

4. The Woodwardian Professorship of Geology, founded about 1730. The net annual value of the estate with which it is endowed is about 400*l.*, but the income is charged with other expenses, all of which, however, have reference to the science of geology. The University makes the Professor's income 500*l.* per annum, supplying whatever may be necessary for that purpose from the University chest.

5. The Lowndean Professorship of Astronomy and Geometry, founded in 1749, is endowed with an estate producing about 400*l.* per annum. The present Professor acts also as Director of the Observatory, for which he receives a further stipend of 250*l.* per annum from the University chest.

6. The Jacksonian Professorship, founded in 1783, seems to have been intended by the founder principally as a Professorship of Natural Philosophy. The present Professor lectures on mechanism, statics, and dynamics, with their practical application to manufactures and the steam-engine. An account has already been given of the income of the professorship.

7. The Sadlerian Professorship of pure Mathematics,

established in 1863, is endowed with a sum of about 550*l.* per annum, being one-half of the net income of the Sadlerian Trust Estate. The remaining half is applied, as has been already mentioned, to the augmentation of the Lucasian and Plumian Professorships.

8. The Professorship of Zoology and Comparative Anatomy, established in 1866, is endowed with an annual payment of 300*l.* from the University chest.

The University has also established a Demonstrator of Anatomy and a Superintendent of the Museums of Zoology and Comparative Anatomy, each of whom receives 100*l.* per annum from the University chest.

A sum of about 400*l.* per annum is paid from the University chest to examiners in various departments of science.

The only prizes that have been founded in the University for the encouragement of science are—

1. Dr. Smith's two prizes to two commencing Bachelors of Arts in each year, the best proficient in mathematics and natural philosophy. The endowment of these consists of half the interest of a sum of 3,850*l.* new 2½ per cents., the other half being appropriated to the augmentation of the Plumian professorship.

2. The Adams prize, given once every two years to the author of the best essay on some subject of pure mathematics, astronomy, or some other branch of natural philosophy. The endowment consists of the sum of 2,147*l.* 13*s.* 7*d.* 3 per cent. consols.

3. The Sedgwick prize, given every third year for the best essay on some subject in geology or the kindred sciences. The endowment consists of the sum of 500*l.* Scinde railway stock.

A sum of 10,000*l.* 3 per cent. consols was transferred in the year 1859 by the representatives of the late Rev. Richard Sheepshanks to the Master, Fellows, and Scholars of Trinity College, in trust, that one-sixth part of the annual proceeds should be applied every year for the maintenance of an exhibition to be called "the Sheepshanks Astronomical Exhibition," the exhibitor to be elected by the Masters and Seniors of Trinity College from the whole University after an examination; the remaining five-sixths for the promotion of the science of astronomy in the University of Cambridge, and for rendering efficient the Cambridge Observatory for the benefit of astronomy, or of terrestrial magnetism or meteorology, or of such other sciences as are or may be continuously followed in an Observatory. The unexpended balance each year is required to be invested and added to the principal, and the proceeds applied in like manner with the proceeds of the original five-sixths.

In addition to the grants from the Sheepshanks fund, the University has expended annually, on the average of the last seven years, the sum of 710*l.* 1*s.* 3*d.* from the University chest on the maintenance of the Observatory, including the above-named stipend of 250*l.* to the Director of the Observatory.

The following endowments have been left for the maintenance of the Botanic Garden:—

1. Rentcharge of 50*l.* per annum by Dr. Walker, formerly Fellow of Trinity College.

2. A sum of 2,000*l.* 3 per cent. reduced annuities, by Lord Maynard.

3. A sum of 2,000*l.* 3 per cent. reduced annuities, by Rev. E. Betham.

In addition to the annual proceeds of these endowments, the University has expended upon the maintenance of the Botanic Garden, on the average of the last seven years, an annual sum of 548*l.* 11*s.* 1*d.* from the University chest.

A sum of 1,500*l.* is appropriated each year from the University chest for the maintenance of the chemical school, and of the various museums of mineralogy, geology, botany, zoology, comparative anatomy, and human anatomy. A further sum of 1,000*l.* is also at present appropriated annually from the chest for the furniture and fittings of the new museums, and the liquidation of the debt on the buildings.

It will appear from the above statement that the annual amount arising from endowments, properly so called, which is applicable to the promotion and encouragement of science in the University of Cambridge is about 3,300*l.* per annum.

The annual amount which is applied to the same purposes from the University chest, for the payment of which the University has rendered itself responsible, is about 6,100*l.*

It may be proper to explain that the income of the University chest arises principally from the capitation tax levied quarterly upon all persons whose names are on the boards of the University, and from the matriculation, previous examination, and degree fees. The net income of the chest from funded and real property cannot be estimated at more than 1,500*l.* per annum.

I shall have great pleasure in giving more detailed information, to the best of my ability, on any matters which may seem to the Commissioners to require it.

I have the honour to be, Sir,

Your very obedient servant,

E. ATKINSON,

Vice-Chancellor of the University of Cambridge.

J. Norman Lockyer, Esq.,

Secretary to the Royal Commission on Scientific Instruction.

COLLEGES.

1. *St. Peter's College.*

St. Peter's College, Cambridge,

July 9th, 1870.

SIR,

IN reply to your letter of the 11th of June, I have the honour to inform you, for the Royal Commissioners on Scientific Instruction and the Advancement of Science, that no sums are received by St. Peter's College for the advancement of science or for scientific instruction from parliamentary grants.

I have the honour to give you the following further information:—

At St. Peter's College there are 14 foundation fellowships. In the case of a vacancy, any one who had distinguished himself in the University examinations for honours in mathematics (including natural philosophy), or in the natural sciences tripos, would have the same claim to be elected as a candidate who had distinguished himself in the classical or moral sciences, or law and history tripos.

It must not be understood that a candidate, who had been first in the natural sciences tripos, would, as a matter of course, rank equally with a senior wrangler or a senior classic; it is only meant that no distinction would be made between the candidates merely on account of the subjects which they had severally selected for their examinations.

There are 21 scholarships, varying in value from 20*l.* to 80*l.* per annum each, and amounting altogether to 1,000*l.* per annum. About one-half of these have been adjudged to candidates who have distinguished themselves in mathematics, and about one-half to those who have distinguished themselves in classics. On two occasions the College has opened a scholarship for public competition in natural science, but the number of candidates in both cases was extremely small. One scholarship only has been so awarded.

I shall be happy to give any further information in my power to the Royal Commissioners.

I am, Sir,

Your obedient servant,

H. W. COOKSON,

Master of St. Peter's College.

J. Norman Lockyer, Esq.,

Royal Commission on Scientific Instruction and the Advancement of Science.

2. *Clare College.*

Clare College Lodge, Cambridge,

July 7th, 1870.

SIR,

IN reply to the printed circular, dated June 11, 1870, which you have addressed to me as Master of Clare College, on behalf of the Royal Commission on Scientific Instruction and the Advancement of Science, I have to state as follows:

No sums of which this College has the disposal are derived from parliamentary grants.

There are no endowments under the control of this College which have been specially designed to aid scientific instruction or the advancement of science. The Master and Fellows are directed to elect no one into a scholarship "nisi qui moribus doctrina et scientia secundum examina quæ hanc in rem instituta fuerint, magistro et sociis sese approbaverit." Mathematics, pure and mixed, always form a principal subject of examination, and, in point of fact, the majority of our scholarships is awarded to those who excel in mathematics, but, in point of fact, it might happen at any examination that all or nearly all the scholarships were given for excellence in other subjects. I am unable, therefore, in respect of the scholarships generally, to specify any particular sum as applied by the College towards scientific instruction or the advancement of science. In each of the last two years, however, the College has offered, and intends for the future to offer every year, a scholarship of 50*l.* per annum tenable for 3½ years for natural science (that is to say, chemistry, light, heat, and

electricity, comparative anatomy, and physiology and geology). In the former of these years no candidate sufficiently deserving offered himself. But in the present year one of the candidates was elected. At the present time, therefore, only 50*l.* per annum is applied expressly towards the encouragement of natural science in the way of scholarships. Should satisfactory candidates offer themselves in future years, the sum which will be annually given for the encouragement of natural science will be 175*l.* three years hence.

The College contributes 10*l.* per term from its corporate funds to each of the two college lecturers who lecture every term in mathematics and natural philosophy, in addition to the share which they receive of the undergraduates' tuition money.

In the election of fellows the Master and Fellows are required by the statutes always to prefer those "qui moribus et conditione fuerint insigniores quosque magister et socii speraverint firmiterque crediderint ad Die honorem et profectum bonarum litterarum et scientiæ cum effecti velle et posse proficere." The Master and Fellows have regard in the election to distinction obtained in any college or University examination of whatever kind. A considerable majority of the present fellows was elected in consideration of their places in the mathematical tripos. Still I cannot regard the income which they receive as Fellows from the corporate funds of the College in the light of money expressly "applied to the advancement of science or to scientific instruction," although these objects are indirectly greatly promoted by such expenditure.

I am obliged, therefore, to state that, according to the best of my judgment, a sum of 50*l.* per annum paid to a natural science scholar, and a sum of 60*l.* per annum paid to two lecturers in mathematics and natural philosophy, are the only sums directly applied to the advancement of science and to scientific instruction, which are derived from the endowments of this College.

I have the honour to be, Sir,

Your very obedient servant,

E. ATKINSON,

Master of Clare College, Cambridge.

J. Norman Lockyer, Esq., F.R.S.,

Secretary to the Royal Commission on Scientific Instruction.

3. *Pembroke College.*

Pembroke College, Cambridge,

June 15, 1870.

SIR,

I BEG to acknowledge the receipt of your letter of the 11th inst., and to return the following reply to the enquiries of the Commissioners.

This College is not in the possession of any funds derived from parliamentary grants.

I imagine that, by the term "science," the Commissioners understand the various branches of natural science only, and that their enquiries do not refer to mathematics. In the above sense of the word, we have no endowments applied exclusively to the advancement of science or to scientific instruction. The scholarships of the College, however, amount to about 1,000*l.* a year, and the Master and Fellows are quite prepared to apply a portion of these to the encouragement of science, if sufficiently qualified candidates present themselves. Hitherto this has not been the case, and the scholarships have all been awarded for classics and mathematics only. An attempt is now being made by the University to establish a Professorship of Experimental Physics, and to provide buildings and apparatus for that department of science, and I trust that by these and similar means the number of students is likely in future to be largely increased, and that we may be able to elect such students, not only to the scholarships, but also to the fellowships of the College. I may add that by an arrangement with several of the adjacent colleges, provision has been made for the delivery of intercollegiate lectures, on scientific subjects, to the students of this and the other allied colleges.

I have the honour to be, Sir,

Your obedient servant,

J. POWER,

Master of Pembroke College.

J. Norman Lockyer, Esq.,

Secretary, &c.

4. *Gonville and Caius College.*

Sandford Park, Oxon.

June 30th, 1870.

SIR,

IN answer to the inquiry contained in your circular of the 11th inst., I have to state that the aid which is

afforded to science by Gonville and Caius College consists, 1st, in its fellowships; and 2ndly, in its scholarships, prizes, &c. The value of the fellowships and scholarships varies with the net income of each year. Last year there was expended:

	£	s.	d.
For 38 scholarship	1,632	0	0
For prizes	60	0	0
For Schuldam plate	10	0	0
For Thruston speech	18	0	0

The Thruston speech is an annual review of the latest advances made in medical science; the Schuldam plate is given to the most deserving among the commencing Bachelors of Arts; and the prizes go to those who have best acquitted themselves at the College examinations. A scholarship is given away every year for proficiency in chemistry, and another for proficiency in the study of anatomy. As these scholarships are held on an average for three years, it follows that 6 of the 38 scholarships are devoted to the encouragement of anatomy and chemistry. The remaining 32 scholarships are given, but not in any definite proportions, as rewards for success in other lines of study—mathematics, classics, the moral sciences, &c.

The most effectual way in which a college may encourage particular studies lies in the election to its fellowships. Fellowships may be confined to the scholars of a college, which is the prevalent custom at Cambridge, or open (as at Oxford) to the whole University. Our own College, as a general rule, follows the Cambridge custom, but instead of examining the candidates, takes for its guide the University degree. By this mode of procedure, it raises its elections above all suspicion of favouritism or jobbery, while its knowledge of the candidates is a guarantee that no man whose moral conduct is open to suspicion will be allowed to intrude himself into the society. A difficulty, however, arises when we have candidates before us who have earned distinction in *different* lines of study. In such cases, we have no common unit whereby we can measure the claims of the candidates, and much trouble has arisen in consequence. It has been suggested that particular fellowships might be considered as appropriated to men who had earned particular distinctions—literary, scientific, or otherwise. If this were looked upon, not as a rigid rule, which might compel us occasionally to admit inferior men, but as a general understanding among the Fellows of the College, we might, I think, in part at least, get over the difficulties, and be able to extend more widely the benefit of these endowments.

Owing to its confined site, and the situation of our College in the very heart of Cambridge, we have had great difficulty in providing suitable accommodation for the study of certain branches of science. We cannot have a proper laboratory, for instance, within the College or in its immediate neighbourhood without danger of creating a nuisance. We have been very anxious to supply the want, but all our efforts in this direction have hitherto been in vain, and our only means at present of studying chemistry, practically, are such as are provided by the University. A proposition was made a short time since to increase the funds of the University applicable to scientific purposes, and our College expressed its willingness to aid this object by its contributions, provided it had some voice in the application and management of the sums contributed. It refused to hand over any portion of its corporate funds unconditionally to another corporation, 1st, because the demand was thought unreasonable, and 2ndly, because little confidence was placed in the judgment ordinarily exercised by the University in the management of the funds placed under its control.

In conclusion, I may be allowed to express my belief that there is, both in our own College and in the University generally, a sincere wish to encourage, as far as they consistently may, that practical study of physics which I apprehend it is the object of the Commission to promote. Where there are so many conflicting interests to reconcile, it is obvious that prudence is necessary in the endeavour to effect this purpose. Precipitate action might do more harm than good. It would be, indeed, a sad thing if, in becoming "Physicists," we were to put into jeopardy the character of our University, as the great mathematical school of Europe.

I have the honour to be, Sir,
Your obedient servant,
EDWIN GUEST.

J. Norman Lockyer, Esq.

5. Trinity Hall.

Trinity Hall, Cambridge,

June 15th, 1870.

SIR,

In reply to your letter of the 11th instant, as it is difficult to determine precisely what portion of the allowance out of the College funds for general instruction of the students can be considered as specially applied for what is termed "scientific instruction" or for the "advancement of science," I think it better to state that at Trinity Hall instruction is given to the students in classics, law, divinity, the English language, and literature, and also in mathematics and natural philosophy.

That, by an arrangement between Trinity Hall and King's College, lectures are given to their respective students, in optics, hydrostatics, and astronomy, and the apparatus to illustrate such lectures is provided by the two colleges. By a like arrangement with some other colleges, students of Trinity Hall are admitted to their lectures in natural and applied science, and in return their students are admitted to lectures at this College in law, the English language, and literature.

By the statutes of Trinity Hall, three fellowships are attached to tutorial offices, their aggregate stipends about 1000*l.*, and the stipend of 120*l.* paid by the College to the law lecturer, constitute the amount paid out of the College funds for the instruction of the students; about one half of the former sum may be considered as applied for "scientific instruction" or for the "advancement of science."

Three other lecturers are employed to assist the College Tutors, who are paid out of the tuition fees payable by undergraduates; the law lecturer receives a portion of these fees in addition to his stipend. A sum of between 500*l.* and 600*l.*, arising from the general college endowments, is disposed of annually on prizes and scholarships for the undergraduates; about one half of this sum is usually given for proficiency in mathematics and natural philosophy.

In December last, a proposal was made, based on the report of a Syndicate, to raise, by contributions from the colleges, the necessary funds for more extended professional instruction on various subjects of science.

This College expressed its willingness to contribute according to one of the plans, namely, an annual sum equal to 3*l.* per cent. on its distributive income, that is, on the aggregate amount of the income paid out of the College to the Master, Fellows, Scholars, and some other college officers, provided the other colleges were willing to make a similar contribution, but from a want of unanimity of the colleges on the subject, the above proposal has not yet been adopted.

I am, Sir,
Your obedient servant,
T. C. GELDART,
Master of Trinity Hall.

J. Norman Lockyer, Esq.,
Secretary, &c.

6. Corpus Christi College.

[See p. 23.]

7. King's College.

King's College, Cambridge,

August 9th, 1870.

SIR,

In answer to your former letter of June 11th last, I had procured from my College the accompanying return, but I abstained from sending it, after hearing from Professor Stokes, in conversation, that it was not the sort of information intended by the Commissioners.

Your second letter of the 6th instant, asking for a return of the number of students attending classes in which science is taught, seems as little to require any information which can be given from King's. But I am unwilling, after a second appeal, to remain entirely silent, and, therefore, enclose the return which I had procured under a first interpretation of the terms "Scientific Instruction and the Advancement of Science."

I have the honour to be, Sir,
Your obedient servant,
RICHARD OKES, Provost.

J. Norman Lockyer, Esq.,
Secretary, &c.

MATHEMATICAL INSTRUCTION AT KING'S COLLEGE,
CAMBRIDGE.

There are two mathematical lecturers at salaries of 150*l.* and 80*l.* per annum respectively.

Prizes to the amount of 10*l.* are annually given for instruction in mathematics.

Mr. Richards, a former fellow of the College, bequeathed to the College a legacy of 20*l.* annually for the scholar who shall have passed the best mathematical examination in his third year.

Mr. Martin Thackeray, formerly fellow of the College, left 1,000*l.*, the interest of which is to be given to the scholar of King's College (educated at Eton) who shall take the highest degree among the wranglers in the mathematical tripos.

RICHARD OKES, Provost.

August 9th, 1870.

8. Queen's College.

Queen's Lodge, Cambridge,

June 14th, 1870.

SIR, I HAVE the honour to acknowledge the receipt of your communication of the 11th.

At an examination for minor scholarships held in the beginning of last month, three scholarships were given for mathematics, and one for classics. Generally more scholarships are given for mathematics than for classics. Not only are the greater number of scholarships in this College obtained by mathematics, but most of the fellowships have also been given for proficiency in them.

We have here a studentship of 50*l.* a year, which is now held for proficiency in the natural sciences.

As for scientific instruction, there are college lectures, and intercollegiate lectures in all the branches of science which are pursued in the University.

I shall be happy to furnish you with any further information you may desire.

I have the honour to be, Sir,
Your obedient servant,

J. Norman Lockyer, Esq.,
Secretary, &c.

GEO. PHILLIPS.

9. St. Catharine's College.

The Close, Norwich,

17 June 1870.

SIR, I HAVE the honour to acknowledge the receipt of your letter of inquiry, dated June 11, 1870.

I beg to inform you that my College enjoys no parliamentary grants either for the advancement of science or for scientific instruction.

There are no endowments in my College for either purposes; but certain fellows of the College, who are appointed to the offices of tutor or of lecturer, are in the habit of instructing the college students in mathematics during each academical term.

As the Commissioners are pleased to invite suggestions, I beg to offer this for their consideration:—That colleges should be empowered to confer fellowships upon scientific professors in their own University. The usual restrictions in reference to celibacy and the amount of private or public income enjoyed by the fellows being, in this special case, abrogated.

I believe that our colleges would avail themselves of this opportunity of thus supplementing the income of professors, and of adding distinguished men to their own governing body.

I am, Sir, your obedient servant,

CHARLES KIRKBY ROBINSON,

Master of St. Catharine's College, Cambridge.

J. Norman Lockyer, Esq.,
Secretary, &c.

10. Jesus College.

[See p. 24.]

11. Christ's College.

Christ's College, Cambridge,

9 February 1871.

SIR, I VERY greatly regret that I have not long ago answered the inquiry which you addressed to me in regard to the aid and encouragement given in this College to students prosecuting natural and applied science.

There is at present no direct instruction given in the College itself on subjects of this nature.

But, in the spring of 1870, we held an examination for open scholarships of students about to commence residence at the University, the subjects being those of the Natural Science Tripos, which comprise Chemistry, Botany, Geology, Mineralogy, and Zoology, with Comparative Anatomy and Comparative Physiology; and we gave two scholar-

26060.

ships of 70*l.* and 50*l.* a year, respectively, for proficiency in some or other of these subjects.

We purpose making this an annual examination.

We shall also, for the future, examine those of our resident students, who are pursuing natural science, in each year of their undergraduate course, and reward those who are distinguished with prizes and scholarships, or increased scholarships, as the case may be.

The Fellows of the College and myself are fully aware of the importance of aiding the pursuit of natural and applied science by our students; and I do not conceive that we are under any legislative disability in regard to the appropriation of our funds to this purpose.

I have the honour to be, Sir,

Your faithful servant,

JAMES CARTMELL,

Master of Christ's College.

J. Norman Lockyer, Esq.

12. St. John's College.

St. John's College, Cambridge,

June 25th, 1870.

SIR, IN reply to the circular letter addressed to me by the Royal Commissioners on Scientific Instruction and the Advancement of Science, dated 11th June 1870, I have the honour to state—

1. That St. John's College receives no parliamentary grant of any description.

2. That no endowment of the College is in terms specifically appropriated to scientific instruction.

3. That under the discretionary powers vested in the governing body of the College, several appropriations of money have been at different times made for the purposes referred to by the Commissioners, viz.:

500*l.* to 600*l.* for the building of a chemical laboratory.

150*l.* per annum for the stipend of a Superintendent thereof, who also gives lectures on chemistry to members of the College, as well as to other students.

100*l.* per annum for the stipend of a lecturer on geology.

150*l.* per annum for the maintenance of three exhibitions for natural science, of the yearly value of 50*l.* each, which exhibitions are more particularly described in the printed paper enclosed herewith. [See below.]

4. That the general staff of College lecturers include within their course of instruction much that is embraced within the term science, which it is probably unnecessary for me to describe more particularly in this statement.

5. That it is the practice of the College to elect to foundation fellowships and scholarships students who are eminent for their scientific attainments, with the same degree of favour as students who are distinguished in the other studies recognised by the University.

To the foregoing statement, I beg leave to add that it will give me pleasure to answer any further inquiries which H. M. Commissioners may address to me; and

I have the honour to be, Sir,

Your obedient servant,

W. H. BATESON,

Master of St. John's College, Cambridge.

J. Norman Lockyer, Esq.,
Secretary, &c.

SAINT JOHN'S COLLEGE, CAMBRIDGE.

Minor Scholarships and Open Exhibitions for the Year 1870.

In the year 1870 there will be open for competition four minor scholarships, two of the value of 70*l.* per annum, and two of 50*l.* per annum, together with

Three exhibitions of 50*l.* per annum, tenable on the same terms as the minor scholarships.

The examination of candidates for the above-mentioned scholarships and exhibitions will commence on Tuesday, the 26th of April 1870, at 9 a.m.

The examination will consist of three mathematical papers, and four classical papers, and the latter will contain passages of Greek and Latin prose and verse for translation into English, and also each a passage from an English author for the corresponding prose or verse composition.

In addition to the papers above mentioned, the candidates will be examined *vivâ voce* in classics; and the Master and Seniors wish it to be understood that a candidate may be elected on the ground of proficiency in either the classical or the mathematical branch of the examination, independently of the other.

Besides the seven minor scholarships or exhibitions above mentioned, there will be offered for competition an exhibition of 50*l.* per annum for proficiency in natural science; the exhibition to be tenable for three years in case the exhibitioner have passed within two years the previous ex-

amination, as required for candidates for honours, otherwise the exhibition to cease at the end of two years.

The candidates for the natural science exhibition will have a special examination on Friday and Saturday the 29th and 30th of April 1870, in

- (1.) Chemistry, including practical work in the laboratory.
- (2.) Physics, viz.

{	Electricity.
	Heat.
	Light.
- (3.) Physiology.

They will also have the opportunity of being examined in one or more of the following subjects:—

- (4.) Geology,
- (5.) Anatomy,
- (6.) Botany,

provided that they give notice of the subjects in which they wish to be examined four weeks prior to the examination.

No candidate will be examined in more than three of these six subjects, whereof one at least must be chosen from the former group. It is the wish of the Master and Seniors that excellence in some single department should be specially regarded by the candidates. They may also, if they think fit, offer themselves for examination in any of the classical or mathematical subjects.

Candidates must send their names to one of the Tutors at least ten days before the commencement of the examination, and if they have not been already admitted members of the College, must send the certificates required previous to admission, viz., a certificate of baptism, and a certificate from some M.A. of Oxford or Cambridge, drawn up in the following form:—

“ I hereby certify that I have examined
“ and I consider him qualified both in manners and learning to be admitted a member of the University of
“ Cambridge.”

The minor scholarships are open to all persons under twenty years of age, whether students in the University or not, who have not yet commenced residence in the University, or who are in the first term of their residence.

A minor scholarship is tenable for two years, or until the scholar is elected to one of the foundation scholarships.

The exhibitions are not limited in respect to the age of candidates.

It is understood that minor scholars or exhibitioners may be candidates for sizarships.

13. *Magdalene College.*

[See p. 24.]

14. *Trinity College.*

Trinity College Lodge, Cambridge,

14th June 1870.

SIR,

I HAVE to acknowledge the receipt of a circular letter, in which you invite me to state for the information of the Royal Commission, what sums, derived from endowments or parliamentary grants, are applied to the advancement of science or to scientific instruction by this College.

By the word “science,” I understand Her Majesty’s Commissioners to mean the sciences of experiment and observation, to the exclusion not only of moral and mental, but of mathematical science also, save in so far as regards its application to practical purposes.

Using the word in this popular and restricted sense, I have to report the following contributions, made by the College out of its collegiate revenues, to scientific instruction in the University.

1. We have recently endowed a “prælectorship” (to use the statutable name) in “pure physiology,” and appointed a prælector, who receives from our funds about 500*l.* per annum, on condition of delivering lectures during term to the students of this and other colleges. These lectures are to be given *gratis* to our own students, and for a small fee to those not belonging to Trinity.

2. We have made a grant of 400*l.*, also out of yearly revenue, to the prælector for the purpose of procuring scientific apparatus required for the prosecution and elucidation of the science he professes. This apparatus will be placed in one of the public rooms of the University, in the event of permission being given to Dr. Michael Foster* to deliver his lectures there.

3. We annually offer one or more foundation scholarships for proficiency in the natural sciences. The value of such a scholarship may be put at about 80*l.* per annum,

and it is open to the competition of all undergraduate members of Oxford or Cambridge.

4 We have this year offered to the competition of all members of the University of the standing of Bachelor of Arts or Law, a fellowship on the foundation of the College. This, to a resident, is worth about 350*l.* per annum, rooms and commons included. To a non-resident it is worth upwards of 250*l.*

5. We have recently bestowed a fellowship (as our statutes enable us to do) on a highly meritorious scientific professor* in the University, whose professorship is understood to be inadequately endowed. This fellowship is tenable with the professorship and not otherwise.

6. The College has supplied with the necessary apparatus a lecturer on general physics, including heat and electricity, who, however, derives his salary at present from the “Tristram fund,” and not from the revenues of the College. His lectures are open by arrangement to the members of certain other colleges, though primarily intended for the instruction of our own students.

These are the contributions which Trinity College at present makes to the scientific instruction of the College and University. It is fair to add that we have on all occasions professed our willingness, indeed our earnest desire, to allot a per-centage of our divisible revenues for the endowment of professorships in the University, for the building of museums, &c., and the purchase of adequate apparatus. Attempts have more than once been made by the Syndic appointed for the purpose, to induce the other colleges to contribute their quota, but it has hitherto not been found possible to obtain the co-operation of all of those bodies. This, I venture to think, would be a perfectly effectual means of extending the instruction given by the University, so as to embrace all the requirements of advancing science. That it is a far more economical method than the endowment of lectureships such as that described in (1.) would be admitted by all competent judges in the University.

I have the honour to be, Sir,

Your obedient servant,

W. H. THOMPSON.

J. Norman Lockyer, Esq.,
Secretary, &c.

15. *Emmanuel College.*

Emmanuel College, Cambridge,

June 23d, 1870.

SIR,

I BEG to inform you, in reply to your letter of inquiry respecting the sums applied at Emmanuel College to the advancement of science, that at this College there is no endowment or grant devoted directly and exclusively to what I understand to be the purpose referred to; but, as it is the desire of the College, in the disposition of its emoluments, to encourage impartially all branches of science and of scholarship, all the advantages and rewards of the College are open to students of natural science, and attainable by them on their showing merit in their course of study.

If I could supply you with any special information which could be of service to your purpose, I would gladly do so at any time.

I am, Sir, yours faithfully,

GEORGE PHEAR, Tutor.

(Locum-tenens of the Master of Emmanuel College.)

J. Norman Lockyer, Esq.,
Secretary, &c.

16. *Sidney Sussex College.*

Sidney Sussex College, Cambridge,

14th June 1870.

SIR,

I HAVE the honour to acknowledge the receipt of your printed letter of the 11th inst., requesting me to furnish a statement of all sums applied to scientific instruction or the advancement of science in Sidney Sussex College which are derived from endowments or from parliamentary grants.

I presume that by “science,” is meant science other than the “classics, mathematics, and divinity,” which have, heretofore, constituted the Cambridge academical curriculum, and to the cultivation of which the whole revenue of this College may be said to have been applied. For promoting the advancement of science, or for aid to scientific instruction in any other or more extended sense, the College has no special endowments, nor has it received parliamentary grants for any purpose whatever.

* The present “Prælector.”

* The Plumian Professor of Astronomy.

A full statement of the revenue and expenditure of the College was submitted to the Royal Commission of 1860, but I do not understand such a statement to be required by the "Scientific Instruction Commission."

The object of the foundation of this College was, almost exclusively, the education of the reformed Protestant Church of England. The practice of the College, in regard to teaching, has been to accept the general course of study of the University, and to elect as fellows and scholars such of its members as most distinguished themselves therein. The College has by this means always secured a highly competent staff of teachers in those branches of learning which have, heretofore, been held to constitute, in the main, the "higher education."

There appears to have been a general expectation, of late years, that the academical curriculum should be extended and diversified by the admission of various sciences other than mathematical, and in accordance with this expectation, a new honour tripos has, in fact, been established in the University, called the "Natural Science Tripos." This College has encouraged students to become candidates for honours in the tripos. The Royal Commission of 1860 gave the College new statutes, relieving half the number of its fellows from the obligation of taking holy orders. The College may, therefore, reasonably look forward to numbering among its fellows students who have been able to devote themselves exclusively to natural science; and, indeed, it has already shown its desire to fall in with the spirit of the times by having elected a fellow from those who had distinguished themselves in the new honour tripos.

What I wish to make apparent is, that although, as it seems to me, Sidney College has no special endowments for scientific objects in the sense of these new studies, there is every disposition on the part of this College to give a liberal interpretation to the objects of the classical and mathematical endowments of which it is possessed, and to make their application co-extensive with the academical curriculum, whatever that may be or become. And as, when that course was limited, or nearly so, to classics and

mathematics, the elections to fellowships and scholarships for distinction therein supplied the College with a staff of competent teachers, so it may naturally be expected that an equally competent staff of teachers of other subjects will result from making fellowships the reward of high attainments in those subjects, and that the College will thus secure the services of teachers co-operating with the University professors in the various sciences which are engaging the attention of the most able men of the age.

To such a view as this, it may possibly be objected that no one College would be likely to enumerate among its fellows men able and willing to give instruction in so great a variety of subjects; and this objection would be valid were it not that a remedy has been devised, and is, in fact, already in operation, and is perfectly compatible with the maintenance of our collegiate system. Three or four colleges combine and enter into arrangements for inter-collegiate assistance. Thus, for instance, one college having a good chemical laboratory, and a competent lecturer and experimenter in chemistry, receives pupils from other colleges for instruction in that science, sending, in return, to those colleges some of its own students, for instruction in other sciences, and so on.

Trusting that the remarks which I have made may not be considered irrelevant to the objects of the Royal Commission on Scientific Instruction, &c.,

I have the honour to be, Sir,

Your obedient servant,

ROBT. PHELPS, D.D.

Master of Sid. Suss. Coll.

J. Norman Lockyer, Esq.,
Secretary, &c.

17. Downing College.

[No answer received.]

II. Heads of Colleges and Halls in the University of Oxford asked to give evidence.

On August 4th, 1870, the following letter was addressed to the Heads of Colleges and Halls at Oxford:—

Aid to Science Commission,
6, Old Palace Yard,
Westminster, S.W.,
August 4th, 1870.

I AM directed by the Duke of Devonshire, the Chairman of this Commission, to transmit to you the accompanying copy of the Royal Commission under the authority of which the Commissioners are conducting their enquiries, and to inform you that they have reached that stage of the proceedings at which it would be convenient that the evidence of the heads of the colleges at Oxford should be taken.

In order that arrangements may be made for taking such evidence immediately after the recess, I am directed to enquire whether you have any facts or suggestions to lay before the Commissioners with regard to College; and to ask if you would be prepared to aid the Commissioners in the prosecution of their enquiry by attending to give evidence in November or December next?

I have the honour to be
Your obedient servant,
J. NORMAN LOCKYER,
Secretary.

The following replies were received:—

1. University College.

SIR,
University College, Oxford,
November 5th, 1870.
I REGRET that some pressing engagements have not allowed me to reply earlier to the communication which you sent to me on October 31st, respecting my attendance on the 22nd inst. before the Commissioners, to give evidence

on the aid given to scientific instruction and the advancement of science in this College.

I beg leave to state that though I should be ready to attend if it should be desired, I should not be able to give any further information than what I have already stated in my answers to a former paper which I had received.

The number of foundation fellowship in this College is small, being 12, one of which is for the present suppressed, in order to raise funds for the augmentation of the scholarships and exhibitions in the College, and these hardly supply a succession in the number of tutors and lectures required for the education in the College.

The number of open scholarships is 12, two of which, lately established by the College, are for proficiency in mathematics or natural science. But these have not yet been offered for natural science, because it was probable from what had occurred in other colleges that very few candidates of sufficient merit would be likely to offer themselves. Only one of our exhibitioners has within the last few years given attention to science, and he obtained a first class on the public examination this year.

If the study of science should be more generally adopted, so that promising candidates would be likely to offer themselves, the College would be ready to offer these two open scholarships to competition, and to provide that they should receive their instruction in such subjects as may be desired from the professors in the University.

If, under these circumstances, it should still be desired that I should appear before this Committee on the 22nd inst., I shall be ready to attend on receiving a notice from you.

I am, Sir,
Your obedient servant,
F. C. PLUMPTRE, D.D.,
Master of University College.

J. Norman Lockyer, Esq.,
Secretary.

2. *Balliol College.*

Balliol College, Oxford,
August 5th, 1870.

SIR, I HAVE the honour to acknowledge your letter of yesterday, and to say in reply that I shall be happy to wait on the Commissioners if they think it desirable. But I have to point out to them that I am no longer Master of Balliol, and am on the point of leaving Oxford for Rochester, and that my successor in the headship of this College will be elected in the early part of next month. Perhaps, therefore, the Commissioners may think it more expedient to apply to him for any information or suggestions regarding Balliol College.

I have the honour to be, Sir,
Your obedient servant,
ROBERT SCOTT.

The Secretary,
Aid to Science Commission.

3. *Merton College.*

[See p. 10.]

4. *Exeter College.*

Exeter College, Oxford,
August 5th, 1870.

SIR, I HAVE no facts or suggestions to lay before the Commissioners, but shall, of course, be ready to attend at any time the Commissioners may require, for the purpose of giving evidence.

I have the honour to be
Your obedient servant,
J. P. LIGHTFOOT,
Rector of Exeter College.

5. *Oriel College.*

Precincts, Rochester,
August 31st, 1870.

SIR, I REGRET that absence from Oxford, and continual employments at this place, to which your letters of August 4th and 5th have been forwarded, have hitherto prevented my answering them.

1. In reply to your letter of the 4th instant, I can only say that I should be happy to aid the Commissioners in the prosecution of their inquiries if it were in my power; but I do not think that I have any facts or suggestions to lay before them—none at all with regard to Oriel College.

In the University there was a sensibly decreasing attendance upon lectures in physical science during many years after the alterations in the public examinations in 1801 and 1807, and this notwithstanding endeavours on the part of the University authorities to correct the tendency.

But subsequently to the passing a new examination statute in 1850, which established a distinct school in natural science, the attention of the junior students to this department of study has greatly increased, and is, I believe, increasing.

2. With respect to the return desired in your letter of the 5th instant, I do not find that more than two of the junior members of this College were attending classes in natural science during the academical year from October 1869 to July 1870.

3. And to your previous question in June last, what sums derived from endowments or from parliamentary grants are applied to the advancement of science, or to scientific instruction, in Oriel College, I have only to reply that we have no sums of the kind to be applied to these purposes.

But, perhaps, I may add, for the information of the Commissioners, that, as Provost of Oriel College, I am a co-trustee with the Vice-Chancellor of Oxford of a sum (originally 1,000*l.*, but now, by accumulations in former years, increased to 3,200*l.*, in the three per cent. consolidated annuities), bequeathed by Lord Leigh, a former member of this College, for the purchase of instruments for the use of the Professor of Experimental Philosophy in the University of Oxford, and the annual interest of this sum is so applied. But this fund has no reference to the advancement of science in Oriel College itself.

I am, Sir, your faithful servant,
EDWARD HAWKINS,

J. Norman Lockyer, Esq.,
Secretary, &c. Provost of Oriel.

6. *The Queen's College.*

[See p. 11.]

7. *New College.*

New College, Oxford,
November 4th, 1870.

SIR, IN reply to the inquiry made in your letter of the 5th of August last, on the part of the "Aid to Science" Commission, I beg leave to state that no lectures on science are given in this College, but that we make arrangements for any students in those subjects to attend the lectures, work in the laboratory, &c., at the University museum; and that the number, therefore, of such students will be included in the returns made from thence. I am not aware that I can assist the Commissioners in their inquiry by further information.

I have the honour to be, Sir,
Yours obediently,
J. E. SEWELL, Warden.

8. *Lincoln College.*

Lincoln College, Oxford,
August 6th, 1870.

SIR, I HAVE to acknowledge your communication of date 5 August. I beg to say, in reply, that I am prepared to be examined by the Aid to Science Commission in November or December, or whenever summoned.

I am yours obediently,
MARK PATTISON.

9. *All Souls' College.*

20, Dean's Yard, Westminster,
August 17th, 1870.

SIR, I AM not aware that I have any suggestions as to the promotion of the study of science in Oxford to lay before the Commissioners with regard to All Souls' College, but I shall be happy to attend and give evidence in November or December next, if it is thought such attendance can be of any use.

I have the honour to be, Sir,
Your faithful servant,
F. K. LEIGHTON,
Warden of All Souls' College, Oxford.

10. *Magdalen College.*

SCIENTIFIC INSTRUCTION, &c.

THERE WAS no special endowment under the original foundation of the College for the promotion of natural science, except that there is mention in the statutes of a prælector who might lecture either in divinity or natural philosophy at the discretion of the College officers.

But under the ordinance of 1857 certain fellowships, demyships, and exhibitions were set apart for the encouragement of the science of physical study, and four professorships instituted, viz., one in moral philosophy, one in chemistry, one in geology, one in physical geography. Of these, two, viz., the professorships in moral philosophy and chemistry, have been already established, and the remainder will be so as soon as the funds necessary for the purpose have accrued.

The payments, therefore, at present made by the College on behalf of natural science are as follow:—

1. Chemistry professor, at per annum	- £600
5. Demies at 75 <i>l.</i> each per annum	- 375
1. Exhibitioner	- 75
1. Fellowship	- 230
	£1,280

And as funds accrue, two more professorships, as stated above, at a salary of 600*l.* each per annum, and three more fellowships, with an increased number of exhibitions, will be added, making, with the sums already stated, a total of 3,280*l.* 10*s.* per annum devoted to the advancement of physical science.

This, it should be mentioned, is entirely exclusive of the same number of fellowships, demyships, and exhibitions, assigned to mathematics.

The demyships and exhibitions are open to any person under 20 years of age, without any restrictions as to place of birth or education.

The fellowships are open to any person who has passed the examinations necessary for the B.A. degree in the universities of Oxford and Cambridge. The holders of fellowships in natural science are not required to take holy orders.

In addition to this, the College maintains a tutor in natural science, who is placed on the same footing as the classical and other tutors of the College, also a laboratory with an efficient curator, and a library for the use of its natural science students. A sum of at least 250*l.* per annum is required for these objects, of which about 30*l.* per

annum is provided by the interest on 1,000*l.* stock, bequeathed by the late Dr. Daubeny towards the maintenance of the curator, which sum of 1,000*l.* is the only *original* endowment granted or bequeathed for the promotion of the study of natural science in this College.

NOTE.—The number and ability of competitors for the natural science demysships is found to fluctuate very much from year to year, and, in this respect, to show a marked difference from the demysships in classics and mathematics. The removal of the limitation as to age would doubtless in some degree obviate this, and, so far as the College is concerned, be an advantage; but, on the other hand, might tend to discourage candidates from the public and other schools, who would be unwilling to come forward with the knowledge that they might have to compete with persons much older than themselves.

Magdalen College,
November 4th, 1870.

FREDERIC BULLEY,
President.

DEMYSHIPS IN NATURAL SCIENCE.

IN conducting the examination, questions will be put relating to general physics, to chemistry, and to physiology; but a clear and exact knowledge of the principles of any one of the above-mentioned sciences will be preferred to a more general and less accurate acquaintance with more than one.

Candidates have also to satisfy the electors of their ability to pass the ordinary classical examinations required by the University, and for this purpose will have:

a. To translate a passage of English prose into Latin.

b. To bring up for examination—

One Greek author, or a portion, such as five books of Homer, or two Greek plays, or any other equivalent.

One Latin author, or a portion, such as the Georgics, or five books of the *Æneid* of Virgil, or three books of the Odes, and the *De Arte Poetica* of Horace, or any other equivalent.

γ. To answer questions in Greek and Latin grammar.

Very superior excellence, however, in natural science will be allowed to compensate for any deficiency which candidates may have shown in the classical part of the examination.

The stipend of the above demysships is 75*l.* per annum, inclusive of all allowances; but there are tenable with them certain College exhibitions, which raise their annual value on an average to about 83*l.* They are tenable for five years.

No one will be admitted as a candidate who shall have attained the age of 20 years.

Candidates will be required to bring with them a certificate of birth and baptism, with testimonials of good conduct and character, extending over a period of at least three years, from the head master of their school, or from the private tutor with whom they may have been reading.

No entrance fees or caution money are required by the College. The university fees payable on matriculation amount to 2*l.* 10*s.*

11. Brasenose College.

Brasenose College, Oxford,
October 2nd, 1870.

SIR, I BEG to acknowledge the receipt of your letter of August 4th, in which, on behalf of the "Aid to Science Commission," you inquire whether I have any facts or suggestions to communicate respecting Brasenose College, and whether I should be prepared to give attendance on the Commission in November or December next.

I have elsewhere stated, in communication with the Commissioners, that no special provision exists in Brasenose College for the study of physical science.

The comparatively few members who pursue that study, work, and for the most part very diligently, in the University museum, either with a view to the B. A. degree, or with ulterior professional objects.

I do not think that there exists, at present, among our members much taste for science for its own sake, and there is no sufficient demand on the College to require the establishment of a laboratory, without which, I suppose, lectures would be very unattractive, and of little use.

If a demand arose, which possible changes in the scheme of University examinations may promote, I should feel disposed to recommend a combination with other colleges to supply a common want. (We have already arranged with some other colleges for combined lectures in certain other subjects of instruction.)

A separate establishment in each college, except the very largest, would seem, unless under greatly altered circumstances, to be a waste of power.

Feeling that the study of physical science is not in a satisfactory position, I could not decline personally to wait on the Commission, if I had reason to suppose that my evidence could be useful.

I should, however, very much prefer to reply with deliberation, on paper, to any inquiry which the Commissioners may think it convenient to make.

I have the honour to be, Sir,

Your faithful servant,

The Secretary,
Aid to Science Commission.

E. H. CRADOCK,
Principal.

12. Corpus Christi College.

Corpus Christi College, Oxford,
August 9th, 1870.

SIR, IN reply to your inquiry of the 4th inst., I beg to say, that although I am quite willing to assist the Commissioners in the prosecution of their inquiry, I have no facts or suggestions on the subject which I wish to lay before them.

I have the honour to be

Your obedient servant,

JAMES NORRIS,

President of C. C. C.

J. N. Lockyer, Esq.,
Secretary, &c.

13. Christ Church College.

Penmorfa, Llandudno,
August 5th, 1870.

SIR, I HAVE prepared a paper [see p. 11] stating in full what we have done at Christ Church, Oxford, for the study of scientific subjects and instruction to be given therein. You will have a corrected proof, I hope, on Monday. If my *viva voce* evidence is required in November or December next, I shall be ready to give it, but I should be glad to be informed on what points I am likely to be examined.

I am your obedient servant,

H. G. LIDDELL,

Dean of Christ Church.

To the Secretary of the Science Commission.

14. Trinity College.

[See p. 13.]

15. St. John's College.

[No answer received.]

16. Jesus College.

[No answer received.]

17. Wadham College.

Wadham College, Oxford,
August 6th, 1870.

SIR, I HAVE the honour to acknowledge the receipt of the Royal Commission transmitted by the direction of the Duke of Devonshire, Chairman, and I beg to assure you, for the information of the Commissioners, that I shall readily attend to their summons at Oxford, and offer such evidence as a very long residence in the University and some interest in the matter of their inquiry may qualify me to give.

I have the honour to be, Sir,

Your faithful servant,

J. Norman Lockyer, Esq.

B. P. SYMONS.

Wadham College, Oxford,

SIR, I AM concerned to say that physical infirmities, of age mainly, will, I fear, preclude my personal attendance on the Commissioners. Of this (my own College), to which you more immediately direct my attention, I am not aware that anything especial, beyond our actual practice, is called for. "Scientific instruction" is provided for students of the College in the several branches recognised in the schools of the University. Nor has "science" failed to receive, in this College, its portion of patronage. Our "scholarships" are always avowedly open to candidates whose pretensions rest on proficiency in "science;" and, from time to time, our election of a scholar is determined exclusively by his scientific attainments. Further, at the last election of a "fellow," we went so far as to limit, by public announcement, the examination of candidates to matters exclusively scientific. More than this, in favour of "science," neither the actual state of the University, nor the preference likely to be given by young men to such studies, would, I think, warrant. Inducements in this direction exist at present fully in proportion to the number of willing students; and any attempt to force the study on unwilling, could not fail to interfere with the legitimate claims of a "liberal education."

"Instruction" and "education" are two very different things, and it is of as much, perhaps more, importance to have the mind well disciplined than even abundantly stored. "Instruction" may be carried to an extent to endanger the great and main purpose of "education."

To any questions the Commissioners may be pleased to put to me, I will readily bring the best consideration that the experience of 20 years as public tutor, and nearly 40 as Head of the College, with a deep interest always in the subject matter of those offices, may have enabled me to give.

I have the honour to be, Sir,
Your faithful servant,
B. P. SYMONS,
Warden of Wadham College.

To Secretary of the
Commission on Scientific Instruction

18. Pembroke College.

Pembroke College, Oxford,
August 16th, 1870.
SIR, IN reply to your letter of the 4th inst., I beg to state that I have no suggestion with respect to this College to lay before Her Majesty's Commissioners, and that I have no fact to add to that which I have already communicated, viz, that we have a medical fellowship in the election to which proficiency in natural science will, in all probability, be always taken into account.

If, under these circumstances, the Commissioners should think proper to summon me, I shall be prepared to attend to give evidence in November or December next.

I have the honour to be, Sir,
Your obedient servant,
E. EVANS, Master.
J. Norman Lockyer, Esq.,
Secretary to H.M. Aid to Science Commission.

19. Worcester College.

5, Hall Bank, Buxton,
August 8th, 1870.
SIR, I HAVE no facts or suggestions to lay before the Commissioners of the Aid to Science Commission. But, of course, I shall feel it my duty to attend them in November or December next, if required.

I may be permitted to state that it would be more convenient to me to appear before the Commissioners in November than in December.

I am, Sir,
Your obedient servant,
R. L. COTTON,
Provost of Worcester College.
J. Norman Lockyer, Esq.

HALLS.

1. St. Mary Hall.

[No answer received.]

2. Magdalen Hall.

SIR, Creff, September 19th, 1870.
IN answer to the inquiries of the Royal Commissioners, I beg to state that only three students of Magdalen Hall attended "classes in which science was taught," with a view to passing a public examination therein, in the years 1869-1870.

It is not in my power to say how many more may have attended lectures in geology and other branches of science, more or less popular, for general improvement or other objects.

I shall be quite ready to give evidence on all subjects connected with Magdalen Hall "in November or December next," if the Commissioners should wish me to do so.

I am Sir
Your obedient servant,
R. MICHELL, D.D.
Principal of Magdalen Hall.

J. Norman Lockyer, Esq.,
Secretary to the Aid to Science Commission.

3. New Inn Hall.

[No answer received.]

4. St. Alban Hall.

St. Alban Hall, Oxford,
August 25th.
SIR, IN reply to your printed letter of the 19th, the receipt of which was delayed by my absence from home, I beg to say that I have no facts or suggestions to lay before the Commissioners respecting St. Alban Hall.

I am, Sir,
Your obedient servant,
W. C. SALTER.
J. Norman Lockyer, Esq.

5. St. Edmund Hall.

St. Edmund Hall, Oxon.
August 22nd, 1870.
SIR, IN reply to your inquiries on behalf of the Aid to Science Commission, I beg to state that no students at St. Edmund Hall attended classes in science during the years 1869-70. I have no facts or suggestions to lay before the Commissioners on the subject, and I presume, therefore, there would be no object in my attending to give evidence before them.

I remain, Sir,
Yours faithfully,
E. MOORE,
Principal of St. Edmund Hall, Oxford.
To the Secretary, Aid to Science Commission.

III. Heads of Colleges in the University of Cambridge asked to give evidence.

On the 13th December, 1870, the following somewhat similar letter was addressed to the Heads of Colleges at Cambridge:—

Aid to Science Commission,
6, Old Palace Yard,
Westminster, S.W.,
13th December 1870.

I AM directed by the Duke of Devonshire, the Chairman of this Commission, to transmit to you the accompanying copy of the Royal Commission under the authority of which the Commissioners are conducting their inquiries, and to inform you that they have reached that stage of the proceedings at which it would be convenient that the evidence of the Heads of the Colleges at Cambridge should be taken, on the subjects of their inquiry generally, and especially as to whether they are under any legislative disability with regard to the appropriation of their funds.

In order that arrangements may be made for taking such evidence immediately after the recess, I am directed to enquire whether you have any facts or suggestions to lay before the Commissioners with regard to

College; and to ask if you would be prepared to aid the Commissioners in the prosecution of their inquiry by attending to give evidence in the early part of February next?

I have the honour to be
Your obedient servant,
J. NORMAN LOCKYER,
Secretary.

The following replies were received:—

1. St. Peter's College.

St. Peter's College, Cambridge,
January 23, 1871.
SIR, IN reply to your circular letter of 13th December 1870, I beg to state, after consulting the Fellows, that I am not aware of any facts or suggestions, with regard to St. Peter's College, to lay before the Commissioners on Scientific Instruction and the Advancement of Science.

The Master and Fellows have already answered some questions emanating from the Commissioners, and they are ready and anxious to give any further information in their power.

As regards my individual willingness to give evidence before the Commissioners, I shall be most happy to do so if called upon, but I fear that I can add nothing to the information which must have been already given to the Commissioners.

I am, Sir,
Your most obedient servant,
H. W. COOKSON.

J. Norman Lockyer, Esq.,
Secretary to the Aid to Science Commission.

2. Clare College.

Clare College, Cambridge,
December 14, 1870.

SIR, I HAVE the honour to acknowledge the due receipt of your letter of yesterday, addressed to me in the name of the Aid to Science Commission, together with the accompanying copy of the Royal Commission, under the authority of which the Commissioners are conducting their inquiries.

In reply to the question which you put to me, I have to say that, although I have not at present in my mind any facts or suggestions which I am desirous of laying before the Commissioners with regard to this College, I shall be prepared, as far as I may be able, to aid the Commissioners in the prosecution of their inquiry, by attending to give evidence in the early part of February next, if such should be the desire of the Commissioners.

I have the honour to be, Sir,
Your obedient servant,
E. ATKINSON,
Master of Clare College.

J. Norman Lockyer, Esq.,
Secretary of the Aid to Science Commission.

3. Pembroke College.

Pembroke College, Cambridge,
Dec. 16, 1870.

SIR, IN reply to your letter of the 13th inst., I beg to say that I am not aware that I have any facts or suggestions to lay before the Commissioners with regard to Pembroke College; but that I shall be most happy to aid them in the prosecution of their inquiry to the best of my power, by attending to give evidence in the early part of February next, or in any other way which they may suggest.

I have the honour to be, Sir,
Your most obedient servant,
J. POWER.

J. Norman Lockyer, Esq.

4. Gonville and Caius College.

Caius Lodge, Cambridge,
Dec. 17, 1870.

SIR, I FEAR I shall not be able to add much to the information already laid before the "Aid to Science Commission" in my last letter. [See p. 15.] But I can have no objection to attending before the Commissioners and answering, as far as I am able, any inquiries they may think likely to promote the objects they have in view.

I am, Sir,
Your obedient servant,
EDWIN GUEST.

5. Trinity Hall.

Trinity Hall Lodge, Cambridge,
Dec. 30, 1870.

SIR, AT a meeting of the Governing Body of Trinity Hall on Saturday last, I called their attention to your letter to me of the 13th instant.

In reply to it I have to inform you that by the statutes (1860) of this College, it is enabled to make contributions, out of its income, for providing additional means of instruction for the advancement of religion and learning either in the College or the University of Cambridge, but not elsewhere.

In December 1869, a Report of a Syndicate was made, proposing various plans for increasing, by contributions from the Colleges, the income of the University for the purpose of extended instruction in physical science and other subjects.

This College expressed its willingness to adopt the plan No. 1: that is, to contribute 3 per cent. of what is termed its "distributable income," namely, the amount of the stipends of the Masters, Fellows, Bursar, and other officers, provided the other Colleges were willing to make a corresponding contribution. From want of unanimity amongst the Colleges none of the plans of the Syndicate were adopted.

The governing body of this College think it desirable and equitable that the income of the University for the above purposes should be increased by contributions from the Colleges.

The Revd. Henry Latham, Senior Tutor of Trinity Hall, has given much attention to the objects of inquiry referred to by you, and he will gladly attend upon the Commissioners, and state his views on the subject: mine would not further assist the Commissioners, and attendance on them in February would be inconvenient to me.

I am your obedient servant,
T. C. GELDART,
Master.

To J. N. Lockyer, Esq.,
Secretary.

6. Corpus Christi College.

Corpus Christi College, Cambridge,
16th January 1871.

SIR, I BEG to send you, for the use of the Duke of Devonshire and the other Commissioners, a copy of the Statutes of this College.

There does not appear to be anything in the Statutes "de qualitatibus sociorum et scholarium" to prevent proficiency in science from being taken into account in the election to scholarships and fellowships.

I shall be happy, with the aid of the Tutors and other Fellows of my College, to answer on paper any questions which the Commissioners may have to ask; but I have no facts or suggestions to lay before the Commissioners with regard to scientific instruction; nor do I think that I could give orally any information that would be of service to them.

I am, Sir,
Your obed. servt.,
J. PULLING,
Master.

7. King's College.

King's College, Cambridge,
December 26, 1870.

SIR I HAVE received your letter of the 13th instant, written under the direction of the Duke of Devonshire, Chairman of the Aid to Science Commission, and with it a copy of the Royal Commission, under the authority of which the Commissioners are conducting their inquiries.

To take the last part of your letter first, I may say for myself, personally, that I have no desire to attend for the purpose of giving evidence to the Commissioners in prosecution of their inquiries; but if it should be thought by them that I could, from my long connexion with the two Colleges of King Henry VI. afford any useful or desirable information, I shall be ready to attend at the Commissioners' call on some day after the early part of February next. I have consulted some senior and official members of the College, with a view of collecting facts or suggestions to be laid before the Commissioners with regard to King's College. The following is a short statement, as the result of my inquiry:—

In answer to the question whether this College is under any legislative disability with regard to the appropriation of its funds, I feel it right to state that, by the present Statutes of the College, which came into operation in April 1861, we are bound to establish, with a due regard to vested interests and the period at which the new Statutes shall come fully into operation, 24 scholarships "appropriated to scholars of the College of King Henry Sixth at Eton," and 24 open scholarships.

Up to the present time, only 21 of the Eton scholarships have been established, and the entire "number of twenty-four Eton scholarships must be completed before any "open scholarships are established."

The College, however, has not been insensible to the propriety of promoting "scientific instruction and the advancement of science."

At the general meeting of the governing body in November last it was agreed that the whole income, now amounting to 88l. per annum, arising from land and funds bequeathed

by a former Fellow of the College, one Edmund Vintner, Doctor in Physic, 1685, and directed to be equally divided amongst the 50 Junior Fellows and Scholars of the College, should be appropriated to form a "Vintner" exhibition, to be awarded for proficiency in natural science. Steps have been already taken for obtaining the sanction of the Court of Chancery to a scheme giving effect to such disposition of Dr. Vintner's legacy.

I have the honour to be, Sir,
Yours very faithfully,
RICHD. OKES,
Provost.

J. Norman Lockyer, Esq.,
Secretary, &c.

8. Queen's College.

[No answer received.]

9. St. Catharine's College.

SIR,
St. Catharine's Lodge, Cambridge,
18 December 1870.
I HAVE the honor to acknowledge your letter of the 13th inst., and, in reply, I beg to state that I have no special facts to lay before the Commissioners with regard to St. Catharine's; but that I am prepared to aid the Commissioners in the prosecution of their inquiry by attending to give evidence in the early part of February next.

I shall be obliged if you will furnish me with some information as to the course the inquiry may take, in order that I may be the better able to give the Commissioners such information as they may require.

I have the honour to be, Sir,
Your obedient servant,
C. K. ROBINSON.

The Secretary, Aid to Science Commission.

10. Jesus College.

SIR,
Jesus College,
14 Dec. 1870.
IN reply to your letter of yesterday, I have the honor to state, for the information of the Duke of Devonshire, that I have no "facts nor suggestions" respecting Jesus College to lay before the Commissioners, of whom his Grace is Chairman; and that I should not be able to lend any "aid to the Commissioners in the prosecution of their inquiry" by personally attending on them early in February, or at any other time.

I have the honour to be, Sir,
Your obedient servant,
G. E. CORRIE,
Master of Jesus College.

J. N. Lockyer, Esq.,
Secretary, &c.

11. Christ's College.

SIR,
Christ's College, Cambridge,
4th January 1871.
I HAVE had the honour of receiving your letter of December 13th, in which you inform me that the Aid to Science Commissioners have reached that stage of their proceedings at which it would be convenient that the evidence of the Heads of the Colleges at Cambridge should be taken on the subjects of the inquiry generally, and especially as to whether the Colleges are under any legislative disability with regard to the appropriation of their funds; and you inquire whether I have any facts or suggestions to lay before the Commissioners with regard to this College; and whether I should be prepared to aid the Commissioners in the prosecution of their inquiry, by attending to give evidence in the early part of February next.

I shall be most ready to aid the Commissioners in the prosecution of their inquiry in any way that I possibly can. I do not conceive that this College is under any legislative disability in regard to giving special encouragement to Natural Science.

I am afraid that I shall not have many facts or suggestions to lay before the Commissioners; but, if they desire it, I shall be most happy to attend them in February for the purpose of giving evidence.

I have the honour to be, Sir,
Your faithful servant,
JAMES CARTMELL,
Master of Christ's College.

J. Norman Lockyer, Esq.,
Secretary, Aid to Science Commission.

12. St. John's College.

SIR,
St. John's Lodge, Cambridge,
15 December 1870.
ALTHOUGH I have no special facts which I desire to lay before your Commissioners, yet it will give me pleasure to attend them at any time that they may wish to see me. So far as I can see at present, any day in February, of which I have received some short notice, will be convenient to me.

I beg to remain, Sir,
Your obedient servant,
W. H. BATESON.

J. Norman Lockyer, Esq.,
Secretary, &c.

13. Magdalene College.

SIR,
Magdalene College,
Feb. 5, 1871.
IN reply to your communication of Dec. 13th, I beg to inform you that I have not any facts or suggestions to lay before the Commissioners with regard to Magdalene College.

I am, Sir,
The Secretary,
Aid to Science Commission. Your obedient servant,
L. NEVILLE.

14. Trinity College.

SIR,
Trinity Lodge, Cambridge,
Dec. 17th, 1870.
IN reply to your letter of the 13th inst., I beg to say that I shall be happy to attend to give evidence before the Commissioners for promoting science, at such time in February next as may be convenient.

I am not aware that I have any facts relating to this College to communicate beyond that which I had the honor to mention to Her Majesty's Commissioners last autumn in reply to previous communications. [See p. 15.]

The bar to our doing so much as we desire in aiding the scientific teaching of the University, consists in the resistance successfully opposed by other Colleges to the University Commission, in consequence of which they are not empowered by their Statutes to tax their revenues for the purpose in question.

Meanwhile, as already stated, we have appointed, at considerable expense, a Prælector in Physiology, and furnished him with a large sum for the purchase of instruments.

This gentleman has been lecturing in the University Museum to all comers during the term just ended.

I remain, Sir,
Your obedient servant,
J. N. Lockyer, Esq. W. H. THOMPSON.

15. Emmanuel College.

SIR,
Emmanuel College,
Jan. 7, 1871.
I AM desired by the Master of Emmanuel College to acknowledge your letter of the 13th ult., and to state that although his health would not allow him to attend to give evidence before the Commissioners, he would be willing to aid the Commissioners by appointing a "Locum-tenens" to answer any inquiry in person which the Commissioners might think it desirable to make respecting Emmanuel College, in furtherance of the objects of the "Aid to Science Commission."

I am, Sir,
Your obedient servant,
GEORGE PHEAR,
Tutor of E. C.
To J. Norman Lockyer, Esq.

16. Sidney Sussex College.

SIR,
Sidney Sussex College, Cambridge,
14th Dec., 1870.
I HAVE the honour to acknowledge the receipt of your letter of the 13th inst., and to state in reply that I have no particular facts or suggestions to lay before the Commissioners with regard to Sidney Sussex College beyond those which I communicated on the 14th June last, [See p. 18.]

I shall, of course, be ready to attend the summons of the Commissioners, and to give them every information in my power.

I have the honour to be, Sir,
Your obedt. servant,
ROBT. PHELPS,
Master of Sidney Sussex College.

17. Downing College.

[No answer received.]

IV.—*Information respecting Fellowships at the several Colleges in the Universities of Oxford and Cambridge.*

The following Letter, asking for information respecting the Fellowships at the several Colleges at Oxford and Cambridge, was sent to the Heads of the Colleges on the 31st of March 1871.

ROYAL COMMISSION ON SCIENTIFIC INSTRUCTION AND THE ADVANCEMENT OF SCIENCE.

6, Old Palace Yard, S.W., March 31, 1871.

I AM directed to communicate to you the following resolution, passed by this Commission, and to request that you will be so good as to furnish the return required:—

Resolved—

That each College be requested to give a return, stating—

- I. The whole number of its fellowships.
- II. The date at which its Statutes, as altered by the late University Commission, came into force, and the number of fellowships filled up since that date, divided into two classes:—
 - (i.) The number awarded by the result of a competitive fellowship examination.
 - (ii.) The number awarded for distinction in University examinations, or other proof of merit.
- III. The number of fellowships awarded during the same period for excellence in the subjects—
 - (i.) of Classics;
 - (ii.) of Mathematics;
 - (iii.) of Law and Modern History, or Moral Science;
 - (iv.) of Natural Science.

N.B.—*In case of excellence in more than one of the subjects, the fellowship is to be reckoned under that which is presumed more especially to have influenced the electors.*

IV. A return of the number of fellowships held at the present time—

- (i.) by non-residents;
- (ii.) by residents engaged in the educational work of the College, or of the University;
- (iii.) by residents holding some College or University office not educational;
- (iv.) by residents not belonging to the classes ii. and iii.

I have the honour to be
Your obedient servant,
J. NORMAN LOCKYER,
Secretary.

From the answers returned, the following tabular statement has been drawn up; and some further particulars (which could not be included in this table) follow, respecting the Fellowships at the Colleges marked with a star (*).

It should be added, that the few particulars given in the table respecting the Fellowships at Jesus College, Cambridge, have been taken from the *Cambridge Calendar*, the Master of that College not feeling himself "at liberty to comply with the request of the Commission."

RETURN of the NUMBER of FELLOWSHIPS at the several
Oxford - - - - -

COLLEGE.	I. The whole Number of its Fellowships.	II. The Date at which its Statutes, as altered by the late University Commission, came into force, and the Number of Fellowships filled up since that Date, divided into Two Classes.—		
		Date	(i.) The Number awarded by the Result of a Competitive Fellowship Examination.	(ii.) The Number awarded for Distinction in University Examinations, or other Proof of Merit.
1. University*	Twelve, one being suspended for a limited period under a College Ordinance. <i>No return</i>	December 14, 1855, and March 4, 1857.	Thirteen	None
2. Balliol	<i>No return</i>	<i>No return</i>	<i>No return</i>	<i>No return</i>
3. Merton	Twenty-four; one vacant	1857	Seventeen	One
4. Exeter*	Fifteen; including a Probationer Fellowship.	June 27, 1856	Eleven	None
5. Oriel	Seventeen	March 28, 1857	Seven	One (a supernumerary Fellowship conferred, under § 21 of the College Ordinance, upon the Regius Professor of Modern History.
6. Queen's	Twenty	January 9, 1858	Twenty-four	None
7. New	Thirty-eight. By an Ordinance of the 24th of March 1871, the number is to be reduced to 30, as soon as the interests of the College, as a place of education, will permit.	March 19, 1857	Eight	One, elected without any competitive examination, as being eminently qualified for the office of tutor, under the powers of an addition to the 21st clause of the Ordinance approved by Her Majesty, April 23, 1868.
8. Lincoln	Twelve; but two are kept vacant, and their proceeds applied to educational purposes, under the provisions of the Statutes of 1855.	1856	Seven	One by nomination of visitor, in whose patronage it is.
9. All Souls'	Thirty; and, at present, two Supernumerary Fellowships make 32.	April 1857	Twenty	None can be admitted as candidates for an All Souls' Fellowship, who have not either gained a first class, or obtained a prize or Scholarship open to the University.
10. Magdalen	Thirty (one Fellowship vacant)	April 1858	Thirteen, being the whole number awarded since the passing of the Ordinance.	None
11. Brasenose*	At present - - - - - 13 Suspended for a short time - - - - - 2 — (One vacant) 15	1857	Nine	None
12. Corpus Christi	Twenty; of which one is attached by Statute to the Professorship of Latin Literature, and one to that of Jurisprudence. Three are vacant, of which one is advertised for competition as a "Science" Fellowship.	1866. The first election to an open fellowship under the amended Statutes was in 1866.	Eight	None
13. Christ Church	On the old foundation 19 Senior Studentships (Fellowships in other Colleges), of which three are also on the new foundation. On the new foundation, established under the Statutes framed by the Commissioners, 18.	Jan. 9, 1858. The first election under the amended Statutes took place Dec. 17, 1858.	Twenty	Two (from University distinctions and testimonials from Professors, especially for educational purposes).
14. Trinity	Twelve, including one suspended	1857	Twelve	One
15. St. John's	Thirty (one Fellowship being vacant).	1861	Seven	One
16. Jesus*	Fourteen. In future 13, when one Fellowship will have been commuted into Scholarships.	April 4, 1857	Nine. No fellowship has been filled up without examination.	
17. Wadham*	Fourteen; one having been suppressed by the late University Commission, to augment the salary of the Professor of Experimental Philosophy.	June 1867	Four; all after public advertisement.	
18. Pembroke*	Ten	Partially in 1858, and completely in 1861.	Four	One (on the ground of University distinction and usefulness to the College)
19. Worcester*	Seventeen	March 19, 1857. The first election under the new ordinance took place in 1864.	Four	

COLLEGES in the UNIVERSITIES of OXFORD and CAMBRIDGE.

Oxford.

III. The Number of Fellowships awarded during the same Period for Excellence in the Subjects:—				IV. A Return of the Number of Fellowships held at the present Time:—			
(i.) Of Classics.	(ii.) Of Mathematics.	(iii.) Of Law and Modern History, or Moral Science.	(iv.) Of Natural Science.	(v.) By Non-Residents.	(vi.) By Residents engaged in the Educational Work of the College, or of the University.	(vii.) By Residents holding some College or University Office not Educational.	(viii.) By Residents not belonging to the Classes (i.) and (ii.)
Twelve	One	None	None	Six	Five	None	None.
No return	No return	No return	No return	No return	No return	No return	No return.
Fourteen	Two	None	One	Eight	Ten	Three	Two.
See note a.	Three	None, exclusively, but see note a.	None	Five	Eight, inclusive of one who has a lectureship in another college.	One, the chaplain, elected under the old statutes. Under the new statutes, the servants of the college, young and old, are, specially in educational matters, and otherwise, placed under the Chaplain's care	One.
Six	One (partly for Physics.)			Ten	Six	One, by the Vicar of the parish of St Mary the Virgin, Oxford, in the patronage of the College, and of which the College is Rector.	—
Nineteen	Four	None	One	Eight	Nine	One	Two.
Eight	One	The subjects of examination for the Fellowships have been mainly those recognized in the classical and mathematical schools of the University, but opportunity has been given to candidates to offer themselves for examination in law and modern history, and in physical science.		Thirty-one	Five	One	One (being until March 31, 1871, a Probation Fellow).
Seven (Classics and Moral Science combined in equal proportions)				Six	Two	One	One.
None	None	Twenty (Law and Modern History).	None	Twenty-seven (but of these, most are resident occasionally for a few days). Seven, occasional residents, five.	Four	None	One.
Ten (i and vii. combined).	Two	(Papers on Law and Modern History, or Moral Science, are always given in the examination, No. 1.)	One	Four	Eleven	Three	Three.
Six (Classics and Moral Science). See note a.	One (for Mathematics only). Two (for Mathematics, with a Paper on Natural Science). See note b.			Four	Eight.	—	—
Six	One	One (Law and Modern History).	None	Ten	Five; in addition to the two held by the Professors (already mentioned).	—	—
Sixteen (including also History and Moral and Mental Philosophy).	Two		Four	Two (of these one will vacate his studentship within the next twelve months).	Eleven	One	Four. (Of these two are preparing to give lectures in Oxford in October next.)
Eleven (Classics & Moral Science).	One			Six	Four	One	None.
Five	Two	None, save only that some degree of competency in these subjects had influence in the election of those who were chosen for proficiency in Classics.	None, except so far as mixed Mathematics involve an acquaintance with Physical Science.	Fourteen	Six	Six	Three.
Eight	One			Seven	Six. (Two of these are also engaged in College employment not educational.)	—	One, in his year of probation.
Three (Classics, History, and Moral Philosophy combined). Two (combined with Moral Science). Four (Classics and Moral Science).	One	One (Modern History combined with Classics).	One (combined with Mathematics).	Seven	Five	One	One.
				Four	Six.	—	—
				Eleven	Three	Three.	—

Cambridge

COLLEGE.	I. The whole Number of its Fellowships.	II. The Date at which its Statutes, as altered by the late University Commission, came into force, and the Number of Fellowships filled up since that Date, divided into Two Classes:—		
		Date.	(1.) The Number awarded by the Result of a Competitive Fellowship Examination.	(2.) The Number awarded for Distinction in University Examinations, or other Proof of Merit.
1. St. Peter's	Fourteen	August 27, 1860	None	Seven
2. Clare	Eighteen, including one founded about a year ago. (<i>One Fellowship vacant.</i>)	April 16, 1861	None	Thirteen
3. Pembroke	Thirteen; and one Bye-fellowship, which will expire with the present holder. (<i>One Fellowship vacant</i>)	April 16, 1861	None	Eight, and one, under a new Statute, of great scientific distinction.
4. Gonville and Caius	Thirty-two	June 30 and August 27, 1860; and April 16, 1861.	None	Fifteen
5. Trinity Hall	Thirteen. (<i>Two vacant</i>)	1860	None	Eight
6. Corpus Christi	Twelve	April 1861	None	Eight
7. King's*	Fifty, to be reduced to 46 by the New Statutes.	1861	None	Seven
8. Queen's	Fourteen	June 30, 1860	None	Seven. One Fellowship has been awarded to the Professor of Arabic on account of his merits as a Semitic Scholar.
9. St. Catharine's	Nine	May 10, 1860	None	Seven
10. Jesus		1862		
11. Christ's*	Fifteen	May 30, 1860	None	Twenty-one
12. St. John's	Fifty-six (<i>one Fellowship vacant</i>)	February 22nd, 1860	Since that date to the present time 69 vacant Fellowships have been filled up at 11 several elections. In each case there was a competitive examination, and regard was also paid to distinction in College and University examinations, as well as to other proofs of merit.	
13. Magdalene	Five; to be increased to eight	1860	None	Five
14. Trinity*	Sixty (<i>three Fellowships vacant</i>)	June 26th, 1861	Fifty-six	One, without examination, and for services rendered to the University as a Professor.
15. Emmanuel*	Twelve (<i>Foundation Fellowships</i>) two vacant.	1861	None	Seven
16. Sidney Sussex*	Nine	1860	None	Four
17. Downing	Eight; two not filled up	October 24th, 1860	None	Three

Cambridge.

III. The Number of Fellowships awarded during the same Period for Excellence in the Subjects.—				IV. A Return of the Number of Fellowships held at the present Time :—			
(i.) Of Classics.	(ii.) Of Mathematics.	(iii.) Of Law and Modern History, or Moral Science.	(iv.) Of Natural Science.	(v.) By Non-Residents.	(vi.) By Residents engaged in the Educational Work of the College, or of the University.	(vii.) By Residents holding some College or University Office, not Educational.	(viii.) By Residents not belonging to the Classes ii. and iii.
Five	Two	None	None	Seven	Two N.B. Two others take private pupils.	None; distinct from those specified in (i.), but both those.	Two, who are employed in private tuition, and are mentioned in N.B. (ii.)
Five, one of the Fellows elected being also distinguished in Moral Science.	Eight, one of the Fellows elected being also distinguished in Natural Science.	None for excellence solely in these subjects.	None, solely for excellence in Natural Science.	Eight	Five, including the college dean.	None	Four. These are all young Fellows, pursuing professional studies.
Three	Six	None	None	Four	Six	One	One, engaged as a private tutor.
Two	Thirteen	None	None	Twenty-one	Nine	Two	None.
Two	Five	One to be Professor of Political Economy.	None	Six	Five	None	None
Two, and one double first in Classics and Mathematics.	Five	None	None	Three	Six	Two	One
Seven	None	None	None	Thirty-eight	Three	Seven	Two.
One	Six	None	None	Nine	Three	None	One, engaged as a private tutor.
Two	Five	None	None	Six	Two, one vacant, to be filled up shortly.	None	None.
Four	Four	None	None.	—	—	—	—
See Note a.	See Note a.	None	None	Eight	Four	Two	One.
Twenty-four, four of the successful candidates having obtained a first class in other departments.	Forty-one, two of the successful candidates having obtained a first class in other departments.	Two; one of the successful candidates having obtained a first class in mathematics. Of the remaining two of the sixty-nine, one was awarded for a Theological Work of remarkable ability, the other for distinguished attainments in Oriental Language and Oriental Literature.	None	Twenty-six	Thirteen	Six	Ten; of these seven are engaged in educational work unofficially.
Three	Two	None	None	Two	Three	None	None.
See Note a.	See Note a.	See Note a.	One	Thirty. See Note c.	Eighteen	Four	Five. See Note b.
Four	Three	None	None	Five	Four	One (the Junior Fellow).	None.
None	Two	None	Two	Five	Four	None	None.
Two	None	None	One	Four	Two	None	None.

OXFORD.

1. University College.

University College,
June 17, 1871.

II. The Ordinances framed by the late University Commissioners and altering the College Statutes are dated December 14th, 1855, and March 4th, 1857 respectively. They did not, however, take effect until approved (shortly afterwards) by Her Majesty in Council. Thirteen fellowships have been filled up since December 14th, 1855, all of which without exception have been awarded by the result of a competitive fellowship examination.

III. During this period, no fellowship has been awarded for excellence in the subjects of (iii.) Law and Modern History or Moral Science, or (iv.) Natural Science, exclusively; one fellowship has been awarded for excellence in the subject of (ii.) Mathematics exclusively. In awarding the other twelve fellowships weight has been given not only to excellence in the subject of (i.) Classics, but also in the subjects of Ancient and Modern History and of Mental and Moral Science, and (on two occasions) of Mathematics.

[N.B.—There is a bye-fellowship (the "Stowell Civil Law"), not reckoned among the fellowships of the College, in awarding which very great weight is given to the subjects of Law and Modern History.]

IV. Of the twelve fellowships of the College, one is temporarily suspended; (i.) six are held by non-residents; (ii.) five by residents engaged in the educational work of the College (one such resident being a probationer fellow). None of the residents belong to class (iii.), nor (exclusively) to class (iv.).

G. G. BRADLEY, Master.

4. Exeter College.

Note a.—Eleven fellows have been elected under the new statutes; three, as stated, for mathematical excellence (one of the three, however, having obtained a first class in natural science), and eight for other excellence. The Rector is unable to state with any accuracy what weight a knowledge of Classics or of Modern History or of Moral Science has had in each election. Papers were set in all three subjects, and probably four of the eight fellows elected may have owed their election chiefly to Classical Knowledge; the other four chiefly to a knowledge of one or both of the other subjects mentioned.

J. P. LIGHTFOOT,
Rector of Exeter College.

Exeter College, April 3, 1871.

11. Brasenose College.

Note (a).—In electing to the so-called classical fellowships, Moral Science may be supposed, on the average, to have influenced the electors in at least an equal degree with Classical Knowledge.

In most cases the examination has included questions in Modern History.

Note (b).—These two fellows were elected mainly for their excellence in Mathematics.

E. H. CRADOCK, Principal.
Brasenose College, April 23, 1871.

16. Jesus College.

The number of fellowships elected to since April 4, 1857, is nine, but of these one was competed for by candidates who had a vested interest; the examination for that one, and for seven of the other eight was classical. The examination for one fellowship was mathematical. Two of the seven elected on classical examination were successors to two others of the seven, who soon vacated their fellowships. Of the seven non-resident fellows, two have only recently taken livings to which they retired in 1870; they are now fellows in their year of grace.

One other is now in India in furtherance of a special provision of the will of the founder, which directs that the fellow when employed abroad should be considered as having all the titles and claims of a resident fellow.

CHARLES WILLIAMS,
Principal of Jesus College, Oxford.
April 24, 1871.

17. Wadham College.

II. The first election of a fellow under the Ordinance of the late University Commission was in June 1867. Four fellows have been elected under that Ordinance, and all after public advertisement, as the result of an open competitive examination.

III. (1.) Three have been elected for combined excellence in "Classics, History, and Moral Philosophy," but by which of those subjects each elector may have been "especially influenced," it is not possible to say.

(2.) One for excellence in "Natural Science" exclusively. It was found upon the general notice of an election to a fellowship, that candidates who rested their pretensions mainly or entirely on attainments in some specified branch of science, rarely offered; and on the last occasion but one, we announced that the exercises would be confined to certain specified branches of science. No exercises, therefore, were given in "Classics, History, or Moral Philosophy," and the election was made accordingly.

It may not be inappropriate to observe that some of the specified sciences had not been the favourite studies in Oxford, that, in fact, there were few who had devoted themselves to them, or were prepared to place their main hopes of distinction on eminent attainments in them. The supply, therefore, was hardly adequate to the increased demand; and there was the danger of introducing and establishing a low standard of attainment for excellence. A great change in intellectual taste, or in the relative estimate of distinction in educational pursuits cannot be effected at once.

One fellowship is vacant.

B. P. SYMONS, Warden.
Wadham College, April 20, 1871.

18. Pembroke College.

Pembroke College, Oxford, June 2, 1871.

BEFORE I reply to the questions addressed to me by the Commission on Scientific Instruction, I beg to state that I feel some difficulty with respect to those contained under Section III., because, at best, I can only give my own impressions in those cases in which candidates have been examined in two or more subjects—and we have never examined in one only—and because my impressions as to the relative weight of the different papers in determining my own choice are by no means clear. Therefore, my answers under this head must not be taken as of much value in the way of statistics. I also wish to explain that in answering II. (ii.), I have treated the exercise of the power given to us by our new Ordinances, § 22, of retaining a Fellow who shall have vacated his Fellowship by marriage or otherwise, if he shall be a professor or public lecturer in the University, as an election.

E. EVANS, Master.

19. Worcester College.

Worcester College, May 19, 1871.

THERE is one resident Fellow holding a non-educational office (bursarship) which is held with educational offices. There is one holding the vice-provostship, and one holding the deanship, also with educational offices.

R. L. COTTON, Provost.

CAMBRIDGE.

7. King's College.

King's College, Cambridge, April 3, 1871.

I. The number of fellowships as constituted by the new statutes of this College is "forty-six."

The present number of Fellows in the College is "fifty," the excess being caused by the large number of vested interests remaining to be satisfied under the old system when the new statutes were passed.

RICHD. OKES, Provost.

11. Christ's College.

Christ's College, Cambridge, June 19, 1871.

a. III. The following table will show the University honours which have been gained by the Fellows elected since May 30, 1860.

It may be premised that no fellowships have been awarded for excellence in law and modern history, or moral science, or natural science.

Also, that in University, mathematical, and classical honours, the candidates are arranged in each of the three classes in the order of merit; and in theological honours, in each of the three classes alphabetically.

A.D. Date of Degree	Mathematical Honours.	Classical Honours.	Theological Honours.
1 1860	42nd Senior Optime	1st, first class; bracketted equal with two others. Also 1st Chancellor's Medallist, bracketted equal with another.	—
2. 1859	14th Wrangler	—	First class.
3 1859	15th Junior Optime	4th, first class.	—
4. 1861	4th Wrangler	—	—
5. 1861	33rd Senior Optime	7th, first class	First class.
6. 1862	5th Senior Optime	7th, first class.	—
7. 1861	—	9th, first class.	—
8. 1862	—	12th, first class	First class.
9. 1863	12th Wrangler	—	—
10. 1865	—	8th, first class.	—
11. 1865	27th Wrangler	6th, second class.	—
12. 1866	Senior Wrangler, also 1st Smith's Prizeman.	—	—
13. 1868	Senior Wrangler; also 1st Smith's Prizeman.	—	—
14. 1868	9th Wrangler	—	—
15. 1868	—	2nd, first class.	—
16. 1869	2nd Wrangler, bracketted equal with two others.	—	—
17. 1869	8th Wrangler	—	—
18. 1869	36th Senior Optime	1st, first class, bracketted equal with another. Also 1st Chancellor's Medallist	—
19. 1869	—	10th, first class	First class.
20. 1870	—	1st, first class, bracketted equal with another.	—
21.	In addition to these, a former fellow, who had vacated his fellowship by marriage, was re-elected on account of his high academical distinction and literary merits		

IV. (i) At the present time eight of the fellows are non-resident (one of them on account of ill-health); and seven are resident.

- (ii) Of the seven resident fellows—
- (iii) Four are engaged in the educational work of the College.*
- (iv) Two are engaged in College or University offices not directly educational, one of them being also partly engaged in private tuition.
- (v) One is engaged in private tuition, and is also an Assistant Curate in the parish of Chesterton, adjacent to Cambridge.

JAMES CARTMELL,
Master of Christ's College.

14. *Trinity College.*

Trinity College, Cambridge.

(a) IN reply to question III., I beg to say that our Fellows are elected without regard to the results of the University examinations, but with regard to their performances in an examination held during five days in the College Hall. The subjects of this examination are varied, embracing Classics, Mathematics, Moral and Metaphysical Philosophy, Political Philosophy, Logic and Political

* NOTE.—In addition to these, two former fellows are also engaged in the educational work of the College.

Economy.—Essays are also written on literary or scientific subjects. Of the nine electors each has one vote, which he exercises subject to no enquiry as to the grounds of his preference; nor is any record kept of the reasons for which any candidate may have been chosen. It is only known that he seemed to the majority of the electors more fit than any of the unsuccessful candidates to be elected a Fellow of the College "as a place of Religion, Learning, and Education."

In one instance only has a Fellow been elected on the avowed ground of his superiority in a special examination, conducted by experts in the so-called Natural Sciences.

A more precise answer to this third question it is not in my power to give.

(b) One of these was appointed to an educational office, which is in abeyance owing to his dangerous illness. He resided in the Michaelmas and Lent terms. Three residents live out of College, but within the precincts of the University.

(c) Of the non-residents, three are prevented from residing by more or less serious maladies; four hold Government appointments; one is Professor of Mathematics in an Irish College; one is an Incumbent in his "year of grace;" four have the care of parishes; one or two are masters in public schools; and nearly all the rest are law students or barristers of less than seven years' standing. Of those in Government employ, three out of four have served the College in the capacity of Assistant Tutors, and one as Tutor and Bursar as well.

W. H. THOMPSON, Master.

Cambridge, May 31, 1871.

15. *Emmanuel College.*

THERE are now two Fellowships vacant, which will be shortly filled up.

It has been the custom of the College to elect to its fellowships from its own members, provided that amongst them were students of sufficient University distinction. Hitherto there have been no candidates in the College, exclusively students of Natural or Moral Science who have been thought to come up to the usual fellowship standard of ability.

S. G. PHEAR, B.D.,

May 1, 1871.

Fellow and Tutor.

16. *Sidney Sussex College.*

Sidney Sussex College, April 5, 1871.

As the above information is calculated to mislead on the very important point of amount of teaching force employed in this College, I think it right to add that there would be ample employment for all the Fellows. It is found, however, in practice, more convenient and satisfactory to allow such Fellows as prefer it to go out of residence, and to engage other resident members of the University, whether of the College or not, to fill up the staff. Of such there are always a great number willing to be so employed. At present several very distinguished men are engaged in this College, in addition to the four resident Fellows, so that the staff is a very strong one and of the highest competency.

ROBT. PHELPS, D.D., Master.

APPENDIX VII. (See Question 2891.)

LIST of POSTS in NATURAL SCIENCE filled by men who have passed through the Physical Science Schools at Oxford.

	No.		No.
<i>Fellowships in Natural Science:</i>		Lectureship on botany at St. George's Hospital	1
Open Fellowship at Merton	1	Do., on medical chemistry, University Museum, Oxford	1
Do. Magdalen	1		
Do. Queen's	1	<i>Professorships:</i>	
Do. Pembroke	1	Chemistry at Cirencester College	1
Do. Wadham	1	Botany, Royal College of Science, Dublin	1
Do. Oriel	1	Hygiene at University College, London, held by Fellow of Pembroke	0
Do. Corpus Christi	1	Geology, Owens College, Manchester	1
Open studentships at Christ Church, called Lee's Readers	3		
	10	<i>Masterships:</i>	
		Physical Science mastership at Eton College, held by Fellow of Queen's	0
<i>Mathematical Fellowships filled by men who have also passed through the Physical Science School:</i>		Do. at Harrow School	1
Open Fellowship at Exeter	1	Do. at Clifton College	1
Do. University	1	Do. at Rossal School	1
Do. called studentship, Christ Church	1		
Do. St. John's	1	<i>Assistants:</i>	
		To Professor Rolleston	3
<i>Lectureships:</i>		" " Acland	3
Physical Science Lecturer at Magdalen and Jesus Colleges	1	" " Brodie	2
Do., at Merton, held with the Fellowship	0		
Lectureship in morbid anatomy at St. Bartholomew's Hospital	1	Geological Survey	2
Do., at St. Thomas's Hospital, held by the Fellow of Magdalen	0		

Some hold more posts than one, but, for the sake of clearness, where two posts are filled by the same person, no number is attached.

APPENDIX VIII. (See Question 2928.)

LETTERS from the CHAIRMAN of the ENDOWED SCHOOLS' COMMISSION to the VICE-CHANCELLORS of the UNIVERSITIES of OXFORD and CAMBRIDGE.

Endowed Schools' Commission,
2, Victoria Street, S.W.

REV. SIR, June 3, 1870.

I HAVE the honour, on behalf of the Endowed Schools' Commissioners, to communicate to you a copy of a letter addressed by me to the Vice-Chancellor of the University of Oxford on an important subject which appears to them equally to concern the other English Universities, and to express the hope that you will take such measures as you may think fit for bringing it under the notice of the University of Cambridge. Accidental circumstances made the present a convenient time for approaching the University of Oxford, and we are unwilling that there should be any delay on our part in asking for the subject the attentive consideration of the body over whom you preside.

I am, &c.,

The Rev. the Vice-Chancellor, LYTTLTON,
Cambridge.

(Copy.)

Endowed Schools' Commission,
2, Victoria Street, S.W.

REV. SIR, June 3, 1870.

1. I VENTURE, on behalf of myself and my colleagues on the Endowed Schools' Commission, to address you on a subject of great importance to the work which has been confided to us, and which may also, in itself, be of moment to the several English Universities. We have learnt that the Congregation of the University of Oxford has recently appointed a Committee of its own body to revise their system of examinations. We conceive, therefore, that, independently of the necessity for action which presses on ourselves, the time may be favourable for approaching the University with reference to a question which, as it affects a portion at least of the higher education of the country, is closely connected with the action of the Universities.

2. That the course of study insisted on by the Universities must to a great extent govern the course adopted in the higher schools is a proposition which will probably be accepted without argument. Though it may be the case that only a very few scholars are intended for the University, those few are the most prominent, stay the longest, and give a bias to the whole education of the place, and numbers of schools are thus forced or irresistibly attracted into a course of study which is not that best suited to the bulk of those for whom they are designed.

3. The practical result is, that the study of the Greek and Latin classics becomes the highest aim of all great schools, an end to which the old system is adapted, and which has hitherto overshadowed and dwarfed all efforts in other directions.

4. We do not propose to discuss here the question whether the Greek and Latin languages are the finest and most efficient organs of mental training. We merely rest upon the fact that many competent judges say that they are not, and that very large numbers of the middle classes in England view with suspicion, if not with aversion, the predominance of these subjects in the ordinary school course. This suspicion or aversion may not always be very intelligent, or founded on clearly assignable reasons, but it is instinctive, it is widely spread, it tallies with the undoubtedly intelligent judgments above referred to, and the fact of its existence is a reason for endeavouring to establish other alternative and additional modes of training, more acceptable to at least a large number of people. The state of opinion is such as to leave no room for doubt that these newer methods will be followed by many who, if they cannot find sufficient aid in this country, will have recourse, as some are now doing, to Germany and other foreign countries.

5. We start, then, from the fact that there exists a strong demand for more training by other than classical studies, and that the subjects generally suggested for this purpose are mathematics, modern languages, and natural science.

6. Mathematics have a recognized footing in the country; they have long been the leading study at Cambridge, and are a fully established study at Oxford, and we do not think it necessary to dwell upon them.

7. The advantage of modern languages for practical use is obvious enough; and there are many who think they may be made an excellent organ of mental training. It will be sufficient on this head to refer to the Schools' Inquiry Report, pp. 25-28.

8. The evidence, in favour of natural science is stronger still. We would refer to the same report, p. 34, and to a

Report made in the year 1867 to the British Association, which will be found published by the Schools' Inquiry Commission in vol. II. p. 219. It is clear that amongst highly-educated men who have studied the subject deeply, there are some who think that both for the practical nature of the knowledge it conveys and for its severe training of the whole range of mental faculties, natural science has a higher claim than any other subject to be the chief instrument of education.

9. It appears to us, as it appeared to the Schools' Inquiry Commissioners (Report, p. 87), that a demand made by so many parents and supported by strong proof of its reasonableness ought to be ungrudgingly conceded. The question for us is not so much whether the demand should be met, as what measures are required to give it practical effect. It is not enough to establish schools with what may be called a modern curriculum, but intended only for those scholars who terminate their school career at 14 or 16 years of age; for the time does not allow of a fair trial of the new methods, nor would such schools meet the want of the more intelligent part of the parents who make the demand. Nor is it enough to add the modern studies to the ordinary classical curriculum in higher schools, for that involves the dangerous risk of distracting the minds of the pupils and dismissing them with a smattering instead of a solid hold of knowledge, and of encouraging habits of skimming over a variety of surfaces instead of grappling closely with difficulties. Nor can the ancient and modern studies be wisely put as rival objects of pursuit in the same school, with the almost inevitable result of the supremacy of the one, and the decay of the other. For, as experience has shown, the one to decay is that which has not got on its side long usage, or established reputation, or the associations of old institutions, or the sympathies of the great body of teachers, or the substantial attractions of endowments.

10. We are convinced that in order to give fair trial and full play to the study of modern languages and natural science, it is necessary to establish some schools of the first grade (*i. e.*, schools retaining their scholars to the age of 18 or 19), in which these subjects should be the staple of the course of study, and to that end the time and importance assigned to classics be much diminished.

11. Nor can we doubt which part of the ordinary curriculum should be sacrificed for this purpose. Something not inconsiderable may no doubt be done by dropping some of the elegancies of Latin scholarship and teaching that language more with a view to a knowledge of its structure and the capacity of understanding its literature than with a view to composition. But that Latin should in the main be retained, we do not question. If modern languages are to be studied, Latin lies at the base of Italian, Spanish, and French, and enters largely into English. Its practical use in life is appreciable: until within the last four centuries Latin was the language in which the largest part of the business of Western Europe was recorded, and almost the whole of its literature was written. No ecclesiastic, lawyer, antiquarian or physician can dispense with all knowledge of it. Greek has none of these uses, while yet it takes more time to learn, is forgotten sooner, and is the object of greater suspicion and dislike to parents. It belongs to the classical region and to that alone; and from its difficulty, and also its attractiveness, must be expected to receive a large share of the students' time and attention, if it is to answer any sufficient purpose. No school can be other than a classical school in which Greek is effectively studied.

12. Influenced by these considerations, we have determined to venture on the experiment of employing some of the educational endowments best adapted for the purpose in establishing among other schools of the first grade, some which may by way of distinction be called *Modern*: that is, schools in which Greek shall be excluded in order to provide adequate test and encouragement for the study of modern languages and natural science.

13. When, however, we propose to establish such schools we are met by the objection that the Universities will be closed to the pupils, however competent, unless they will spend money and time in acquiring that quantum of Greek which is exacted from all who go there. The quantum itself is not great, and might doubtless be acquired perfunctorily and, according to the common phrase, by "cram;" but in that case it would be of little value for the purpose of mental training, and the exertion spent in acquiring it would be almost pure waste in a life which may have little to spare.

14. The broad result is, that as long as Greek is made a *sine quâ non* at the Universities, those schools of the new

type which it is proposed to establish will labour under the serious disadvantage of being cut off from direct connection with the Universities through a want of agreement in their course of studies with University requirements, while, if the schools flourish, the Universities will in some degree lose their control over a portion of the higher culture of the nation.

15. We trust that we shall not be understood as desiring to intrude speculations of our own concerning the internal arrangements of the Universities. But we are confident in the belief that, for our own work, we are bound to attempt to establish such schools as we have indicated; and it is with reference to them that we venture to suggest to the Universities to modify those arrangements, so that, for instance, a first-rate man of science who knows no Greek shall not (at least in theory and intent) be at any

greater disadvantage than a first-rate Greek scholar who knows no science. How this is to be done, we do not pretend to suggest; but if once the object be considered desirable, we presume that no great practical difficulty will be felt in giving effect to it by those who are familiar with the details of University organization.

16. We shall be much obliged if you will be kind enough to bring this matter before the recently-appointed Committee, or before any more competent authority; or to inform me whether there is any more appropriate mode in which we can approach the University on this topic, than through yourself.

I am, &c,
(Signed) LYTTELTON.

The Rev. the Vice-Chancellor,
Oxford.

APPENDIX IX. (See Question 2949.)

NUMBER OF STUDENTS attending Science Classes during the Session 1869-70.

THE following letter was sent, on the 5th August 1870, to the English, Scotch, and Irish Universities, University College and King's College, London, Royal School of Mines, London, and Owens College, Manchester :—

Aid to Science Commission,
6, Old Palace Yard, Westminster, S.W.,
August 5th, 1870.

SIR, I AM directed by the Duke of Devonshire, the Chairman of this Commission, to state that the inquiries of the Royal Commissioners would be much aided if they had before them a return of the number of students attending any classes in which science was taught during the session 1869-1870.

I am, therefore, directed to ask you to be so good as to further the inquiries of the Commissioners by causing such a return to be prepared and forwarded to me as soon as possible. The return should not include pure mathematics or moral science; and it is of importance that it should embrace only those students who are attending at any one time.

I have the honour to be, &c.,
J. NORMAN LOCKYER,
Secretary.

From the returns received, the following table has been compiled :—

RETURN of the NUMBER OF STUDENTS attending SCIENCE CLASSES during the Session 1869-70.

ENGLAND.

OXFORD.

UNIVERSITY.

Attending the lectures of the Regius Professor of Medicine (Dr. Acland)	-	-	[No return.]
Attending the lectures of the Savilian Professor of Astronomy (only a short course given in May 1870)	140		
Attending the lectures of the Sedleian Professor of Natural Philosophy (Revd. Prof. Price)	-	-	[No return.]
Attending the lectures of the Professor of Botany (Prof. Lawson)	-	-	30
Attending the lectures of the Professor of Experimental Philosophy (Revd. Prof. Clifton):			
Michaelmas Term, 1869, number of names on register	-	-	38
[N.B.—Only fresh students are obliged to sign the register; many students who have previously joined the class do sign, but not all.]			
Lent Term, 1870	-	-	33
Easter and Trinity Term, 1870, laboratory class	-	-	5
[N.B.—But few students could be received in these Terms, in consequence of alterations in the rooms, necessitated by the removal of the department to new buildings.]			
Attending the lectures of the Professor of Chemistry (Sir B. C. Brodie, Bart.)	-	-	[No return.]
Attending the lectures of the Professor of Mineralogy (Prof. Maskelyne) on Crystallography	-	-	6 or 7

26060.

Attending the lectures of the Professor of Geology (Prof. Phillips):			
October 1869, twelve lectures:			
Gentlemen	-	-	56
Ladies	-	-	30
Easter and Trinity Term, 1870, twelve lectures:			
Gentlemen	-	-	29
Ladies	-	-	20
Attending the lectures of the Linacre Professor of Physiology (Prof. Rolleston):			
Three terms—Oct. 1869, Hilary 1870, and Easter 1870	-	-	56
Attending the lectures of the Hope Professor of Zoology (Mr. Westwood)	-	-	none.
[The Hope Professor states, that although due notice was issued in the <i>Oxford University Gazette</i> of his intention to give lectures, he was unable to form a class, and consequently no lectures were given. Several undergraduates availed themselves, however, of consulting the Professor privately; and, in conjunction with the Professor of Botany, a series of scientific excursions in the neighbourhood of Oxford took place during the Summer Term, which 12 students attended.]			

COLLEGES.

University.			
Attending natural science classes	-	-	1
[This student obtained a place in the first class at the public examination in natural science in the Trinity Term, 1870.]			
Balliol.			[No information received.]
Merton.			[See pp. 10 and 34.]
Exeter.			
Students attending science classes	-	-	8
[No special classes for the teaching of science are assembled in Exeter College.]			
Oriel.			
Junior members of the College attending science classes	-	-	2
Queen's.			
Students attending science classes	-	-	6
[Three in science and three in mixed mathematics.]			
New.			[No information received.]
Lincoln.			[No information received.]
All Souls'.			[No information received.]
Magdalen.			
Attending the lectures given in Magdalen College laboratory by Mr. Edward Chapman, Tutor in Physical Science to the College:			
Michaelmas Term 1869	-	-	17
Lent Term and Easter Term 1870	-	-	24
Brasenose.			
No lectures in physical science given. The members of the College who study science attend the lectures at the University Museum.			
Corpus Christi.			
Attending classes in which science was taught	-	-	6

<i>Christ Church.</i>	
Attending the lectures of the Chemical Reader (Mr. Harcourt) - - - - -	16
Working in laboratory - - - - -	9
Attending the lectures of the Physical Reader (Mr. Reinold):	
In the Lent Term - - - - -	16
In the Summer Term - - - - -	30
<i>Ten</i> of these were from Wadham, Merton, and Magdalen Colleges; <i>one</i> was an unattached student, <i>twelve</i> were Christ Church men, and <i>the remainder</i> were members of other Colleges in Oxford.	
Attending the lectures of the Physiological Reader (Mr. Thompson):	
In the October Term - - - - -	10
In the Easter Term - - - - -	8
In the Summer Term - - - - -	12
<i>Trinity.</i>	
Students of the College attending University science classes in which science, other than pure and mixed mathematics and moral science, was taught	3
<i>St. John's.</i>	
[No information received.]	
<i>Jesus.</i>	
[No information received.]	
<i>Wadham.</i>	
[No information received.]	
<i>Pembroke.</i>	
Attending science classes - - - - -	2
<i>Worcester.</i>	
No students of the College at present attending classes for scientific instruction (exclusive of pure mathematics), nor have been during the past year.	

HALLS.

<i>St. Mary.</i>	
[No information received.]	
<i>Magdalen.</i>	
Students attending science classes - - - - -	3
[It is not in the power of the Principal of Magdalen Hall to say how many more may have attended lectures on geology and other branches of science, more or less popular, for general improvement or other objects.]	
<i>New Inn.</i>	
[No information received.]	
<i>St. Alban.</i>	
[No information received.]	
<i>St. Edmund Hall.</i>	
No students attended science classes.	

The following additional information has also been received from Oxford on the subject.

OXFORD UNIVERSITY LABORATORY.

REPORT on the Number of Students working in the University Laboratory from May 1868 to July 1870.

Term.	Year	No. of Students.
Michaelmas - - - - -	1868	16
Hilary - - - - -	1869	21
Easter - - - - -	1869	19
Michaelmas - - - - -	1869	23
Hilary - - - - -	1870	24
Easter - - - - -	1870	22

In Easter Term of 1869, the laboratory system of instruction was arranged as in the printed paper affixed.* The

* LABORATORY INSTRUCTION, MICHAELMAS TERM, 1869.—The fee for students working in the laboratory for three days in the week during the term is 3*l.* 10*s.*, for students working every day 5*l.*

This fee includes the use of all apparatus and re-agents essential to the student, with the exception of a small amount of apparatus peculiarly liable to be broken. The ordinary course of instruction in the laboratory includes those methods of *qualitative* analysis, a knowledge of which is required for those candidates for honours in the school of natural science who make chemistry their special subject.

In addition to this, two courses of instruction will be given in the laboratory, the one on the methods of *quantitative* analysis, on Mondays, Wednesdays, and Fridays, at 10 o'clock, by the Demonstrator in Chemistry, Mr. Heathcote Wyndham, M.A., the other a course of elementary practical instruction in chemical manipulation.

The fee for each of these classes will be, to students otherwise working in the laboratory, 10*s.*, to others 1*l.*

The following text books are recommended.—
For *quantitative* analysis—Fresenius' "Quantitative Analysis;" Grenville Williams' "Chemical Manipulation"
For general *qualitative* analysis—Fresenius' "Qualitative Analysis."
For *qualitative* analysis of simple salts and elementary chemical manipulation—Harcourt and Madan's "Exercises in Practical Chemistry."

University Museum, October 21, 1869.

system of instruction provides for the teaching of students coming to the University with various amounts of knowledge of practical analysis. If the student is commencing the study of chemistry, and has not practically acquired the knowledge to be gained in such a class, he is placed for one Term in the "Elementary Practical Class," where he makes, under the eye of the instructor, the simpler form of apparatus required in the laboratory, and also prepares practically the gaseous compounds which are more frequently met with. During this term he does not work in the students' laboratory.

Elementary practical class.

The student who has passed this class, or who is already, on entering the University, practically acquainted with this work, enters the laboratory, and, under the eye of the Professor and Demonstrator, works by himself at the properties of the simpler bases and acids, till he can determine with facility the composition of a substance containing only a single acid and a single base. After this, he works out practically the processes by which the bases and acids are detected in the presence of other bases and acids, and by which the elements hydrogen, nitrogen, and carbon are detected in organic compounds. As soon as he is acquainted with these methods, he enters the "Advanced Practical Class," in which he performs certain selected experimental methods of quantitative research under the eye of the Demonstrator, the method of work having been previously explained to him, and, on the days on which he is not working in the practical class, works at a selected series of quantitative determinations under the care of the Professor and Demonstrator.

Course of instruction in the laboratory.

The advanced practical class is so arranged as to include in successive Terms methods of quantitative research selected from—

- A. Method of general use in quantitative analysis.
- B. " of volumetric analysis.
- C. " of gravimetric.
- D. " of organic.
- E. " for analysis, determinations of vapour densities.

Advanced practical class.

1870.

MERTON COLLEGE, OXFORD.

REPORT on the ENCOURAGEMENT given to NATURAL SCIENCE by the College.

Out of 24 *Fellowships*, the College has given one Fellowship, after an examination in natural science only. The Fellow then elected is resident, and has charge of the natural science instruction in the College.

Fellowship given for natural science.

The average number of *Scholarships* vacant in each year is three. Of these, the first is devoted to classics, the second to mathematics, the third to natural science, so that, with few exceptions, a natural science scholarship will be given every year. The value of the scholarship is 80*l.* per annum for five years.

Scholarships in natural science.

In addition to the scholarships, three *exhibitions** of the value of 25*l.* per annum for three years are annually vacant. These are distributed amongst the candidates in the three subjects, according to the comparative excellence of the candidates.

Exhibitions in natural science.

The number of natural science scholars already elected is three. In the scholarship-examination of 1867, 16 candidates presented themselves; in the examination of 1868 15 candidates. In 1869 there was no election, owing to a change in the time of examination. A natural science scholarship will be given in 1870, on December 7th. A notice of the scholarship is appended.*

Number of scholars elected at present time, and number of candidates at scholarship examinations.

The natural science instruction given in the College is in chemistry, partly by lectures, partly by individual teaching. The Lecturer gives lectures and instruction in chemistry only, but by a private arrangement with the Lecturer in Physiology in Magdalen College, and the Lecturer in Physics at Wadham College, of the nature of the exchange of pupils, he provides instruction in these subjects also.

Instruction in natural science in the college. Nature of the instruction.

The College has fitted up a *lecture room* for natural science and mathematics, in such a way that the students

Natural science work and reading.

* NATURAL SCIENCE SCHOLARSHIP AND EXHIBITIONS.—At the annual election on December 7, a scholarship of the value of 80*l.* per annum for five years will be given after an examination in natural science.

One or more exhibitions, of the value of 25*l.* per annum for three years, will also be given, provided that candidates of sufficient merit present themselves.

Papers will be set in chemistry, physics, and physiology, and an opportunity will be given of showing a knowledge of practical work in chemistry and physiology.

The scholarship and exhibitions will be given either for special excellence in one subject, or for excellence in two of the three subjects; but no candidate will be examined in more than two subjects.

There is no limit of age for the candidates, but a limit of six Terms of University standing.

The examination will commence on Friday, December 2, at 9 a.m., in Merton College Hall. Candidates are required to call on the Warden on Thursday, December 1, between 4.30 and 5.30 p.m. October 12, 1870.

room, containing instruments, library of books and periodicals.

can make use of it as a *reading room* and *work room*, when not required for lectures. It is lighted and warmed in the evenings as well as in the daytime, and a microscope and certain pieces of apparatus have been provided, as well as a small *library of scientific books and periodicals*.

MAGDALEN COLLEGE, OXFORD.

Magdalen College, Laboratory,
Nov. 2, 1870

DEAR MR. PRESIDENT,
IN forwarding my report of the number of students who have attended my lectures during the session 1869-1870, I think it might materially aid the inquiries of the Royal Commissioners if I gave a short account of the machinery now at work for the teaching of Physical Science in Magdalen College.

The College laboratory is a block of buildings containing a number of rooms exclusively devoted to science. On the ground floor is the laboratory proper, a large lecture room fitted up with the ordinary appliances for chemical demonstration, and containing also a quantity of physical and chemical apparatus. Adjoining this is a private room used by your tutor, containing the more valuable instruments, and also the geological collection of the late Professor Daubeny. Over this is a similar room containing a collection of minerals, which, together with the geological collection below, are well catalogued and arranged. In a room on the ground floor I have placed all the instruments, connected with meteorology, the examples of barometers and thermometers being numerous and varied. Above this room is placed an achromatic telescope, with a 5½-inch object glass, equatorially mounted, and with tangent screw motions.

A large upper room has been fitted up as a reading room for students, and is supplied with several scientific periodicals; it is much used also as a convenient place for the examination and working up of specimens by the pupil after a demonstration by the teacher. I am here forming a collection of specimens to illustrate comparative osteology.

This room, and in fact the whole laboratory, is accessible to students at all reasonable hours.

The method of teaching I have adopted has been—

- (1.) A course of advanced lectures intended for candidates for honours in the Physical Science School. These lectures combine formal teaching in a class with attention to the individual requirements of each candidate in private.
- (2.) A course of lectures on elementary chemical physics, intended for beginners. These lectures are not given with the view of training men necessarily for the physical science school, but as a means of general education, in the hope that an intelligent interest may be excited in the mind of the student, and habits of observation and accuracy established.

With this view I have instituted a series of meteorological records. The daily observations include corrected and reduced readings from a standard barometer, readings of the maximum and minimum temperature—the wet and dry bulb thermometers—maximum solar radiation, direction and speed of wind, and the rainfall.

These observations are duly registered, and I believe have not been without use to my pupils.

In conclusion, I must add that it has always been my aim to supplement the work of our professors by taking care that each student in physical science shall receive the same help and attention from his College Tutor as that enjoyed by the classical or mathematical candidate. I am the more confirmed in this view, as I have found that such a system often reaches men who, but for the fact that the subject was brought to them in college, would never have taken up the study at all.

Considerable experience in tuition has convinced me that physical science as an instrument of education will flourish the better in Oxford the more it becomes an integral part of our College System.

I append the list of undergraduate members of Magdalen College who have attended my lectures during the session 1869-1870. The figures show the actual number attending. The number on my register for Easter Term 1870 is 16, but of these, 3 did not attend (by arrangement), owing to the pressure of University examinations. I may add that the number attending was 3 in Lent Term 1869, and 4 in Easter Term 1869.

I remain, dear Mr President,

Yours very truly,

EDWARD CHAPMAN, M A.,
Tutor in Physical Science at Magdalen College,
and Public Examiner in the School of
Physical Science.

Return of the Number of Students attending Lectures from October 1869 to June 1870.

	Mich. Term, 1869.	Lent Term, 1870.	Easter Term, 1870.
Students being Undergraduate members of Magdalen College.	9	14	13

N.B.—The total number of resident undergraduates in the College during the same period was .

	Mich. Term, 1869.	Lent Term, 1870.	Easter Term, 1870.
Total number of Undergraduate residents in Magdalen College.	55	50	55

Examined and found correct.

FREDERIC BULLEY,
President.

Magdalen College,
November 5, 1870.

CAMBRIDGE.

UNIVERSITY.

Attending the lectures of the Regius Professor of Physics (Dr. Bond) -	16
Attending the lectures of the Lucasian Professor of Mathematics (Prof. Stokes) -	33
Attending the lectures of the Professor of Chemistry (Prof. Liveing) on Chemistry -	52
Attending the practical class -	24
Attending Prof. Liveing's lectures on Physics -	65
Attending the lectures of the Professor of Astronomy and Experimental Philosophy (Prof. Challis) -	9
[This is the number attending at one time; the number attending in one year has seldom exceeded twenty. Professor Challis says, "I ought, perhaps, to explain that my astronomical lectures are mainly adapted to the class of students who are candidates for the higher mathematical honours."]	
Attending the lectures of the Professor of Anatomy (Prof. Humphry) -	42
Attending the lectures of the Professor of Botany (Prof. Babington) -	61
Attending the lectures of the Woodwardian Professor of Geology (Prof. Sedgwick) -	35
Attending the lectures of the Professor of Astronomy and Geometry (Prof. Adams) -	4
Attending the lectures of the Professor of Natural and Experimental Philosophy (Prof. Willis) -	17
Attending the lectures of the Downing Professor of Medicine (Prof. Webster Fisher, Dr. Latham acting as his deputy) -	11
Attending the lectures of the Professor of Mineralogy (Prof. Miller) -	7 or 8
Attending the lectures of the Professor of Zoology and Comparative Anatomy (Prof. Newton) -	-

[Professor Newton makes the following statement:

"The only record I have of the number of students attending my lectures is a list of those who write their names on a board at the lecture room door, and, should they be students of medicine requiring a certificate of diligent attendance, leave their card with me at the end of the lecture. Of the former there were, in the Michaelmas Term, 1869, 22, and in the Lent Term, 1870, 18. Of the latter, the largest and smallest number present on any one day was, in the Michaelmas Term, 16 and 6 respectively, and in the Lent Term 13 and 8. During the present Term, 26 persons have inscribed their names on my board, while the largest number of cards has been 22, and the smallest 11. Others, as well members of the University as strangers, attend, and their number is occasionally not inconsiderable, but I have no means of making any estimate on the subject.—Alfred Newton, Cambridge, 2nd December 1870."]

COLLEGES.

St. Peter's.
Students attending science classes - - - 12

Clare.
[The Master of Clare states: "If I understand the sense in which the term 'science' is used in the circular, there have been no classes of science held in this College during the year 1869-70."]

Pembroke.
Students attending lectures on applied mathematics and natural philosophy (candidates for honours in the Mathematical Tripos) - - - 14
Students attending lectures on botany, zoology, anatomy, chemistry, and medicine (candidates for Natural Sciences Tripos and for medical degrees)- 2
Student attending lectures on geology - - - 1
Students attending lectures on elementary mechanics and hydrostatics, for ordinary degree - 12

Gonville and Caius.
Number of students, members of Caius College, who have attended lectures on science.

Michaelmas Term, 1869:
Chemistry - - - 6 } 12
Anatomy and physiology - - - 6 }

Lent Term, 1870:
Anatomy and physiology - - - 5

Easter Term, 1870:
Anatomy and physiology - - - 5
Six other students attended two courses each of University lectures on anatomy, chemistry, botany, and geology - - - 6

Students of both Gonville and Caius College and Clare College attending mathematical lectures.

Michaelmas Term, 1869:
Rigid dynamics - - - 1 3 = 4
Mechanics - - - 12 2 = 14

Lent Term, 1870:
Statics - - - 7 6 = 13
Mechanics - - - 7 1 = 8

Easter Term, 1870:
Dynamics and Newton - 4 3 = 7
Astronomy - - - 3 3 = 6

Long Vacation, 1870:
Rigid dynamics - - - 1 3 = 4

Trinity Hall.
Students attending lectures in Michaelmas Term, 1869 - - - 45
(Students in residence, 100.)
Students attending lectures in Lent Term, 1870 - 46
(Students in residence, 85.)
Students attending lectures in Easter Term, 1870 - 36
(Students in residence, 78.)

Corpus Christi College.
[No information received.]

King's.
[See p. 16.]

Queen's.
Students attending lectures in natural philosophy - 11
In natural sciences - - - 3

St. Catharine's.
Students attending science classes - - - 2

Jesus.
[No information received.]

Christ's.
[There is at present no direct instruction given in this College in natural and applied science.]

St. John's.
[No information received from *St. John's*, but see below under *Trinity College*.]

Magdalene.
Students attending classes in which science is taught - - - 9

Trinity.
Lectures on science, 1869-1870.
The numbers attached signify the number of students attending.

Michaelmas Term, 1869.
Optics and hydrostatics (higher class) - - - 9
Elementary optics - - - 19
Elementary mechanics (for ordinary B.A. degree: two classes) - - - 30
*Electricity and heat - - - 6
*Botany - - - 4

Lent Term, 1870.

Newton's Principia - - - 12
Elementary mechanics and hydrostatics (three classes) - - - 36
Hydrostatics (higher class) - - - 16
*Electricity (elementary) - - - 7
* Do. (advanced) - - - 8

Easter Term, 1870.

Honour Classes: { Rigid dynamics - - - 8
Astronomy - - - 17
Statics and dynamics - - - 15
Elementary dynamics - - - 16
Mechanics and hydrostatics (for ordinary B.A. degree: three classes) - - - 29
*Heat (elementary) - - - 5
* Do. (advanced) - - - 6

* By an arrangement with *St. John's College*, members of that College are admitted to these lectures, and members of *Trinity College* are admitted to the lectures on natural science at *St. John's*.

In addition to the above regular courses of lectures, occasional lectures are given on various subjects, according to the taste of the lecturer, of which no record is kept.

E. W. BLORE,
Senior Tutor.

Emmanuel.
Students devoting their attention exclusively to natural science - - - 2
[No record has been kept of the students of the College who have attended various University lectures on science.]

Sidney Sussex.
Students attending science classes:
Lectures on heat - - - 5 }
" on geology - - - 2 } 15
" on mineralogy - - - 1 }
" on physiology - - - 2 }
" on botany - - - 2 }
" on natural science in College laboratory - - - 3 }

[The College laboratory is open to all the students, and used by many. All the students attend lectures in College on applied as well as on pure mathematics.]

Downing.
Students who attended natural science lectures - 4

DURHAM.

University.
[No information received.]

LONDON.

UNIVERSITY COLLEGE.

Return of the Number of Students attending the under-mentioned Science Classes in the College, during the Session of 1869-70.

Architecture - - - 28
Chemistry (theoretical) - - - 140
" (practical) - - - 132
" (analytical) - - - 22
Botany - - - 101
Comparative anatomy and zoology - - - 21
Engineering and mechanical drawing - - - 8
Geology and mineralogy - - - 44
Logic and mental philosophy - - - 28
Mathematics and mechanics (applied) - - - 27
Physics (= "Natural philosophy") - - - 90
Physical laboratory - - - 9
Physiology (theoretical) - - - 164
Physiology (practical) and histology - - - 52
Political economy - - - 15

Nov. 21st, 1870.
JOHN ROBSON, B.A.,
Secretary to the Council.

KING'S COLLEGE.

Number of matriculated students (attending the whole course of instruction) - - - 66
Number of occasional students—
in chemistry - - - 6 }
in practical chemistry - - - 0 }
in physical laboratory - - - 10 }
in arts of construction - - - 5 }
in manufacturing art - - - 3 } 40
in mineralogy and geology - - - 3 }
in photography - - - 1 }
in mechanics (lectures) - - - 2 }
in workshop - - - 8 }
in drawing - - - 2 }

These numbers are taken for the Lent Term, 1870. The number of matriculated students was then the largest; but it may easily have happened that the number of occasional students in various classes may have been greater at other periods.

ALFRED BARRY, D.D.,
Principal.
August 17th, 1870.

ROYAL SCHOOL OF MINES.

[No answer received; but see the evidence of Mr. Trenham Reeks, Qu. 372, p. 26.]

MANCHESTER.

OWENS COLLEGE.

Return of the Number of Students attending the several classes in which Science was taught in the Session 1869-70.

I.—DAY CLASSES.

1. Natural Philosophy.	No. of Students.
A. Experimental Classes:	
a. Mechanics: statics, dynamics, hydrostatics, and optics	81
b. Physics: light, heat, and sound	27
B. Mathematical Classes.	
a. Junior: elementary statics, dynamics, hydrostatics, and geometrical optics	11
b. Senior: statics and dynamics of a particle, rigid dynamics, hydrostatics and dynamics, physical optics	2
2. Chemistry.	
A. Lecture Classes	
a. Junior: inorganic	105
b. Senior: inorganic and organic	19
c. Analytical chemistry	15
d. Technology	9
B. Laboratory Classes	51
3. Engineering.	
a. Mechanical engineering	12
b. Civil do.	8
c. Senior class (mechanical and civil)	2
d. Geometrical and mechanical drawing	16
4. Natural History.	
a. Animal physiology and zoology	9
b. Geology	12
c. Botany	5

II.—EVENING CLASSES.

1. Natural Philosophy:	
Experimental physics	18
2. Chemistry.	
A. Lecture Classes:	
a. First course: non-metallic elements	63
b. Second course: the metals	18
c. Third course: organic	6
B. Laboratory	10
3. Engineering, mechanical and civil:	
a. Junior class	24
b. Senior class	12
c. Geometrical and mechanical drawing	5
4. Natural History:	
a. Zoology	5
b. Geology	14
c. Botany	21
d. Pharmaceutical botany	28

J. G. GREENWOOD,
Principal.

18th August 1870.

SCOTLAND.

ST. ANDREW'S.

UNIVERSITY.

Students attending classes in natural philosophy	33
" " " in chemistry	19
" " " in physiology and hygiene	42

ABERDEEN.

UNIVERSITY.

Students attending classes in—	
1. Natural philosophy	90
2. Natural history (winter), zoology, with comparative anatomy	71
Ditto ditto (summer)	41

3. Anatomy (winter), attending lectures on practical anatomy, or both	125	} 221
Ditto (summer), attending general anatomy or osteology	96	
4. Physiology	-	38
5. Chemistry, theoretical	96	} 158
Ditto practical (summer)	62	
6. Botany, only in summer	-	77
7. Materia medica	-	53

P. C. CAMPBELL, D.D.,

University of Aberdeen,
Principal.
17th August 1870.

[The Principal adds in a postscript, "I presume that the students attending the class of logic, in which mental physiology is taught, are not intended to be included, as the moral philosophy class, in which that subject is also taught in some of its aspects, is excluded. The number attending the logic class was about 70."]

GLASGOW.

UNIVERSITY.

[On making a second application for the desired return, the Clerk of the Senate replied on the 9th of December 1870, "I am instructed to inform you that the Senate have no other means of making up such a return except from the Class Catalogues, which I sent you in August last." It was not possible, however, for the Commission to make out from the Class Catalogues an accurate return of the number of the students attending the science classes at any one time, as a "notice" at the beginning of the Catalogues states that "in the following printed Catalogues the occurrence of a name merely indicates that such a student was enrolled in the class in which the name is found, but affords no evidence of his having attended even for a day. This can be ascertained only from the Professor's certificate."]

EDINBURGH.

UNIVERSITY.

Returns of the Number of Students attending classes in which science was taught during the session 1869-70.

Note. — Attendance at the classes of botany, natural history, and chemistry, is required for graduation in medicine.

1. Natural philosophy	185
2. Applied mathematics	3
3. Physical laboratory	20
4. Practical astronomy	1
5. Agriculture	27
6. Music { Division 1 (under "H"), about	50
Do. 2 do.	8
7. Engineering	26
8. Mechanical drawing	9
9. Surveying and levelling	12
10. Chemistry	232
11. Practical chemistry	135
12. Chemical laboratory	15
13. Systematic physiology	127
14. Practical physiology	89
15. Lectures on anatomy	240
16. Anatomical demonstrations	159
17. Practical anatomy { Winter course	264
Summer course	97
18. } Natural history and mineralogy	[No return.]
19. } Geology	-
20. } Botanical class	283
21. } Vegetable histology class	38
22. } Materia medica	124
23. } Winter session, practice of medicine	64
24. } Summer session, medical psychology and mental diseases	31
25. } Surgery	110
26. } Bandaging class	110
27. } Operative surgery (summer)	28
28. } Midwifery	110
29. } Systematic course of general pathology and morbid anatomy	100
30. } Summer course of practical morbid anatomy and pathology	18
31. } Clinical medicine, average for summer and winter sessions, about	100
32. } Clinical surgery { Winter session	116
Summer session	62
33. } Medical jurisprudence	69

IRELAND.

DUBLIN.

UNIVERSITY.

[No information received.]

QUEEN'S UNIVERSITY IN IRELAND.

1. Queen's College, Belfast.

Return of the Number of Students attending any classes in which science was taught during the session 1869-1870. Not including pure mathematics.

	Number in Class.	Number taking Science.
Arts, 4th year	10	5
" 3rd "	36	23
" 2nd "	38	38
" 1st "	43	—
Engineering	23	23
Law	23	—
Various	14	9
Medical :		
Matriculated	145	96
Non-matriculated	22	13
Various :		
Non-matriculated	6	6
	360	213
In two departments	7	
Number at College	353	

N.B.—Arts men of 1st year all take pure mathematics. All medical students take science classes at some period of their course.

(Signed) RD. OULTON,
Registrar.

2. Queen's College, Cork.

A Return of the Number of Students attending classes in Queen's College, Cork, in which science was taught, excepting pure mathematics or moral science, during session 1869-70.

	Number of Students.
Chemistry	69
Practical chemistry	48
Natural history	56
Natural philosophy	78
Political economy	6
Geology and mineralogy	15

ROBERT J. KENNY,
Registrar, Queen's College, Cork.

In addition to the above, there were attending the engineering classes, during session 1869-70, 36 students.

ROBERT J. KENNY,
Registrar.

Approved,

ROBERT KANE,
President.

16th August 1870.

3. Queen's College, Galway.

[No information received.]

APPENDIX X. (See Question 5936.)

FORM used by the INSPECTOR of SCIENCE SCHOOLS conducted under the SCIENCE AND ART DEPARTMENT.

Science and Art Form No. 337.

South Kensington, Oct. 1870.

SCIENCE AND ART DEPARTMENT of the Committee of Council on Education, South Kensington.

Inspector's Report on the science and art classes, established at [Name of Institution]

taught by [Names of Teachers and their Qualifications.]

Visited on the 187 [Signature of the Inspector.]

NOTE.—The Inspector is requested to answer the questions in this report as briefly as possible. Any more lengthy observations or recommendations he may feel called on to make, he should insert after "Remarks" under each head.

I.—COMMITTEE.

1. Are the chairman, secretary, and members of the committee respectively qualified according to the requirements of the Department?

2. Are they properly acquainted with the duties which they have to perform?

3. As far as you can judge, do you consider them sufficiently intelligent and responsible to ensure the examination being honestly conducted according to the rules of the Department?

4. Endeavour to ascertain and report whether the committee as a body take any active interest in the welfare of the classes; or whether the management be left in the hands of a few, or of the teacher alone?

5. How many members of the committee were present on the occasion of your visit?

REMARKS :—

II.—SCHOOL PREMISES.

1. Are the class rooms convenient and well suited, in point of size and accommodation, for the instruction given in them? And are they well lighted, heated, and ventilated?

2. Is the institution in which the classes are held endowed? Or is there any subscription or contribution on the part of the locality in aid of the science instruction?

3. On what terms, and under what conditions, are the teachers allowed to use the rooms for instruction?

REMARKS :—

III.—EXAMINATION.

1. Is the room or building in which the examination is to be held convenient as regards size and accommodation?

2. Are any other classes held within a convenient distance?

N.B.—If this question is answered in the affirmative, state under the head of "Remarks" below the reason for or against an amalgamation according to the rules of the Science Directory, and add a recommendation of your own on the subject.

REMARKS :—

IV.—REGISTERS.

A.—General Register.

1. Are the entries in this register properly made?

2. Is it kept by the secretary or a member of the committee? If not, by whom?

3. Give the number of middle-class students (if any), that is, students on whom, owing to their social position, no claim can be made.

4. What fees are paid by the students?

5. Are the meetings of the committee entered on the eighth page of the form? Or is there any means of recording visits of the members of the committee to the class?

B.—Class Registers of Attendance.

1. Are these registers properly kept?

2. Does a properly qualified teacher attend every meeting of the class?

3. State the subjects in which lessons were given on the occasion of your visit, and the number of pupils present.

4. Has the attendance of pupils fallen off or increased since the commencement of the classes?

REMARKS :—

V.—INSTRUCTION.

1. Do you consider the instruction in science to be efficiently given?
2. Do the pupils show signs of having been crammed or of learning by heart?
3. Is the apparatus sufficient in quantity and quality to properly illustrate the teaching of science?

REMARKS:—

VI.—APPARATUS.

1. Have any examples of apparatus been supplied by and from the Department? If so, of what kind?
2. Are there presses or other proper places for keeping them when not in use?
3. Are they kept clean and in good order?

REMARKS:—

APPENDIX XI. (See Question 6188.)

MEMORANDUM on the Progress of Scientific Instruction in Yorkshire, by Henry H. Sales.

The Paris Exhibition of 1867 aroused the attention of Yorkshire manufacturers to the importance of scientific instruction. A special meeting of the Central Committee of the Yorkshire Union of Mechanics' Institutes was held on the 22nd of August, under the chairmanship of Mr. Baines, M.P., President of the Union. This meeting unanimously resolved—

"That the Council of the Yorkshire Union of Mechanics' Institutes, feeling the great importance of encouraging and extending the scientific instruction given in mechanics' institutes, and deeply impressed with the evidence recently published, as to the comparative low state of scientific education in England, authorise Mr. Henry H. Sales to visit the towns of Yorkshire in which scientific instruction is given, in mechanics' institutes or otherwise, and to report the state of that instruction and the opinions of the officers or others as to the best practical means of increasing the efficiency of scientific classes."

The report on the condition of scientific instruction presented to the committee in conformity with this resolution was a very unfavourable one. On the 13th of February 1868, another meeting of the committee was held, and the following resolutions were unanimously adopted—

"That the Report of the Agent of the Union on Technical Education in Yorkshire be laid before the Government."

"That the committee, in submitting this report to the Government, beg to recommend that a Royal Commission or Parliamentary Committee be appointed to make an inquiry into the present state of technical education in this country, and on the continent, with a view of devising such methods for its improvement in England as may render it more commensurate with the wants and conducive to the prosperity of this great manufacturing country."

"That the committee think it their duty to draw the special attention of the Government to the want of properly-trained and qualified teachers of science in this country, and to the consequent inefficiency of the scientific instruction given in mechanics' and other popular institutions and evening classes, which are otherwise capable (with efficient teachers) of rendering the most valuable aid to practical science."

"That the committee would also express their belief that Technical Colleges or Schools of a superior kind, might with the greatest advantage be established in the principal centres of manufacturing industry in the United Kingdom."

No immediate steps having been taken by the Government to provide a supply of properly-trained and qualified teachers of science, and it being impossible for the Yorkshire Union of Mechanics' Institutes to organise classes without such teachers, the central committee directed the attention of the Council of the Yorkshire Board of Education to the difficulty in which they were placed, and asked for the co-operation of that Board. The council immediately took action, and a series of public meetings for schoolmasters was convened by the council, to induce them to qualify themselves, in accordance with the requirements of the Government, to give instruction in science. The first meeting was held in Leeds under the presidency of Sir Andrew Fairbairn, mayor. At Stockton the chair was taken by Mr. Whitwell. The Rev. Canon Sale, D.D., Vicar of Sheffield, presided over a meeting in that town; and at Huddersfield and Wakefield, the mayors of the respective towns occupied the chair. In addition to the members of the Council of the Yorkshire Board of Education, many of the principal manufacturers and educationists took part in the proceedings. But the Board did more than hold meetings. Special science classes for schoolmasters were organised at Leeds, Sheffield, Wakefield, and

Huddersfield, of which upwards of 100 schoolmasters became members. In the following autumn the mayors of Bradford and Halifax presided over similar meetings in those towns, and classes were also established. The work of the Board in this movement has been singularly successful, and, so far as the teaching of the rudiments of science is concerned, there is now in Yorkshire a fair supply of duly-qualified teachers. So important was the action taken by the Board considered to be, that it formed the subject of a leading commendatory article in the "Times," on the 9th of November 1868.

A supply of teachers having been provided, the extension of the science classes in connexion with the Government was proceeded with by the Yorkshire Board of Education.

The number of science schools in Yorkshire, actually fulfilling the requirements of the Government, at the close of the last official year was 84, and the number of students 2,389, a marked contrast to the results for the year 1868, when the numbers were: schools 14, students 426. But the contrast is in still stronger relief when the numerical details are considered. In Bradford, in 1866, there were no science schools; in 1870, there were seven with 185 students. In Huddersfield, in 1866, there was one school with 26 students; in 1870, seven schools and 230 students. In Leeds, 1866, there was one school with 33 students; in 1870, eight schools and 465 students. In Hull, in 1866, omitting the special navigation school, no classes existed; in 1870, two classes and 74 students. Sheffield had no classes in 1866, but eight in 1870, and 257 students. Wakefield, likewise, had no classes in 1866, but three classes and 105 students in 1870.

But the extension of the system of Government science schools revealed a new unoccupied field of necessary work. To maintain a science constituency, competent to profit by instruction in the higher branches of science necessary for the maintenance of our manufacturing prosperity, the alphabet of science must be learned during the period of ordinary school life. Insurmountable difficulties are in the way of teachers who have to commence the scientific instruction of young men destitute of all scientific knowledge, and yet, if such students are to earn Government results for the remuneration of the teacher, they must, in a very limited period, be prepared to pass a severe examination. Again, at the request of the Yorkshire Union of Mechanics' Institutes, the council of the Yorkshire Board of Education took steps to remove this evil. At Wakefield and Sheffield classes, under Mr. Patchet and Dr. Harrison, were formed for giving instruction in the rudiments of science to school-boys.

For 30 weeks, the elder boys of the primary schools in Sheffield were assembled on one evening in each week, for the purpose of receiving instruction in the rudiments of inorganic chemistry. The object the council desired to accomplish was, to awaken in the boys an interest in the subject which, in so many cases, will enter into their future labour, and thereby to create a desire for fuller acquaintance with it, thus substituting for the "rule of thumb" an intelligent knowledge of the principles of their work. 112 boys formed the class. Measured by the examination of the Department of Science and Art, the amount of knowledge gained was considerable, for no less than 26 passed in the annual May examinations of the Department. But the testimony of the parents, shown in their great interest for the advancement of their children, is far more conclusive respecting the value of the class. And still more important is the evidence of the schoolmasters, who have unanimously expressed their opinion that the class-lessons have developed the intelligence of the pupils, and created in them a love for instruction in the rudiments of science.

It is now unnecessary for the committee to continue these classes, for three reasons: Firstly, the Sheffield class

is a sufficient proof that children can be taught some branch of science; secondly, classes for school boys are now being extensively organised throughout the country; and thirdly, the introduction of scientific instruction into primary schools, so persistently advocated by this Board, has been effected by the Right Hon. W. E. Forster, M.P., Vice-President of the Committee of Council for Education, who has directed that a special grant be made to the managers of State-aided schools for each scholar who passes a satisfactory examination in some definite branch of natural science.

In advance of the instruction in science now provided for in the elementary State-aided schools is the more advanced instruction in trade schools. No system can provide for our countrymen the like amount of education as is given in continental institutions, if early instruction in science be neglected. It is to the establishment of trade schools that we must look for the source of our advancement in technical knowledge. It is now understood that a trade school is an institution that will provide for the education of the sons of skilled workmen, managers of factories, and manufacturers, who are able to pay a fee that, with the aid from the Science and Art Department, will make the school self-supporting. The education therein given includes all the branches of an ordinary English education, but adds thereto special instruction in science and art, more particularly bearing on the trade of the district. The establishment of such schools has for some time engaged the attention of the Yorkshire Board of Education, and two years since the executive submitted to the Committee of the Keighley Institution plans for the organisation of a trade school in the building then in course of erection. The suggestions made by Mr. Sales, though unexpected, were well received, and have ultimately been adopted. At that time the Endowed Schools' Commissioners had not commenced the reform of the grammar schools, but the passing of the Act and the consequent re-organisation of the Yorkshire grammar schools has produced unlooked for beneficial results in the furtherance of scientific instruction generally, and, in the case of Keighley, in placing upon a permanent basis its trade school. The grammar school was established in 1713. Its independent re-organisation, as a second grade modern school, would have seriously militated against the progress of the trade school, but negotiations having been opened between the building Committee and the Commissioners, the latter having propounded a scheme whereby the grammar school will be reconstituted as a girls' school, and a portion of the endowment, which will eventually reach the sum of 200*l.*, be transferred to the managers of the trade school. By this scheme, the important subject of female education is satisfactorily dealt with, and, at the same time, provision is made for technical education. The importance of the trade school cannot be overrated. It will form the constituency of the advanced classes in the schools of art and science, and herein is its great value. Art and science masters bitterly complain of the raw material placed in their hands for evening tuition, but pupils from the trade school will have been already prepared by those masters, and, after a life of labour has commenced, they will be able to carry on, and not commence, their special education in the schools of art and science. The trade school will, therefore, be a component and indispensable part of a comprehensive system of technical education for Keighley.

The operations before detailed refer to the means adopted to promote the scientific instruction of the rising generation.

It is not to be expected that adult workmen, now engaged in daily labour, will very generally devote their evening leisure to attendance upon scientific classes, yet it is expedient that assistance should be given to these men to enable them to gain some knowledge concerning the scientific principles involved in their work. A conference of the trade societies of Leeds and its neighbourhood, summoned by the Executive Committee, was held at the Mechanics' Institute, on February 12th, and was numerously attended by delegates, when it was proposed to arrange for a course of six lectures on science, as applied to the industrial arts. Application was then made to the Science Department for the services of one or more of the gentlemen who are engaged to deliver similar lectures at the School of Mines, London, but the only reply received was to the effect that State aid could not be given to the provinces for such lectures. This anomalous position requires rectification. Lectures on mining and mineralogy are given by eminent professors, engaged by the Government, to a London audience largely composed of clerks and non-artisans, but in the mineral districts, where labour the workers in coal and iron, it is not thought desirable to send suitable instructors at the expense of the State. The Committee having been refused the aid of the Department were thrown upon their own

resources, and agreed to provide lectures, if the trade societies collected an audience. The lecture-room was lent by the Committee of the Leeds Mechanics' Institute. An admission fee of 6*d.* was charged for the whole course of lectures. 280 tickets were sold, and the attention and interest manifested by the audience were most satisfactory. The following was the syllabus :—

Tuesday, March 8th; Tuesday, March 15th.

Two Lectures on the Formation and Consumption of Coal, by Mr. Louis C. Miall, Curator of the Museum of the Bradford Philosophical Society.

SYLLABUS :—

Lecture I.—The Origin of Coal—Coal Plants—Structure of a Coal Seam—Microscopic Structure of Coal—The Yorkshire Coalfields.

Lecture II.—Constituents of Coal—Products of burnt Coal—Varieties of Coal—The history of the Introduction of Coal as a Fuel—Coalfields of the World—Fuel, the Source of Power—Probable Duration of British Coal.

Tuesday, March 22nd; Tuesday, March 29th.

Two Lectures on the Elements of Mechanics, by Mr. Thomas Hick, B.A., of the University of London, and Certificated Master in Science by the Lords of Her Majesty's Committee of Council on Education.

SYLLABUS.

Lecture I.—Force and Matter—Work—Machines: their general action and structure—The simple Mechanical Powers—The Lever—Examples of its Use—Relation of Force employed to Work performed—Mechanical advantage—Force not created—Wheel and Axle—Mode of Action and Mechanical Value.

Lecture II.—Results of First Lecture—Pulleys—Structure and Action—Tension—Different Arrangements—Mechanical Value of each System—The Inclined Plane—Its Use as a Mechanical Agent—The Screw: essentially an Inclined Plane—Mode of Action and Mechanical Advantage—Examples of its Use—Conclusion.

Tuesday, April 5th; Tuesday, April 12th.

Two Lectures on Chemistry, by Mr. George Ward, Fellow of the Chemical Society, and Certificated Master in Science by the Lords of Her Majesty's Committee of Council on Education.

SYLLABUS :—CHEMICAL ACTION.

Lecture I.—Simple Substances or Elements—Compounds—Modes of Chemical Action—Distinction of Chemical Force from every other Force of Matter—Two different kinds of matter necessary for the Operation of Chemical Force—Change of Properties resulting from Chemical Action—Conditions favourable to Chemical Action—Chemical Force only exerted between fixed Quantities of Matter.

WATER.

Lecture II.—Water a Compound of Two Gases—Sixteen Parts by Weight of Oxygen, with Two Parts of Hydrogen: or, Two Volumes of Hydrogen with One Volume of Oxygen, producing Three Volumes of Aqueous Vapour—Oxygen—Preparation—Properties—Its Existence in the Atmosphere in a Free State—Hydrogen—The Lightest Substance known—Properties of Hydrogen—A Combustible Substance—Producing when burnt in Oxygen intense Heat—With Formation of Water—Properties of Water—Its Boiling Point—Its Solvent Action—Pure Water—Rain Water—Spring Water—Impurities in Water—Importance of Pure Water.

The Executive Committee have since received the following resolution, agreed upon at a general meeting of the Leeds and district Trades' Council :—

“ That this council tender their heartfelt thanks to the Yorkshire Board of Education, for the admirable course of scientific lectures especially provided for the artisans of Leeds. The council will hail with pleasure the opportunity to render any assistance in their power to the Board in their efforts to benefit our class.

EDWARD C. DENTON, President.
THOMAS ALBERTON, Secretary.”

The provision being made for scientific instruction in Yorkshire embraces instruction in the rudiments of science in the elementary schools; the establishment of trade schools in Mechanics' Institutes; the introduction of science as a portion of the curriculum of all the re-organised endowed

schools; the extension of evening science schools; and the delivery of courses of scientific lectures to the manual-labour population. There is yet wanting a central county institution for the promotion of scientific study under the direction of professors of the highest eminence. A special meeting of the General Council of the Yorkshire Board of Education was convened on the 5th of November 1869, to consider the establishment of a "Yorkshire College of Science." The meeting was held in the Town Hall, Leeds, under the presidency of Lord F. Cavendish, M.P., and the following resolutions were unanimously adopted:—

Resolution I.
Moved by Colonel Akroyd, M.P., seconded by Colonel Morrison, M.P. :—

"That, in the opinion of this Council, it is desirable that a College of Science should be established in Yorkshire."

Resolution II.
Moved by Mr. I. Holden, seconded by Mr. Baines, M.P. :—

"That a committee be appointed, with power to add to their number, to investigate, consider, and propose the best means to be adopted for the establishment of a Yorkshire College of Science, in co-operation with the Endowed Schools' Commissioners. The Committee to consist of the following gentlemen:—Lord F. Cavendish, M.P. (President); Colonel Akroyd, M.P.; E. Baines, M.P.; J. Behrens; S. Beaumont, M.P.; T. Brooke; W. B. Denison; T. F. Firth; Sir A. Fairhairn; J. G. Fitch; A. Harris; Dr. Heaton; E. Huth; A. Illingworth, M.P.; I. Holden; J. Kitson, junr.; Sir J. Meek; J. G. Marshall; A. J. Mundella, M.P.; Colonel Morrison, M.P.; F. S. Powell; H. W. Ripley; B. Samuelson, M.P.; T. Salt, junr.; W. S. Stanhope; J. Stansfield; the Mayors of Yorkshire, and the Chairmen of the Yorkshire Chambers of Commerce and Agriculture."

The College Committee have since been engaged in visiting existing Institutions of like nature, and in collecting information, and will shortly issue a special report.

APPENDIX XII. (See Question 5965.)

ANALYSIS OF TEACHERS OF SCIENCE CLASSES IN CONNEXION WITH THE SCIENCE AND ART DEPARTMENT, 1869-70.

Country.	Employed as Organising Masters.		556 Day School Teachers.				311 not otherwise employed as Teachers.				
	Day.	Evening.	Qualified to teach Science.		Not qualified to teach Science.		Holding Honorary Certificates.	Certificated previous to 1867.	Qualified at the May Examinations.	Certificated in some Subjects previous to 1867. Qualified in other Subjects at the May Examinations.	Those who have other employment.
			Certificated as Elementary School Teachers by Whitehall and Dublin.	Uncertificated.	Certificated as Elementary School Teachers by Whitehall and Dublin.	Uncertificated.					
England, Scotland, and Wales.	—	2	273	90	7	7	72	31	164	23	242
Ireland	—	—	156	22	1	—	7	2	12	—	17
Total	—	2	429	112	8	7	79	33	176	23	259

December 23rd, 1870.

J. F. D. DONNELLY, Capt. R.E.,
Official Inspector.

APPENDIX XIII. (See Questions 7129-7202 and 7779-7902.)

AID given to SCIENTIFIC INSTRUCTION and the ADVANCEMENT of SCIENCE by the University of London, and University College, London.

A similar Letter to that addressed to the Heads of the Colleges at Oxford and Cambridge (see Appendix VI., p. 9.) was sent in June 1870 to the Vice-Chancellor of the University of London, and the President of University College, London, and the following statements were received.

UNIVERSITY OF LONDON.

University of London,
Burlington Gardens, W.

SIR,
June 17, 1870.
In reply to the inquiries contained in your letter of the 13th inst., I am directed by the Vice-Chancellor to inform you that the aid afforded to this University by Parliamentary grants, and by endowments for the promotion of scientific instruction and the advancement of science, has reference chiefly to the examinations instituted by this University, particulars of which are contained in the regulations of which I forward you a copy. The examinations, of which scientific subjects constitute the principal part, are those for degrees in science; but the scientific examiners take part also in the matriculation examination, and in the medical examinations.

The expenses of this University are provided for by an annual Parliamentary grant; the sums received from fees, &c., being repaid into the exchequer.

26060,

The annual expenses of the examinations in scientific subjects (putting aside the maintenance of the general establishment of the University) mainly consist of the salaries of the examiners, which are as under:—

Two examiners in chemistry, 175l. each	-	-	350
Two assistant examiners in chemistry, 25l. each	-	-	50
Two examiners in experimental philosophy, 100l. each	-	-	200
Two examiners in botany, 75l. each	-	-	150
Two examiners in geology and palæontology, 75l. each	-	-	150
Contingent expenses of practical examinations each	-	-	60
			<u>£960</u>

For the encouragement of proficiency in scientific study, the following exhibitions and scholarships are annually offered:—

First Bachelor of Science Examination.

Four exhibitions, each of 40l. per annum for two years, in experimental physics, chemistry, botany and zoology	-	-	£320
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Of these, the exhibition in experimental physics proceeds from an endowment provided by Dr. Neil Arnott; the rest are supplied by the Parliamentary vote.

In addition to the foregoing, first B.Sc. candidates can compete with first B.A. candidates for an exhibition of the same amount in mathematics and mechanical philosophy.

4 Q

Second Bachelor of Science Examination.

Three scholarships, each of 50*l.* per annum, for two years; in chemistry, zoology, and geology, and Palæontology - - - - - £300

All these are provided by Parliamentary vote.

In addition to the foregoing, second B.Sc. candidates can compete with second B.A. candidates for scholarships of 50*l.* per annum for three years, in mathematics and natural philosophy, and in logic and moral philosophy.

As the exhibitions and scholarships now open to B.A. and B.Sc. candidates conjointly, were provided for candidates in arts previously to the institution of degrees in science, their annual value is not included in the preceding statement.

The sum annually applicable by this University for the promotion of science, is, therefore, as follows:—

Expenses of scientific examinations - - - - -	£960
First B.Sc. exhibitions - - - - -	320
Second B.Sc. scholarships - - - - -	300
Total - - - - -	£1,580

Of this total, the sum of 80*l.* is provided by Dr. Arnott's endowment, the remaining 1,500*l.* by Parliamentary vote.

I beg to add, that if the Commissioners should desire any further information in regard to the working of the system of scientific examinations carried on by this University, I shall be happy to afford it, either by letter or by personally appearing before them.

I have the honour to be, Sir,
Your obedient servant,
WILLIAM B. CARPENTER,
Registrar.

J. Norman Lockyer, Esq.,
Secretary, &c.

UNIVERSITY COLLEGE, LONDON.

University College, London,
July 20th, 1870.

SIR,
By a circular letter, dated June 17th, 1870, addressed to the President of this College, Her Majesty's Commissioners, appointed to make inquiry with regard to Scientific Instruction and the Advancement of Science, asked to be furnished "with a statement of all sums applied to the advancement of science or to scientific instruction" in this College; and the President forwarded the circular to me, with directions to prepare the required statement, and to transmit it to you, for the information of the Commissioners.

In conformity with those directions, I now have the honour to forward the accompanying statement, which I beg you to have the goodness to lay before the Commissioners.

I remain, Sir,
Your obedient servant,
JOHN ROBSON, Secretary.

J. Norman Lockyer, Esq., F.R.S.

STATEMENT OF ACCOUNTS, 1826 to 1869.

EXPENDITURE.

	£
Freehold land - - - - -	30,000
Buildings and furniture - - - - -	125,070
*Books - - - - -	4,425
Anatomical and materia medica museums - - - - -	6,153
Chemical, physical, and physiological apparatus - - - - -	4,336
Museum of comparative anatomy and zoology - - - - -	602
Birkbeck laboratory of chemistry - - - - -	3,123
Expenditure beyond the College share of fees - - - - -	18,393
Do do. amount paid to professors in augmentation of fees, and for annuities and pensions - - - - -	10,180

* The College libraries consist of upwards of 68,000 volumes and 18,000 pamphlets, a considerable part of which has been derived from gifts and bequests. Last year Mr. James Morris bequeathed to the College, subject to the life interest of his widow, the whole of his valuable library, consisting of nearly 10,000 volumes, and in the course of the present year the College has received 9,982 volumes and 4,577 pamphlets, constituting a splendid library of works on Mathematics, Astronomy, and Physics, being a bequest by the late Mr. J. T. Graves, of Cheltenham, who was formerly Professor of Jurisprudence in the College.

The whole of this money has been provided from the original share capital, from donations, and from legacies, no part whatever of it having been derived from "Parliamentary grants."

The special attention of the Commissioners is respectfully directed to sections 4-9 of the College Act passed last session, copies of which will be found in the Calendar for 1869-70, pp. 177-187.

Particulars of DONATIONS and BEQUESTS still in hand.

(For particulars of Investments, see A. in the next page.)

I. General Purposes.

Name of Fund.	Annual Income.
Bacon Legacy - - - - -	£ 550 0 0
Hebb " - - - - -	13 0 0
Cama Donation - - - - -	140 0 0

II. Special Purposes.

Holme Legacy -	To be applied to the purposes of the Medical Department of the College as the Council shall order.	900 0 0
Atkinson-Morley Scholarships	For founding and establishing in perpetuity three scholarships for the promotion of the study of Surgery amongst the students of the College.	102 0 0
Filiter Exhibition.	To found an exhibition in Pathological Anatomy.	35 0 0
Fellowes Chemical Medals	Two gold and two silver medals to be given to the four students who shall most distinguish themselves by reports on the medical cases in the hospital.	16 0 0
Laston Clinical Medal.	Dividends to be applied in defraying the expense of a gold medal to be conferred annually on the most deserving pupil in Clinical Surgery in the College.	8 10 0
Andrews -	To be applied to the purposes of the College in such manner as the Council shall think fit, the name "Andrews" to be given to any application of the fund.	227 0 0
Hume Memorial	Upon trust for the establishment of scholarships to advance the science of Jurisprudence and Political Economy.	52 0 0
Goldsmid Professorship.	Two-thirds of the income to be applied to or towards the maintenance of a Professor of Hebrew, and the remaining one-third to or towards the maintenance of a Professor of Geology.	56 0 0
Jews' Commemoration Scholarships.	To found two scholarships of 16 <i>l.</i> a year, tenable for two years, for general proficiency.	30 0 0
Bacardo -	Originally devoted to the purchase and maintenance of a library of Political Economy, but, in 1857, the Council resolved to apply the greater part of the income to the foundation of a scholarship in Political Economy of 20 <i>l.</i> a year tenable for three years.	36 0 0
Cook Memorial -	For an annual prize of books in the College School for the highest proficiency in Mathematics and Natural Philosophy	5 15 0
Holloway -	To be applied in defraying the charges of educating in the School as many boys as the income shall allow, the boys to be thoroughly instructed in the English language, arithmetic, and such elementary parts of the sciences as may be considered useful in their future probable station and employment.	83 0 0
Peene Library -	The interest to be annually applied to the purchase of books, chiefly of foreign literature and science, to augment the library.	53 0 0
Robinson: Flaxman.	The income to be applied towards the preservation, custody, more convenient and complete exhibition to the public, and augmentation of the Flaxman Gallery in the College, any surplus thereof to be applied in the decoration of the Flaxman Gallery, and in the purchase of books, engravings, drawings, and works of art.	90 0 0
Retired Professors.	The income to be set apart, to be paid whenever the Council think fit, to such retired professor or professors as they shall judge to have been least remunerated in proportion to services rendered to the College.	33 0 0
Slade Scholarships.	For the establishment of six scholarships of 50 <i>l.</i> per annum, tenable for three years, to be awarded to the students of the College who shall most distinguish themselves in drawing, painting, and sculpture.	300 0 0
Slade Professorship.	For the establishment and endowment of a Professorship of fine art.	210 0 0

I hereby certify that the foregoing statements are correct, to the best of my knowledge and belief.

JOHN ROBSON,
Secretary to the Council.

July 20th, 1870.

A. INVESTED AND OTHER FUNDS.

	Consols.	New 3 perCents.	Bank Stock.	3 perCents. Reduced.	New 5 perCents.	INDIAN RAILWAY SHARES.					Great Western Railway.
						Bombay.	Madras.	Punjab.	Scinde: Delhi.	Scinde.	
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Bacon Legacy, for general purposes						1,144 4 4		1,426 4 0	4,432 15 9	1,218 15 0	
Ditto, loan to hospital - 3,000l.											
Hebb legacy, for ditto	412 12 10					2,855 15 8					
Cama donation											
Holme Fund, for the purposes of the Medical Department of the College			2,700 0 0				10,000 0 0	3,573 16 0			
Atkinson-Morley Surgical Scholar- ships' Fund.					3,870 7 9						
Do. do. Accumulation of dividends.					109 4 8						
Faliter Exhibition Fund					866 18 7						
Dr. Fellowes' Clinical Medal Fund		500 0 0									
Liston Clinical Medal Fund		292 9 3									
Andrews' Fund Exhibitions, Prizes, and Scholarships for Proficiency in General Literature and Science.					4,970 2 3						
Ditto Accumulation of dividends - Hume Memorial Fund - Scholar- ships in Jurisprudence and in Political Economy.					603 15 9						
Ditto Accumulation of dividends - Goldsmid Professors' Fund	178 10 11				1,090 13 5						
Ditto Accumulation of dividends - Goldsmid Professors' Fund					62 1 2				2,780 4 3		
Jews' Commemoration Scholar- ships' Fund.	1,000 0 0										
Ricardo Fund: Library and Scholarship in Political Economy.					497 17 9						
Ditto Accumulation of dividends - Holloway Fund - School Exhibitions					389 9 8						
Cook Memorial Fund - an annual school prize for proficiency in Mathematics and Natural Phi- losophy.					2,030 8 0						
Peene Library Fund - for the pur- chase of books, chiefly of Foreign Literature and Science.					141 0 0						
Peene Library Fund - for the pur- chase of books, chiefly of Foreign Literature and Science.					1,294 7 7						
Peel Memorial Fund: Income applied in gifts of books, maps, and other aids to knowledge, to Mechanics' Institutions, &c.	1,745 15 1										
H. Crabb Robinson Fund: for keep- ing up Fexman Gallery, &c.											2,000 0 0
Retired Professors' Fund	1,058 4 0										
Library Deposit Fund					73 13 5					72 8 0	
Reserve Fund		959 5 8									
Brundrett Fund (reversionary after the death of annuitants) 1,144l 11s. 3d											
Hollier Fund (reversionary after the death of Mrs. Hollier).				4,907 11 10							

APPENDIX XIV. (See Question 7483.)

PAPER handed in by Professor MASKELYNE.

In my evidence I allude to a subject on which I proposed to make a suggestion to the Commission: namely, the removal of the Mineralogical Collection to South Kensington, with the rest of the collections appertaining to natural history.

The suggestion I would make in regard to this removal is, that the biological collections, that is to say, those of the zoology and botany, together with that of paleontology (now called geology), should be united to form a National Museum of Biology; and that the Mineralogical Department should hereafter be combined with the Government School of Mines, wherever that institution may ultimately find its home, provided that its distinctive character be preserved.

So long as the British Museum might be retained in its integrity, or its collections might be regrouped into distinct divisions at the present locality, the mineral collection would seem to be in its place among them. But when once a separation of a part of these collections from the rest is determined on, the logical position of a collection of minerals in the midst of a series of biological collections assumes a new and very questionable phase.

The division of created things into animal, vegetable, and mineral is no longer exhaustive; it no longer represents the whole world known to science. Organic chemistry and the sciences that deal in organisms treat of certain forms of matter that are organic from one point of view and yet are not organic from another, and even inorganic chemistry deals in substances that can only be called mineral by using the word in what must, even in the present age, be termed an ambiguous sense. The place of a collection of minerals is cer-

tainly either by the side of the crystallised products of the laboratory, that is to say, it should aid in illustrating the science of chemistry, or that place is to be found where minerals are most completely studied, technically as well as scientifically, that is to say, where mining is especially taught.

The term mineralogy, in fact, inadequately represents the purport of a science the limits of which should include the morphological and the classificatory problems of chemistry; for the mineralogist, in his capacity of crystallographer, makes a study of the former, and, in the arrangement of a mineral collection, seeks to solve the latter class of problems, but does so with only such of the products of chemical combination as he meets with ready formed in nature. It would certainly be well if the traditional perversity which has confined mineralogy to natural chemical products should be broken through in the case of the National Collection of Minerals, which is now by far the first in the world, and which might then be expanded into a complete collection, illustrating all definite chemical products, whether formed artificially by the chemists' art, or found naturally produced by the processes in operation in the great laboratory of nature.

The collection taking this development is not at all inconsistent with its being connected with the School of Mines. That school, under any form that may be given it, must retain, as a part of its system, instruction in chemistry, and a great collection of natural and artificial chemical compounds would be quite appropriately placed in juxtaposition with the other collections, illustrative more immediately of mining industry and its products.

The study of natural minerals in their relation to

mining will always be necessary, as will collections to illustrate it. The National Collection would well subserve that purpose for a National Mining School; and it would best be retained in connexion with such an institution, as the additions to its strictly speaking mineral part, which, it is to be remembered, will always be expensive, and will need a special education on the part of the Keeper, would be more likely to be kept up in such a connexion than if the collection were attached as an appanage to some great chemical laboratory, where its mineral element would be liable to be lost sight of or overgrown by the purely chemical laboratory element. For these reasons, I consider the School of Mines and Metallurgy to be the best and most practical destination for the Mineral Department of the British Museum under the supposed change in the distribution of the collections; and I think this is equally so, whether the objects embraced in this col-

lection be confined, as at present, to natural minerals, or whether the limits of that collection be enlarged in the manner I have proposed, so as to embrace artificially formed "mineral" or chemical products.

I consider, also, that it is equally the best and most logical destination of the collection, whether the School of Mines be retained where it is, or be removed to another site.

Under any circumstances, a gallery must be built to contain the mineralogical collection, and the cost of building it will not be very different, whether it be associated with the Biological Museum or with the School of Mines. But I beg leave to place on record, and in the hands of Her Majesty's Commissioners, my strong opinion that the least appropriate destination of this collection would be in association with a Biological Museum.

N. STORY-MASKELYNE.

APPENDIX XV. (See Questions 7739-40.)

PAPER handed in by Mr. CARRUTHERS.

I had carefully read and considered the proposals contained in the anonymous communication on "Botanical Museums," published in "Nature" on the 23rd March last, and was fully prepared to deal with them had they been made the subject of examination. Indeed, at the close of my answers to questions 7739-40, I was proceeding to deal with them, when I was interrupted by a question which gave a different direction to my examination. I treated the communication in "Nature" as one is accustomed to treat anonymous papers, estimating only the value of its arguments. Now, however, as it appears with all the weight which the name of Mr. Bentham carries with it, I desire to submit to the Commissioners my views:—

1st. On the statements contained in the paper,

And, 2ndly, on the matters naturally flowing out of those statements.

I. The statements contained in the paper.

1. The views expressed by Mr. Bentham regarding the main purposes of a botanical museum and herbarium, and the requirements of a collection for such a close study of plants as would supply a "sound foundation upon which the science of botany can be usefully established," arise from his estimating the science of botany as limited to that particular department of it to which he has devoted his life, and in which he has done important service. The profound study of plants is, in his view, "their accurate determination and practical classification," and he states that he requires for its prosecution nothing more than an exhaustive herbarium of the fragments of plants supplying the diagnostic characters at present employed for distinguishing genera and species, with a complete library and staff of officers. This is, in my opinion, a very defective estimate of the science of botany, and of the materials required for its advancement.

Robert Brown took a very different view of the profound study of plants, and in the Botanical Department of the British Museum he tried to develop that masterly grasp of the science which is to be found in his works, by illustrating, as far as possible, the structure of all the parts from the lowest to the highest, both existing and extinct. Accordingly, the National Herbarium, large as it is, forms but a part of the Botanical Collections. The specimens placed in the outer rooms, which exhibit chiefly the form and structure of the stems and roots of plants, are as necessary a part of the purely scientific collection as the dried foliage and flowers in the herbarium. While such specimens "excite the interest," and "gratify the curiosity" (and, what is more important, instruct the minds) "of the general public," these are very far from being their principal, still further from being their only purpose, in a botanical museum, as Mr. Bentham appears to imply. The scientific investigator,

whose notion of systematic botany is somewhat larger than ascertaining the technical name and Order of a plant, consults these specimens as he does the herbarium. It is, therefore, a mistake to suppose that they, "when once placed, require no further handling."

The purely scientific collection of the British Museum consists of:—

I. The herbarium, comprising,

- a. The General herbarium.
- b. The British herbarium.
- c. Various separate small and complete herbaria of historical interest.

II. The Structural series, comprising,

- a. The fruit collection.
- b. The collection of gums, resins, and other natural products.
- c. The general collection, exhibiting the form and structure of plants, and consisting of the larger specimens chiefly exhibited to the public; and
- d. The Microscopical preparations, illustrating the minute structure of recent and fossil plants.

2. The limitation of the science of botany to the plants now existing on the earth is another grave defect. No subject has recently received more attention from biologists than the relation between existing and extinct plants and animals. Every philosophic estimate, or systematic classification of the one kingdom or the other must include the fossil as well as the recent. This is fully acknowledged and acted upon by zoologists, and no better illustration can be adduced than Professor Huxley's "Introduction to the Classification of Animals" (1869). In botany, also, in the standard and only complete *Genera Plantarum*, by Endlicher, the fossils are ranged in their systematic position with the recent plants. It is true that the *Genera Plantarum* now in progress, of which Mr. Bentham is one of the authors, ignores all extinct plants. This retrograde step is in entire accordance with the views expressed by Mr. Bentham in "Nature." A systematic account of the *Lycopodiaceae*, which took no notice of the aëroscant forms of the palæozoic age, or of the *Cycadeæ*, which ignored the numerous forms and remarkable variations of this order in the secondary rocks, would be obviously very incomplete and unsatisfactory. In forming a collection to supply a sound foundation for the science of botany, it would be as reasonable to exclude the plants of any existing botanical province—say Australia—as to omit those which have existed at any particular period of the earth's history—say that of the Wealden.

3. The distinction which Mr. Bentham draws between a herbarium "for the close study of plants" and one for their "rapid determination without dissection" is most undesirable, and, in my opinion, practi-

cally impossible. No botanist has so extensive an acquaintance with the vegetable kingdom as to be able to make "a close study," in his necessary work, of every group of plants he may be naming or arranging; he must in many groups make a "rapid determination without dissection." If Mr. Bentham's distinction were in force, and the two herbaria he proposes existed, he would himself, when rapidly naming some of the important collections which have passed through his hands, have often been driven from the great scientific collection to work in his single specimen herbarium with the "general naturalist," "the palæontologist," and "the mere amateur." Every systematic botanist is at first, and more or less all along, a "comparer" of plants. The man who begins as a mere comparer, naturally becomes a close student under the influence of the collection he is consulting, and the workers he encounters in that consultation.

4. Mr. Bentham's single specimen herbarium is chiefly intended for the palæontologist, and, in addition, he proposes to provide him with "separate collections of leaves and fruits, * * so arranged as to enable them to be rapidly glanced over," and these, it is added, "would be most useful." No better testimony to the utter worthlessness of such materials for the purpose proposed can be adduced than the criticisms of Mr. Bentham himself, on the evidence for the existence of the natural order *Proteaceæ* in Europe, from leaves found in Tertiary strata. Mr. Bentham was specially fitted to deal critically with the hundred fossil species referred to this Order, as he had just made the analysis and detailed descriptions of between five and six hundred *Proteaceæ*. The Order is also the best fitted to test the value of the leaf characters on which the fossils had been referred to it, because, as he testifies, it "is one of the most distinct and most clearly defined amongst phanerogams," and is without "a single plant intermediate in structure between that and the nearest allied Orders." With regard, then, to the leaves of this Order, Mr. Bentham says: "I must admit that there is a certain general *facies* in the foliage of this Order that enables us, in most, but not in all, cases, to refer to it with tolerable accuracy—leafy specimens known to have come from a proteaceous country, even without flowers or fruit—but as to detached leaves, I do not know of a single one which, in outline or venation, is exclusively characteristic of the Order, or of any one of its genera." I cannot reconcile this declaration by Mr. Bentham, to the Fellows of the Linnean Society, as their President, in May 1870, with the statement published by him within a year thereafter, that such a collection of detached leaves, not for a limited and exceptionally defined Order, but for the whole vegetable kingdom, "would be most useful."

I must further observe, that Mr. Bentham has overlooked the fact that a large proportion of fossil plants have been determined from their internal structure, that is, on evidence which no mere herbarium, however extensive, can supply, far less one for rapidly determining plants without dissection, or a collection of detached leaves. The palæontologist requires the most extensive collections possible for his work, and he must be a working zoologist or botanist. All such work done by mere "geologists," and on such data as Mr. Bentham proposes to supply, would always deserve strong condemnation.

II. In considering the matters naturally flowing out of Mr. Bentham's paper, and the views I have now expressed, I venture first to submit the reasons which make it desirable, in my opinion, to retain the two herbaria as separate and independent institutions.

1. The two herbaria already exist, and are, to a considerable extent, parallel collections. Mr. Bentham, whose extensive private herbarium formed the foundation of the public herbarium at Kew, declared, in 1858, "that a great portion of the additions to the Banksian herbarium, since Sir Joseph's death, are duplicates of those already at Kew." As the Banksian plants form less than a quarter of those now existing in the

British Museum herbarium, the duplicates would be, according to Mr. Bentham, about three fourths of the whole. Sir William Hooker, also, whose large collections form the great bulk of the Kew herbarium, testified, in 1858, that "the Museum specimens are to a great extent duplicates of those at Kew." And the present Director of Kew Gardens corroborated this statement at that time. In 1860, Sir William Hooker further said, in reference to the transfer of the National Herbarium to Kew, as affecting the herbarium there, "To Dr. Hooker and myself it literally and truly can be a matter of no consequence."

2. The two herbaria have been under different management, and, to some extent, express different results of "the close study of plants." The important bearing of this consideration on botanical science in Britain can scarcely be overestimated. One practical illustration may be adduced. The most varied views are entertained by botanists as to the limits of a species, and consequently as to what constitutes a duplicate. Thus, in the case of the indigenous flowering plants of Britain, Mr. Bentham considers them to form 1,274 species; Dr. Hooker, in his recent *Flora*, makes 1,473 species; Professor Babington increases the number to 1,648 species; while a botanist adopting the views which Jordan and some continental authors have applied to local floras, would make them three or four times more numerous than even the last estimate. It is quite obvious that these different botanists have each very different notions as to "duplicates," and that a distribution undertaken by Mr. Bentham would certainly result in the loss to the herbarium of plants which Dr. Hooker would consider good species, and the "duplicates" distributed by Mr. Bentham or Dr. Hooker would include numerous plants which would be of the utmost value in M. Jordan's eyes. The two herbaria, existing, as they do, under different directors, to a considerable extent counteract these and other analogous evils.

III. The objects of the two herbaria are fundamentally different, and, in as far as they fulfil their objects, they are employed for totally different purposes. The National Herbarium at the British Museum was founded in 1827 for the use of the scientific botanist, while that at Kew was, as Dr. Hooker says, "originally maintained expressly for the use of the gardens." This was the primary object for which Sir W. J. Hooker accepted the private herbarium of Mr. Bentham in 1855. Before that year the gardens had been fulfilling their proper functions without a scientific herbarium attached to them. The two editions of the "*Hortus Kewensis*" are the best testimony to the efficiency of the gardens, and to the value of the collections brought together there under the Aitons. No herbarium of any kind, I believe, existed at the gardens during their time. The Banksian Herbarium was often, and for a long time, systematically used for naming the Kew plants; and the strictly scientific portion of the "*Hortus Kewensis*" was the work of Solander, Dryander, and Brown, the successive Curators of the Banksian Herbarium. Even Sir W. J. Hooker, the successor of the younger Aiton, who raised the gardens to their present eminence, had no public herbarium from the time of his appointment in 1841 till 1855. It is, therefore, evident that a great scientific herbarium is not a necessity to the efficiency of the Gardens at Kew.

It is, however, certain that such a herbarium as Sir W. J. Hooker and Dr. Hooker desired, that is, one sufficient to enable the officials to name the plants in the gardens, would be a most useful adjunct at Kew, as it would save the great waste of time which would be incurred in consulting a herbarium at a distance. Inasmuch as growing plants are, to the extent that they are developed, perfect, and permit thorough examination, it is obvious that the single specimen herbarium, proposed in "*Nature*," would meet all the requirements at Kew; and this could be kept up, as suggested by Mr. Bentham, from the duplicates not required in the great National Herbarium, all being accurately named before being sent.

Return to House of Commons, No. 126, p. 3.

Evidence before the Select Committee on the British Museum, 1860, p. 100.

Handbook of the British Flora.

Report by Sir W. J. Hooker, on Kew Gardens, in Civil Service Estimates for 1855-56.

Report by Sir W. J. Hooker, on the Progress of Kew Gardens, 1859, p. 10.

Vol. III. p. 401.

Proceedings Linnean Society, 1870, p. LXXXV.

Linnean Collection, p. LXXXVI.

Return to House of Commons, No. 126, 11th March 1859, p. 7.

IV. The practical difficulties in the administration of two separate, and to some extent independent, herbaria would be numerous and serious, and, in the course of time, a condition of things similar to what at present exists would result. It is needless to speak of a London herbarium, consisting of single specimens of each species, because such a herbarium, if practicable, would, as I have already shown, be utterly worthless for the purposes to which it is proposed to be applied. If the London herbarium were to contain only specimens sent by the keeper of a herbarium whose notion of the science of botany was confined to the "accurate determination and practical classification" of herbarium specimens, it is obvious that the palæontologist would not find there the materials for prosecuting his work. If, on the other hand, the London herbarium were constituted to be of real use to the palæontologist, the keeper must have the power of acquiring, as opportunity offered, the suitable materials, and he would necessarily secure collections which a future agitator might demand to be transferred to Kew, with as pertinent reasons as those Mr. Bentham now employs.

V. It is not an unimportant consideration that the continued separate existence of these two great herbaria is a great security against their destruction by fire.

VI. The expense of the two herbaria is very small. I am unacquainted with the amount granted for Kew herbarium, but it cannot greatly differ from that required by the National Herbarium, which amounted for the financial year lately completed to 1,767*l*. I know of no way in which the country can at once advance the interests of science and encourage its students at a smaller cost and with more important results than by maintaining in their full efficiency the two botanical collections at present existing.

It must be admitted that the formation of a single great National Botanical Establishment, comprising the two public herbaria now existing within a comparatively small distance from each other, is a very attractive scheme, and should the Commissioners think that its realisation is desirable, I submit the following considerations as, in my opinion, essential :—

I. It must form part of the National Museum of Natural History. Such a museum, as far as it is an exhibition of biological science, will consist of animals and plants, both existing and extinct. It is absolutely necessary, in the study of geology, that the plant remains should not be separated from the animal remains; and, further, it is as necessary for the satisfactory interpretation of the fossil plants, as well as for forming a true estimate of the vegetable kingdom, that the recent plants should not be separated from the fossil. The separation of any one department would be a serious injury to all.

II. It must represent the whole science of botany, and not consist of only dried foliage and flowers, which constitute a herbarium properly so called; and, consequently, it must be formed on the principle adopted by Robert Brown, and exhibited in the Botanical Department of the British Museum, and not on the imperfect plan advocated by Mr. Bentham.

III. It must be placed in the position in which it will be most serviceable to the public, and most accessible to botanists, and that place is, beyond all question, London. The statistics which I submitted on the occasion of my examination establish this, by showing the extent to which the botanical collections at the British Museum are made use of. Further, it is universally acknowledged that a herbarium for scientific use must exist in London. The long experience of Mr. Brown and Mr. Bennett in the National Herbarium made them entertain and express very decided views as to this necessity. My shorter experience has been long enough to convince me that its removal to Kew would be practically placing it out of the reach of the busy men who frequently use it to the advantage of science. Of course, the working botanist who devotes himself exclusively to the science

would follow the collections wherever they went; but the active professional man, and the man of business, who devote their spare hours to botany, would be deprived of the assistance necessary to their work which they now obtain at the British Museum. That such men do a large proportion of the scientific work of the country may be shown in many ways, as, for instance, by the fact that out of the 19 botanical memoirs contained in the last two volumes of the Linnean Transactions, four are produced by professional botanists, and 15 by others.

The late Professor Henfrey,⁽¹⁾ as representing the botanical teachers of London, Sir Charles Lyell,⁽²⁾ for the palæontologists, and Dr. Falconer,⁽³⁾ Mr. Bentham,⁽⁴⁾ and Dr. Hooker⁽⁵⁾ have recorded it as their decided opinion that the interests of science require that a public herbarium should exist in London. Such a herbarium, even if used only by palæontologists, must be, as I have shown, as extensive as possible; otherwise, it will tend to mislead, like all other imperfect sources of information.

I would further add, in favour of London being the proper site for the National Botanical Collections, that important collections of plants, both recent and fossil, accessible to students, but not to the general public, now exist and must still remain in London. These are: 1st, the Linnean herbarium, containing the plants described by Linnæus; 2nd, the great Wallichian herbarium; 3rd, the Smithian herbarium of British plants, all belonging to the Linnean Society; 4th, the collection of fossil plants belonging to the Geological Society; and, 5th, the extensive public collection of fossil plants in the Museum of Practical Geology. The removal of the National Botanical Collection from London would so separate them from these collections as seriously to injure their value to scientific investigators.

IV. The accommodation provided for the Botanical Department in the New Museum of Natural History, the plans of which have been accepted by the Trustees of the British Museum, will be in every way superior to any that exist in the world, and will be amply sufficient to accommodate the proposed single National Herbarium, as well as fully to display the structural, histological, and palæontological departments of the science. All the requisites specified by Mr. Bentham for the close study of plants, excepting the connexion with a garden, exist to a greater or less degree at the British Museum, and some of them in a greater degree than at Kew. That living plants are a requisite adjunct to a herbarium, is in opposition to the testimony of Mr. Brown and Dr. Falconer, to the effect that there is no necessary connexion between a herbarium and a garden; and is opposed, moreover, to the testimony of Mr. Bentham himself, as well as to his declaration that his extensive systematic labours have all been based on herbarium specimens, although they have been carried on in close proximity to the finest scientific garden in existence.

In the event, then, of its being resolved to maintain only one great national botanical collection, I would submit that it should not be cut off from the allied biological collections, but be placed with them in the same building in London. And that, for this end, the collections presented by Mr. Bentham to the public, and all that have been added to them by purchase or presentation, be removed to London and incorporated with the National Herbarium; and, further, that the extensive botanical library formed at the national expense at Kew be made, with the Banksian library, the foundation of that National natural history library which will be required for the National Museum of Natural History.

It is necessary, in dealing with Mr. Bentham's printed and publicly expressed views on this matter, to bear in mind that he cannot be considered an unprejudiced witness. I have frequently referred to his relations to the herbarium attached to the Royal Gardens at Kew. He has thus stated the reasons by which he was influenced in presenting his herbarium and library to the

(1) Return to House of Commons, No. 128, p. 7.
(2) Return to House of Commons, No. 128, p. 10.
(3) *do.* p. 9.
(4) *do.* p. 6.
(5) Memorandum respecting the Botanical Collections of the British Museum and Royal Gardens, Kew, p. 3, 31st Decem-ber 1868.

Nature, Vol. III, p. 401

Return to House of Commons, p. 128, p. 9.
Return to House of Commons, No. 128, p. 7.

Return to
House of
Commons,
No 126, p. 7.

public in 1855:—"I thought that, at that time, there was no herbarium and library in London sufficiently open for the use of botanists, and I presented them on condition that they should form the nucleus of a national herbarium and botanical library, to be kept at the expense of Government, and open to the free use of botanists." I can assert, in opposition to Mr. Bentham's belief—and a similar opinion has been, I understand, recently expressed—that at that time the National Herbarium and the National Library, as far as it is an adjunct to the herbarium, were fully and freely accessible to botanists, and were largely used by botanists; and this I am able to maintain from the contemporary records of this Department, as well as from the testimony of botanists who were then

in the habit of consulting the collections. Under the influence of this erroneous supposition, Mr. Bentham made his own herbarium a national institution, and a rival to the Banksian Herbarium, and, under the influence of this same spirit of rivalry, he now believes that there exists "a state of continual competition" between the two herbaria. I am sure that Dr. Hooker, and the authorities at Kew, will as strongly repudiate this statement as I do now, if it is meant to imply a competition in any way to the injury of science or the public. It is only in keeping with the motives which actuated him at the first that Mr. Bentham now agitates for the incorporation of the Banksian Herbarium with that of which his own forms the nucleus.

Nature,
Vol. III.,
p. 401.

APPENDIX XVI.

EXTRACTS from the Reports for 1867 and 1868 of the Committee of Governors of the Worcester, Lichfield, and Hereford Training College, of which the Rev. Canon Gover is Principal.

The cry for technical education, though, perhaps, not very intelligent or clear, points to a more extended training. It indicates dissatisfaction, as regards the amount of intelligence brought out, and of power given to our workmen, with the shortcomings of the present system of elementary education.

Formerly, a third year of study for special subjects was recognised, and at one time, indeed, a residence of three years was all but imposed upon the training colleges by the Committee of Council, whilst, in the second year, alternative subjects, diversely chosen by the officers of the various colleges, formed part of the second year's course. The alternative subjects have been withdrawn, and the system, throughout the colleges, has been compressed into a rigid uniformity; the third year's course has been abolished, and therewith the best preparation for assistants on the staff of the training colleges themselves.

The examinations of the Department of Science and Art, in various subjects, seem to offer a remedy. Although your committee think it undesirable that any of these subjects should be taken up by the students during the second year's course, unless such as fall in with it, yet these examinations afford the means of partially restoring the third year's studies. The Committee of Council, it is to be hoped, will recognise the *continued residence of selected students* for these examinations. Accordingly, this experiment has been set on foot by your committee; and a sub-committee and classes have been formed in accordance with the requirements of the Department.

On another subject of general interest with reference to training colleges, their concern with technical education, and the connexion which has sprung up among them with the Department of Science and Art, it is expedient to make some remarks. In the Report of the Committee of the House of Commons, of which Mr. Samuelson was chairman, one of the recommendations is—

"That the managers of training colleges for teachers of elementary schools should give special attention to the instruction of those teachers in theoretical and applied science, where such instruction does not exist already."

But the Committee of the House of Commons do not appear to have been aware that the training colleges cannot, as formerly, elect the subjects in which they will seek examination. This was, indeed, the system at first pursued; but it has long since been superseded by the course laid down in the syllabus, and, from time to time, more and more narrowly contracted at their will by the Committee of Council, to an undeviating uniformity of subjects. The very same course and subjects of instruction, under existing arrangements, are prescribed to, and required from the student in a metropolitan college, in a college amongst the keenest activities of manufacturing life, or in a Welsh college, preparing teachers for remote agricultural valleys and a population strange to, or unversed in the English tongue.

The re-action from this rigid curriculum has found expression in the introduction of science classes (so popular amongst the students that the authorities of the training colleges are constrained to go along with the movement) in connexion with the Department of Science and Art.

Yet, there is much in this movement of obvious good. The students are not herein examined in a close and exclusive class, limited to those only who are to be of their own profession. On the contrary, they are thrown into open competition with the minds most athirst for know-

ledge to be found among those engaged in numerous callings, of which the social rank is not very different from their own. They take their place, as it were, in a republic of letters for all those eager intellects, who would carry on to special subjects the education gained in the best of our elementary schools.

Still, the distraction incident to preparation for two distinct examinations under separate departments is not without its disadvantages.

It would be better if the former diversity of studies in the various colleges could be restored by the co-operation of the two Departments of the Education Office.

It would go further still to meet the demand for technical education, if the colleges could retain, after the two years' course was finished, selected students to prepare for special subjects in the following May examinations of the Department of Science and Art.

This experiment, indeed, your committee, in the beginning of 1868, endeavoured to carry out, as they believed, with the concurrence of the Education Department. The class list for the subjects in which their students sought examination appears in the present Report (page 52). With regret, then, your committee learnt that, in the opinion of the Council Office, existing Minutes would not warrant this extension of the time of training; and they have, therefore, been compelled, with great reluctance, to suspend their design.

In one subject in which the Education Department authoritatively avails itself of the Syllabus of the Department of Science and Art, namely, Drawing, some modification seems requisite.

At present, the certificate for competency to teach drawing is given for passing in the second grade. Now, many students have reached or nearly reached this at the end of their first year; some even when they enter the college. But the third grade, or art teacher's certificate, lies so far beyond the second, and involves the expenditure of so much time in the preparation of the prescribed group of works, as to make nearly hopeless the attempt to reach it in the portion of time which the college can allot to drawing.

Yet, it is most desirable that those who have evinced more than ordinary talent or taste in this direction, should not be left to fall back from the proficiency they had acquired, or be kept with the body of the students, reiterating work they have already mastered.

Considering the importance of drawing to the schoolmaster, whether for the power which it confers on himself in his methods of teaching, or for the use he can make of it as a subject of instruction, a recognised intermediate stage, between the certificate of the second grade and that of the art teacher, appears to be called for.

RESULT of the Examinations of the Science Classes held in connexion with the Science and Art Department, May 1868.

Animal Physiology.

Class I.—Daphne, Mapp.

Geology.

Class II.—Daphne, | Class III.—Mapp, Spencer.

Physical Geography.

Class I.—Daphne (1867); Powell (1867); Timms (1867).

Class II.—Bates (1867), Bullock, Jackson (1867), Mapp (1867), Heath, Woodward.

Class III.—Binner, Butler, Booth, Cowlishaw, J. Doyle, Eccleston, Hingley, Lea, Riley, Sargeant, Padfield (1867), Pedley (1867), Spencer, Williams.

Elementary Mathematics.

Class I.—Mapp.

Class II.—Bullock, Daphne, Doyle, Williams.

Class III.—Binner, Booth, Butler, Heath, Lea, Sargeant, Woodward.

Theoretical Mechanics.

Class II.—Mapp.

Class III.—Doyle.

Class V.—Spencer.

Practical Plane and Solid Geometry.

Class II.—Daphne, Doyle. | Class 3.—Mapp.

All in the first three classes in each subject received Queen's Prizes; those in the first two classes are qualified to become science teachers.

N.B.—The science classes in connexion with the College were only established at the end of January 1868.

APPENDIX XVII.

REPORTS FROM EXAMINERS UNDER THE SCIENCE AND ART DEPARTMENT.

The following Letter was addressed to the Professional Examiners for Science under the Science and Art Department of the Committee of Council on Education, South Kensington, on the 15th of June 1871.

Royal Commission on Scientific Instruction and the Advancement of Science,
6, Old Palace Yard, S.W.

SIR, June 15th, 1871.

I AM directed by the Duke of Devonshire, the Chairman of this Commission, to ask you to be so good as to aid the Commissioners in their inquiry by answering (with the least possible delay) the following questions with reference to the examination papers, under the Department of Science and Art, for 1871.

1. What opinion have you formed as to the amount of good which is done by the South Kensington System generally, and the value of the examination in the different grades?

2. What is the evidence afforded as to the practical nature of the teaching?

3. What opinion have you formed as to the amount of "cram," and the power of testing it by examination?

4. What test is afforded, by passing in the advanced papers, as to the fitness of a candidate to become a teacher?

5. Whether any evidence is afforded, in the badly spelt and ungrammatical papers, that they are, as a rule, the work of young persons?

I have the honour to be,

Sir,

Your obedient servant,

J. NORMAN LOCKYER,

Secretary.

The following replies were received:—

Royal Military Academy, Woolwich.

SIR, June 25, 1871.
IN compliance with the wish you have done me the honour of expressing, I beg to submit the accompanying report, premising:—

1st. That I have had no experience as inspector of schools connected with the Science and Art Department, and but a few years' connexion with it as examiner, and, therefore, my knowledge of the inner working of those schools must necessarily be limited, and my opinion of little weight.

2nd. That my subject is a peculiar one—one that is only of late years fully recognised as a necessary branch of education, and, consequently, much in want of a text book within every one's reach—one, moreover, that requires a considerable amount of previous mathematical training, if any extensive knowledge of it is required, or (for even an elementary course) models and aids to learning which are not attainable by all who take it up. I must beg, therefore, that the exceptional nature of the case may be taken into consideration while reviewing my remarks upon the results that have passed through my hands. I beg to submit that the teachers, owing to the system of payment by results, are too apt to look upon the Science and Art Department as having been established to supply a source of income for themselves, rather than for the promotion of education, and, owing to this feeling, resent any innovation or alteration in the style of examination, or in the course of study in any given subject, which they think will interfere with the number of their successes in that subject. They appear to insist upon having a minute syllabus of the course of study requisite for any subject taken up for examination, and any deviation from this syllabus, or even the setting of a question in a form not familiar to them, is made the subject of dire

complaint. In my own case—when first appointed examiner in subject I,—I offended in both these respects, and the letters of remonstrance from teachers were many, and bitter in tone. Some averred that the questions were impossible, others, that they were beyond the reach of ordinary mortals, and one, that I knew little or nothing of the subject. This was because the syllabus laid down in the Directory had not been exactly adhered to.

Now, I beg to submit that teachers ought not to be permitted to dictate to the Department or the examiner in reference to any particular examination which is intended to test general knowledge in a certain subject, and that the syllabus should give the barest outline of the subject or grade of subject it refers to, merely indicating the points at which the course of study in that subject should begin and end.

I would also beg to submit that more stringent rules should be established, and carefully carried out by committee and inspectors, to prevent students attempting too much, and to prevent teachers from encouraging them in those attempts. I would suggest that some means should be devised by which a student should be debarred from taking up an "advanced" paper in any subject unless he had previously obtained a class in the "elementary," or from attempting an "honours" paper till he had passed well in the "advanced." The difficulties to be met with in carrying out this system would doubtless be great, and, equally doubtless, have been under the consideration of the Department.

In consequence of the plain evidences of the "cram" system pursued, which are afforded by the results that have passed through my hands, I beg leave to give my unqualified opinion that no student who has obtained even a first class, in either first or second grade, should be allowed, on the strength of that success only, to constitute himself a teacher of others. (I again beg to remind you that I am speaking only from experience in my own peculiar subject.) In the case of "honours," things would be different. A successful candidate in that grade would probably be well qualified to undertake the tuition of beginners, being most likely experienced as a draughtsman, and well grounded and practised in mathematical reasoning.

One of the questions submitted for my consideration has reference to the writing and spelling of the candidates. On this point I am but little qualified to form an opinion, as in my subject scarcely any writing has been hitherto required. The words scholarship, exhibition, problem, or, now and then, a word or two of explanation, have been the only means that I have as yet had of judgment on this point, but I have always considered the handwriting to be very fair, indeed, and do not remember any instance of flagrant mis-spelling. This year I had a question in my paper that required a short written answer, and on conferring with my assistants I find that we are agreed that both spelling and writing were on the whole very good.

I have only to add that if I can possibly afford Her Majesty's Commission information upon any other points connected with my position as examiner to the Science and Art Department they have only to command me.

I have, &c.

F. ALF. BRADLEY.

To the Secretary,
Royal Commission on Scientific Instruction.

The College, Homerton, E.,

SIR, July 14, 1871.
I HAVE the honour to acknowledge the receipt of your communication dated June 15th. My absence from

England has prevented an earlier reply. A copy of your letter forwarded to me failed to reach me while abroad.

My connexion with the Science and Art Department has not been of long duration. I have superintended only two examinations in machine construction and drawing. Further, I ought to remark that there, is at present, a special difficulty in securing the proper teaching of the subject in which I examine. There are no satisfactory English Text-books of machine design of an elementary character. In Germany and in France some progress has been made in reducing to method the principles of machine design, and treatises have been prepared for use in polytechnic schools, for which, at present, we have no equivalent. Such materials as exist in our engineering literature are either contained in treatises too difficult for use by the class of students who come up for these examinations, or are scattered in a fragmentary way through treatises on special departments of engineering. The result is, that, whilst machine drawing is fairly taught, machine design is, at present, hardly taught at all. Subject to these remarks, I have pleasure in returning the following answers to the questions of the Commissioners:

1. In forming an opinion as to the good effected by the science examinations, three points may be considered:—(a) Whether the examiner can, by the form of the examination paper, direct and gradually improve the character of the instruction; (b.) whether the system of the Department secures fairly competent teachers; (c.) lastly, whether it creates sufficient interest to secure the formation of classes and the attendance of students.

I am of opinion that the examiner has the power, to a considerable extent, to direct and shape the teaching. Recommendations which I thought it desirable to make after the examination in 1870, had, I believe, the effect of improving the character of the teaching, especially in the better schools, and the results in 1871 were more satisfactory than in 1870.

As to the competence of the teachers, I must speak with rather less satisfaction. In many of the schools the teaching is good, but many of the teachers have not sufficient practical acquaintance with the details of machinery to render their teaching effective. Probably an examination, which is mainly an examination in drawing, appears easier to many than it really is, and thus the teachers are tempted to send up students who are unprepared to pass the examination. It is to be hoped that the failure of inefficient teachers to pass their students, the gradual improvement of the more efficient teachers, and, above all, the introduction of suitable elementary text-books, in this subject, may in time secure a higher standard of teaching.

As to the third point mentioned above, nearly three thousand students offered themselves for examination in machine construction last year, a number so large, that it is evident that a considerable stimulus to instruction in this subject is created by the system of the Science Department.

2. The question of the Commissioners as to the practical nature of the teaching has already been answered in the above remarks. The teaching in the subject in which I examine does not, in my opinion, attain so high a standard as it is desirable and practicable that it should. I have pointed out some special causes which have hindered its improvement, and I have also mentioned that it is improving.

3. I am of opinion that in so wide a subject as machine construction, the examination for which requires skill as well as knowledge, cramming may be prevented, if the examiner is sufficiently careful.

4. It is, no doubt, highly desirable that teachers of an important technical subject of this kind should have a higher training than is implied in the fact of their ability to pass the advanced stage examination. For example, it is important that all teachers of this subject should have some general knowledge of the strength and resistance of materials and structures. I have set, in the advanced stage, some questions involving elementary knowledge of this kind, but it is impossible, at present, to make the answering of these a condition of passing the examination.

5. The papers in machine construction, in the elementary and advanced stages, do not involve written answers. Hence I have formed no opinion on the point to which attention is directed in the fifth question of the Commissioners.

I have, &c.

W. CAWTHORNE UNWIN.

J. Norman Lockyer, Esq., F.R.S.

School of Military Engineering, Chatham,
June 21, 1871.

SIR, In reply to the questions in your letter of the 15th instant, I have the honor to state:—

1. I have only had two years' experience, 1870 and 1871, of the South Kensington System, and that only in one subject, building construction.

The opinion I formed, from the examination of 1870, is fully stated in my report to the Secretary, Science and Art Department, dated 7th June 1870.

That which I have formed from the examination of this year is stated in my report, which is now in the hands of the Secretary, Science and Art Department, for printing.

It will be seen from these reports that the opinion I formed last year, as to the knowledge of the students, and as to the teaching, was as unfavourable as it could possibly be, but that the improvement this year is very marked.

I think that there is reason to expect, for some years, great further improvement in the teaching, and, in that case, the effect can hardly fail to be to get rid of a number of inferior methods of construction in details, now used locally, and to bring into more general use those methods which are considered the best.

2. The teaching has this year improved much, and is in the right direction to give a practical knowledge of the subject, but there is room for great improvement, which may be attained by the more general use, by the teachers, of large diagrams and models.

I should say that such diagrams and models of the simpler details of construction are already supplied to some extent.

A special Text-book is also a great desideratum.

3. Taking "cram" to mean, that, by it, a student is enabled to give a correct answer, the meaning of which he does not understand, there is little opportunity for "cram" in this subject.

The examinations are almost entirely by drawing, and if a student can draw a detail of construction correctly, he must generally understand the construction itself.

4. None.

5. The papers being almost entirely drawing papers, no evidence is afforded on this point.

I have, &c.

HENRY WRAY,

Lt.-Col. R. E.

The Secretary,
Royal Commission on Science.

39 Ashburnham Grove, Greenwich, S.E.,

SIR, June 22, 1871.

In compliance with your letter of the 15th inst., respecting the examination papers under the Department of Science and Art for 1871, I beg leave to state that I have thought over the several questions contained therein, and have now the honour to furnish the following answers:—

1. My opinion, as to the amount of good which is done by the South Kensington System, may be expressed as follows: it puts within the reach of young persons the means of acquiring technical education which they, if left to their own resources, could not obtain, and who would, probably, remain ignorant of fundamental principles and theories which, in after life, will be found to be most useful to them. It encourages industry, inasmuch as it induces them to devote their spare time to improving their minds, instead of wasting it in idleness. It suggests subjects for study adapted to the various tastes and circumstances of the students; and, upon the whole, it cannot fail to make them better artisans, and, consequently, better members of society. The examinations provoke a spirit of emulation among the students, and also stimulate them in their studies.

2. The evidence afforded as to the practical nature of the teaching is such as to lead to the supposition that the teachers are upon the whole qualified for their work; and the advanced papers, for instance, show that a decided improvement has taken place since the same candidates worked the elementary papers, thereby proving that a benefit has been conferred upon those who have received instruction in this manner.

3. With regard to the amount of "cram," and the power of testing it by examination, I may mention that the subject of naval architecture is so wide, and the questions that can be given are so numerous and varied, that unless the student has been fairly taught, he must inevitably fail at the examination.

4. The test afforded, by passing in the advanced papers, as to the fitness of a candidate to become a teacher in naval architecture is, that he thereby displays a fair knowledge of practical shipbuilding, and shows that he understands the

principles of drawing to a scale, and the geometry of ship-building, or what is technically called "laying off."

5. No evidence, in my opinion, is afforded in the badly spelt and ungrammatical papers that they are, as a rule, the work of young persons.

I have, &c.

W. B. БАСКОМБ,
Examiner in Naval Architecture,
Science and Art Department.

The Secretary,
Royal Commission on Science,
6, Old Palace Yard, S.W.

127, Harley Street, Cavendish Square,
June 21, 1871.

SIR,

I ENCLOSE a paper containing my replies to the questions you ask in your letter of the 15th June.

I am sorry to see that the drift of the questions indicates hostility to the scheme under which science teaching is now promoted. As, for some years, I was Principal of the Engineering College at Putney, the only attempt made in this country to give a good scientific practical education, I have for a long time had the subject before me, and I became convinced that it was hopeless to expect anything like an "École Polytechnique" in England, unless the Government would set it on foot.

If any plan is to be successful, it must *begin* by encouraging science teaching in a humble manner over a very wide area, so that those who have aptitude for such studies should be found out.

The next step is to provide for the higher scientific education in connexion with actual applications of theory, laboratories, and workshops, a forge or foundry, actual surveys, both superficial and geological.

Such a plan has been conceived and partly carried out. Its success was sufficient to show that it was necessary to have Government aid to perfect it, and the experiment was brought to a close by the difficulties which attended a project depending solely on private aid, chiefly that of the Duke of Buccleuch, and some others.

The Government has lately recognised the necessity of such a scheme for the civil engineering service of India.

In returning my answers to your questions, I may, perhaps, be permitted to add, that I hope the recommendations of the Commission will be for the improvement of existing means of encouraging science, and not for discouraging them; and I say this disinterestedly, for I must soon retire altogether from my work in the education of the country, and shall regret very much if, after labouring, more or less, for 30 years, I should not be able to discern real steps of progress in this subject.

There has been much talk about scientific education, some little advance to it: a noble encouragement by Sir Joseph Whitworth, the schemes of the Government in the School of Mines, the School of Naval Architecture, and, then, the more prominent place assigned to science in the older Universities and in the University of London. But the discovery of scientific aptitude in the labouring and middle classes is only provided for by the examination of the Science and Art Department, at South Kensington, which, if judiciously managed and *steadily continued*, will stimulate and bring out the great mass of latent force which must exist in our people.

I have, &c.

The Secretary of the
Royal Commission on Science.
B. M. COWIE.

MATHEMATICS.

I. As to the general value of the South Kensington scheme, I think it has stimulated the desire to obtain scientific knowledge, and called into being the teachers who impart it. The amount of *good* will be greater or less according to the popularity of the teacher, and his judgment. All that the Department can do is, to secure proficiency in the subject which he professes to teach, but this will not secure the teaching faculty, nor the power to attract, nor the power of selecting proper students for the class. The examination itself shows the *result* of these qualities, as well as the scientific acquirements of the teacher.

There is very great difference in the three grades of the subject in which I examine.

Stage i. A very little acquaintance with algebra as far as a simple equation, geometry as far as it is contained in the first book of Euclid, and arithmetic, will secure a second class.

A great number of boys are sent in who know very little. As they do not pass, they merely give trouble which is of small consequence. Of those who do well (class i.), I generally should say that they have acquired some mathematical faculty. Of those who pass in class ii., a fair proportion may be said to have *some* useful mathematical knowledge. A great many are not very satisfactory, but they get a class by marks, and ought not to be discouraged or rejected.

Stage ii. We require that those who pass should get fair marks in *two* subjects at least. No one can get a class by one subject only. The paper contains questions in algebra, geometry, and trigonometry. Too many take the paper only because they have passed the first stage, and fail. Still, speaking of those who pass in this stage, I am of opinion that they have made a *good* step in the subject.

Stage iii. These men, also, speaking of those who pass, and leaving out of the case those foolish candidates who know very little, and think it a fine thing to say that they took an advanced paper, show a very fair progress in mathematical knowledge.

Putting all this together, I think a very fair amount of good is done by the system. I think the grades i., ii., iii., in mathematics, are very fairly distinguished, and that progress from one to the other is real progress.

II. There are many teachers who know their business and teach well. There are some whose pupils show, by their papers, that they are not well taught. These we try to discourage. This year, one school was reported as showing, in the aggregate, that the teacher is incompetent, and it was recommended that no payments should be made.

The "practical nature of the teaching" is, however, a phrase which I hardly understand. In my subject, part is theory, part is practice. I think the theoretical questions, corresponding to what we called "book work" at Cambridge, are better answered than the questions which are of the nature of problem, rider, or example. I apprehend that this is a specimen of the universal experience of examiners, who would all tell the same tale.

We can hardly expect there will be many teachers who have the faculty of making thorough mathematicians. There is a natural gift of this kind which is rare; besides, the capacity of being made a mathematician is not universal either.

III. The amount of "cram" is considerable in some subjects, such as geometry and the introductory part of trigonometry.

In the former subject, it is an undoubted fact that *Euclid is learned by heart* in many schools. A question distinctly put in the words of Euclid can be answered by such scholars. It is not easy to check this. If an enunciation is changed, it is generally changed for the worse. We try to add to the demonstration of a proposition in the same question, some rider to which we give half the marks, because it determines whether the proposition has been understood as well as learned.

In trigonometry it is easily checked. The questions are so set that the crammed student is betrayed at once.

In mathematics it is tolerably easy to check "cram," when you get beyond the elements. It is always possible to set questions which are easy enough to the well-instructed student, and throw out the "crammed" completely.

IV. This is already answered under I. The fitness of the candidate to become a teacher is tested to this extent: you ascertain the acquirements of the teacher. The examination of his pupils gives us a measure of his capacity for teaching that which he knows.

The first qualification is sufficiently tested by his passing in the advanced papers, and if his employers wish for a higher test, a very efficient one is afforded by the honours paper.

V. There is no doubt that, in the elementary stages i., ii., the majority of candidates are very young, and often very ill educated; writing, spelling, and power of expression being in such cases defective. Sometimes we have to remark that such candidates would have been better employed in completing their elementary education. But, taking the examination generally, it is not true that the majority are too young or too ignorant of spelling, and certainly the successful students are not liable to any such imputation.

It is especially in Ireland that numbers of candidates are sent up, who are too young and too ignorant of spelling and composition. No particular harm is done, as they all "fail." This will correct itself in time, as teachers will not persevere in sending up pupils who fail.

B. M. COWIE.

June 21, 1871.

REPLY to QUESTIONS relating to the Examinations conducted by the Department of Science and Art, by T. Archer Hirst, Ph.D., F.R.S., formerly Professor of Mathematics in University College, London; now Assistant Registrar in the University of London, and Examiner in the Higher Pure Mathematics for the Department of Science and Art, South Kensington.

Question 1. "What opinion have you formed as to the amount of good which is done by the South Kensington system generally, and of the value of the examination in the different grades?"—I believe that the Science and Art Department are doing good service by promoting instruction in science, and by affording aid and encouragement towards the foundation and maintenance of science schools and classes throughout the country. The system of examinations they have instituted is comparable, in point of thoroughness and utility, with any now in existence. These examinations have revealed, and also increased, the desire for scientific instruction on the part of the middle and artisan classes, and they have, moreover, proved the necessity of supplementing the present action of the department by measures more directly calculated to raise the character and tone of the existing instruction in science. Under present circumstances, the practice of paying teachers according to the results of competitive examination is, perhaps, as good as could be devised for rendering teachers more painstaking; it does not, however, sufficiently secure good teaching. Competitive examinations, by means of papers which have to be worked under pressure of time, are, at best, but a very imperfect test of the soundness of the knowledge possessed by candidates, and of the training which they have received; and, as a consequence of this, we find that those who, in reality, are most successful in preparing candidates for such examinations do not rank amongst the best teachers, and frequently are not even good ones. They do not, as a rule, teach with that singleness of purpose which is so essential to sound education; the examination-value of their lessons occupies too prominent a place in their own thoughts, as well as in those of their pupils; the true objects of study are thereby overlooked, and a love for it checked rather than fostered. The extraordinary development given, in recent years, to the system of competitive examinations is, in fact, far from being an unmixed good. A deterioration in the quality of the instruction given accompanies the rapid increase in the number of those who receive it. To the universal struggle to score marks at competitive examinations, or, rather, to the habit of study which is engendered by the too exclusive preparation for this struggle, I am inclined to attribute most of the prevailing superficiality of scientific knowledge. The only remedy for this to which I look with any degree of hopefulness is the establishment of well-organised training schools for teachers,—schools wherein those who intend to devote themselves to teaching should not only have opportunities for extending and maturing their own knowledge, but also for exercising themselves in the art of teaching under the direction and inspection of the best masters of that art. The more frequent contact, too, with superior minds, which would be secured to him in such a school, would do more towards raising the *morale* of the teacher, and giving him a proper appreciation of his high vocation than, perhaps, any other measure that has been proposed. In my answer to question 4 I shall probably have occasion to return to this subject.

Question 2. "What is the evidence afforded as to the practical nature of the teaching?"—I am not sure that I correctly understand the bearing of this question on the examinations which I have had to conduct, and to which I prefer to limit my remarks. To me, the most practical teaching of pure mathematics is simply that which is most thorough and theoretically sound; that which seeks, above all things, to establish habits of accurate reasoning, which tolerates no shirking of difficulties, and no looseness or obscurity of expression; that, finally, which keeps mere manipulation, according to rule, in due subordination to a clear comprehension of the nature and origin of rules. Judged by this standard, the worked papers submitted to me at the South Kensington Examinations afford very little evidence, indeed, of teaching of a practical nature. For reasons before alluded to, I am quite prepared to admit that these papers may represent but very imperfectly the result of the teaching which their writers have received. Making all due allowance for this, however, evidence enough remains of the prevalence of mathematical teaching which is not practical, because it is not sufficiently sound and well grounded on principles.

Question 3. "What opinion have you formed as to the amount of 'cram,' and the power of testing it by examination?"—To some extent I have already answered this question. By "cram," in mathematics, I understand the loading of the memory with verbal answers to anticipated

questions, and with rules and demonstrations which the understanding has not fathomed. This vicious habit undoubtedly prevails to a deplorable degree. It is the natural offspring of competitive examination, the invariable resource of the incompetent and indolent, who covet, but do not deserve, the worldly advantages which success in examinations secures. Nothing is more easy than to detect "cram" in mathematics. A slight alteration in the enunciation of a theorem, or in the conditions of a problem, is in general quite sufficient to reveal its existence. What is here said, has reference, of course, to "cram" in its worst forms; it should not be forgotten, however, that it exists in all possible degrees, and that, in its milder forms, it loses much of its repulsive character, and becomes simply imperfect knowledge.

Question 4. "What test is afforded, by passing in the advanced papers, as to the fitness of a candidate to become a teacher?"—No one whose studies have not extended far beyond the subject matter of the lessons he has to give, can properly teach the elements of any science. A teacher, therefore, ought to be able to pass an examination in the higher branches of the subject he professes to teach. This, however, is a very insufficient test, indeed, of his fitness to teach. Other qualities, moral and intellectual, are required in a teacher, the presence or absence of which written examinations cannot in the least reveal. This brings us again to the subject of the selection and training of teachers, touched upon in my answer to question 1. I am convinced that it is the question of most pressing importance in the present inquiry, and I trust that, through the intervention of the present Commission, more decided steps towards its solution will speedily be taken. I am aware that, at present, a certain number of teachers are yearly brought to London for the purpose of hearing lectures delivered by Professors Huxley, Frankland, and Guthrie, and of attending practical classes conducted under their superintendence. An extension of this practice, in the shape of a well-organized and supported training college for teachers of science, is now greatly needed. It is to such a college that we must chiefly look for the production of a class of teachers possessing wider culture, more matured knowledge, higher aims, and greater *savoir faire* than those upon whom candidates for competitive examinations are now, for the most part, dependent.

Question 5. "Whether any evidence is afforded, in the badly spelt and ungrammatical papers, that they are, as a rule, the work of young persons?"—Bad spelling and grammar do occasionally, but not very frequently, disfigure the worked papers which are submitted to me. The haste with which such papers are written sufficiently accounts for the fact, and, consequently, I attach but little importance thereto. The subject in which I examine being the higher mathematics solely, very young persons are necessarily excluded from competition.

MEMORANDUM in Answer to Questions proposed by the ROYAL COMMISSION ON SCIENTIFIC INSTRUCTION.

1. The existence of the South Kensington System presupposes that there are persons who wish to acquire a knowledge of one or more branches of science. I have no doubt that the *direct* effect of the system is to induce those persons to pursue the studies in which they are interested with more system and thoroughness than they would do, at least in all ordinary cases, if left to themselves. It produces also, I suppose, the indirect effect of inducing many to study one or more branches of science, who would otherwise have paid no attention to such matters.

With regard to the value of the examinations I may remark, that, with a few exceptions, the successful candidates are arranged in two grades, and in two classes in each grade: four classes in all. There are two papers of questions, one for each grade. Speaking with reference to the subject in which I have acted as examiner, viz., theoretical mechanics, I may state, that those who get into the lower class of the lower grade have all given evidence of having acquired, at least, a real knowledge of the very elementary parts of the subject; those who stand high in the lower class, and those in the higher class must know the leading facts of the science, and be able to reason on them and to work examples in them. Those who pass in the advanced paper must have studied to some purpose as much of the science as can be treated without a knowledge of the differential calculus, while those who pass well in it give clear evidence of having thoroughly mastered the subject up to the point indicated.

The few exceptions mentioned above are those who pass in honours. In this part of the examination the questions asked are such as could only be answered by candidates having a very considerable knowledge of the subject, such, for instance, as might be possessed by a wrangler.

It may be well to add that the test applied is sufficiently strict to ensure the failure of a considerable proportion of the candidates in each grade.

The value of the examination, then, consists in this, that it supplies candidates with an obvious motive for mastering instead of playing with their subject, it enables them to judge of their success in their study, and, doubtless, in very many cases, it serves as an inducement to begin a study which would not otherwise have been taken in hand. In this view the value is very great.

(2.) If I rightly understand this question, I should say, speaking with reference to my own subject, that a person who has learned such matters as the properties of the centre of gravity, the relations between the forces acting on simple machines, the principles of rectilinear and circular motion, the pressure of fluids, the conditions of flotation, &c., has learned matters of a very practical nature. It is, however, to be borne in mind, that in most practical work the rules actually used are not the first principles with which science is conversant, but are secondary, and are derived in many cases from the principles of several sciences. Consequently, a knowledge of scientific principles would, in ordinary cases, be of little *direct* use to an artisan. The *indirect* use, however, would, I suppose, be very great, e.g. in cases which cannot fail to arise, when the accustomed rule has to be varied.

(3) A candidate is said to "cram," I suppose, when, without understanding the matter, he commits to memory answers to particular questions which the examiner is thought likely to ask. I have observed very little, if any, work of this kind in the answers to my questions. In my opinion, an examiner, by carefully framing his questions, can, almost without fail, prevent any candidate from passing who trusts mainly to "cram," understood as above.

I may, perhaps, be allowed to state further, that I very much doubt whether, in any but the most exceptional cases, candidates could hope to pass by using their memories without their understandings. Thus, even if such simple questions are asked as "What is meant by the specific gravity of a solid or liquid?" or "State the three laws of motion," it rarely happens that the statements are quite satisfactory, except those made by the better class of candidates, showing, either, that no attempt has been made to commit such points to memory, or, else, that the memory has failed.

The case in which "cramming" may be occasionally resorted to with success is, I suppose, when a candidate has studied only part of his subject, and at the last moment gets up at hazard a proposition or two in the other parts which he does not know, on the chance of their being set; but, then, it will rarely happen that he will select the right propositions, and, even if he do, he will commonly fail to write them out correctly.

4. A candidate who passed *high* on the advanced paper might be safely set to teach candidates for the lower paper, I mean, of course, so far as his knowledge is concerned. Such a person, it may be added, will increase his own knowledge of the subject by teaching others.

5. A considerable number, but quite a minority, of the candidates show, by bad spelling and want of power of expressing their meaning, that they are comparatively uneducated. I suppose that these are, for the most part, young persons of the artisan class.

JOHN F. TWISDEN, M.A.
Examiner in Theoretical Mechanics.

June 21, 1871.

Machinery Department, Royal Arsenal,

SIR,
July 13, 1871.
IN reply to your letter of the 15th June 1871, respecting certain questions with reference to the examination papers under the Department of Science and Art for 1871, I have the honour to furnish the following answers for the information of His Grace the Duke of Devonshire, and the Royal Commissioners on Science.

1st question. "What opinion have you formed as to the amount of good which is done by the South Kensington System generally, and the value of the examination in the different grades?"

I am decidedly of opinion that good is being done, probably not so much as may appear upon the surface, still it is a useful agency for disseminating real knowledge among a class of men where scarcely any knowledge existed before. In my official capacity I am constantly in want of men of a superior class for Turkey, who have not only to be good workmen themselves, but they require to be qualified to teach other men in a professional capacity. In selecting such teachers, I rarely find one who could answer the questions in the elementary papers, unless they happen to have been connected with these classes; workmen in general, and even good workmen, know next to nothing of

any mechanical subject which is not a part of their handicraft. Of course, there are many exceptions, but, as a rule, it is so, and no one has had a better opportunity than myself of finding this out, because, for a number of years past, I have been in search of such men; but I am led to hope that the efforts of South Kensington will gradually work a change for the better.

Another point is raised in this No. 1 question, namely, "the value of the examination in the different grades." This is a more difficult point to answer; at the same time, I do not see any better mode of ascertaining the result of the teaching than by the present system. If the examinations were left to local efforts, I fear that there would be a greater tendency to partiality than is the case at present. In my opinion, the questions are often fairly answered by some who have not acquired much of the real natural knowledge of the subject.

2nd question. "What is the evidence afforded as to the practical nature of the teaching?"

This is a most important question, referring to my own subject of Applied Mechanics. I am under the impression that some of the teachers have but little practical acquaintance with the subject, that they have derived their knowledge mostly, if not altogether, from books; this is wrong; it seems to me that the teachers should be men who have been applying mechanics *practically* for some time, and who, in addition, have acquired the book knowledge; the two sorts in combination are essential.

3d question. "What opinion have you formed as to the amount of 'cram,' and the power of testing it by examination?"

There is evidence of a good deal of "cram," but I do not see how it can be avoided under the circumstances, but "cram" is better than nothing, and when the good men leave the classes, it will be found that the good seed will bear fruit afterwards.

4th question. "What test is afforded, by passing in the advanced papers, as to the fitness of a candidate to become a teacher?"

I have carefully considered this question, and, in my opinion, there is no evidence whatever that such men are qualified to become teachers.

5th question. "Whether any evidence is afforded, in the badly spelt and ungrammatical papers, that they are, as a rule, the work of young persons?"

The answers given in the papers are so varied, that no general inference can be drawn; there are some who can write and spell correctly, but have no real knowledge of the subject, while others show real knowledge who may spell very badly.

I have, &c.

JOHN ANDERSON, LL.D.
The Secretary, Examiner in Applied Mechanics.
Royal Commission on Science.

Royal Institution, Albemarle Street,

SIR,
June 22, 1871.
THE results of the examination of 1871 had not reached me when your letter of the 15th arrived, but I am now in a position to answer the questions which the Duke of Devonshire and the Commission of which His Grace is chairman have done me the honour of submitting to me.

My relation to the South Kensington examinations is this:—I set all the examination papers, and organise a staff of gentlemen as assistant examiners. These are divided into two portions who respectively take charge of the two subdivisions of experimental physics comprised in the examination. Two principal assistant examiners are appointed, who take charge of the honours papers, and who also check and revise the other papers. With these two gentlemen I have been recently in communication regarding the questions which you have submitted to me.

1. In reply to the first question, I have to state that the two principal assistant examiners are decidedly of opinion that through the agency of such examinations as that just concluded, a great amount of sound scientific knowledge is diffused throughout the country. This, I may add, is the opinion which I formed of the effect of the examinations when I read the examination papers myself.

2. The second question is this: "What is the evidence afforded as to the practical nature of the teaching?" It is difficult to answer this question, the term "practical" is so eminently vague. If by it is meant teaching by aid of experiments and suitable apparatus, then the teaching must be defective in a great number of cases. The teachers in this country have never had any systematic training in practical experimentation. And although men may be found who become experimentists through the force of natural bent, it is not to be expected that teachers generally are of this class, or that they can dispense with practical

instruction. It is, therefore, an object to be aimed at, the founding of institutions in which teachers should be instructed in the use of apparatus sufficiently cheap, simple, and effectual, to be introduced with profit into class instruction.

I would here remark that although no scheme of education in physics is even approximately complete without illustrative experiments, an able teacher, even in the absence of apparatus, can do a great amount of good. It is possible, by the judicious use of the blackboard and chalk, and of simple models, to convey clear conceptions of various parts of physics, so clear, indeed, that, should the pupil afterwards witness the experiments, he shall witness that of which he had previously an accurate, though, it may be, an incomplete conception. Indeed, even where apparatus exists, the performance of experiments ought to go hand in hand with this diagrammatic exposition.

3. The third question has reference to the prevalence of "cram." This word I find differently interpreted, but I take the significance of the word to be knowledge, which bears some such relation to the mind as undigested food does to the body. This interpretation excludes the idea that all knowledge of experimental science, which does not embrace the experiments themselves, is necessarily "cram." For, as I said before, by proper descriptions, diagrams, and models, clear conceptions may be conveyed, and the mind of the pupil exercised in a salutary manner. On the other hand, I hold that pernicious "cram" may co-exist with the performance of experiments; for experiments may certainly be conducted in such a way as to address the senses without laying any real hold upon the intellect.

Judged by this standard, the amount of "cram" revealed in the recent examination is greater than it ought to be. Many teachers evidently set before themselves, as the main object of their efforts, the bettering of their own pecuniary estate; and a good number of them appear to entertain the notion that this end is more likely to be gained by increasing the number of candidates than by aiming at more excellent instruction. Of the 7,000 pupils recently examined in physics, many ought never to have appeared at all. Their incapacity must have been known to their teachers, provided the teachers themselves be not utterly incapable. Some method, I think, ought to be devised which should not only deprive such teachers of any advantages expected to arise from mere numbers, but which should also subject them to a definite penalty for the perfectly fruitless trouble and expense which they entail upon the Department of Science and Art.

The detection of "cram" must depend upon the sagacity of the examiner; a thorough insight of the working of the pupil's mind is here essential, and it is for this express reason that I have sought the co-operation of gentlemen experienced in teaching as well as distinguished in science.

4. With regard to the fitness of candidates to become teachers, it is no easy point to decide. Knowledge and teaching power are not necessarily the same. The latter implies the former, but the former does not imply the latter. Teaching power is, to some extent, a question of character, which is but imperfectly revealed by a written examination. Still, the chances undoubtedly are that the youth who expresses himself in writing with clearness and straightforwardness, will also prove efficient as a teacher.

5. I think the bad spelling may, for the most part, be traced to the more youthful candidates. Still, cases now and then arise in which knowledge, sound in quality and considerable in amount, is found associated with defective spelling. This defect, however, is a great nuisance, and ought to be stringently dealt with.

While commending much of the work accomplished by the teachers, and recognising, in this examination, many creditable results, I think it ought to be the aim of the Department to employ the less satisfactory returns with a view to lessening the incompetence or neglect which these returns imply.

I have, &c.

To the Secretary of the
Royal Commission on Science.

JOHN TYNDALL.

Royal College of Chemistry,
June 21, 1871.

SIR,
IN reply to the queries which you have addressed to me at the request of his Grace the Duke of Devonshire, I have to state that—

First, I consider the South Kensington System of examination to be of great service in stimulating the teaching of experimental science throughout the country, and although much of that teaching is necessarily of an imperfect character, owing to the defective training of the

instructors, yet, on the whole, it contributes to the diffusion of scientific knowledge to probably a greater extent than is done by all the other means of scientific instruction put together. In my visits to various parts of the country, during the past three years, as one of Her Majesty's Commissioners for the Prevention of the Pollution of Rivers, I have been much impressed by finding science classes, in connexion with the Department, in many out-of-the-way places, where youths and working men, connected with mining and manufacturing industries, were receiving instruction. In most of these places the instruction could not be given without some such assistance as that afforded by the Science and Art Department.

With regard to the value of the examination in the different grades, I consider that, at present, the elementary and advanced stages are of the most importance, the honours stage having, as yet, in chemistry at least, attracted but few competitors. Persons coming up for the elementary examination appear to have been taught, for the most part, from books, or from lectures very imperfectly illustrated, but, during the past year, the instruction has become more practical, owing to the operation of the "laboratory grant" minute. Pupils attempting the advanced stage papers exhibit, in the examination just held, a much greater proficiency in experimental or practical knowledge than was the case in former years, and a large proportion of the papers in this stage are of a very satisfactory character.

Second. In the elementary stage, the evidence afforded as to the practical nature of the teaching is, as just mentioned, somewhat feeble, whilst in the advanced and honours stages it is strong and conclusive, proving that much sound practical instruction has been imparted to the candidates coming up in these stages.

Third. In preparing pupils for the elementary stage, there has undoubtedly been a good deal of "cramming," but, in the early stages of instruction in science, there is always a considerable amount of information, such as laws, nomenclature, notation, &c., which must be acquired by mere effort of memory, as distinguished from observation and experiment, and I am, therefore, not disposed to look with utter disfavour upon a certain amount of what may be termed "cram" in the earlier stages of scientific instruction. Our whole system of literary and arithmetical education is so largely founded upon cram, that I fear we must not expect, for some time to come, so much attention to be paid to observation and experiment as is desirable.

Amongst the pupils attempting the advanced and honours papers, the evidence of cram is by no means wanting; nevertheless, they also give unmistakable evidence of a fair amount of knowledge acquired from observation and experiment.

There is but little difficulty in detecting "cram" in the chemical examination papers, and nothing would be easier than to frame all the questions so that "cram" would be entirely useless, or nearly so, to the candidate, but, for the reasons already given, I do not consider this desirable. A certain number of anti-cram questions are always set, and by the avoidance of these questions the crammed candidates are immediately recognised.

Fourth. I do not think that passing in the advanced papers is a sufficient guarantee of the fitness of a candidate to become a teacher. Nevertheless, at present, the choice lies between these men and others with still slighter qualifications.

Fifth. I do not think that badly spelt and ungrammatical papers afford conclusive evidence that they are the work of young persons, because I have repeatedly had letters from adult candidates exhibiting such defects; as, for instance, one I received on the 14th inst., from which I append some extracts.

I have, &c.,

E. FRANKLAND.

J. Norman Lockyer, Esq., F.R.S.

APPENDIX.

COPY OF LETTER FROM ADULT CANDIDATE.

I am sure you will pardon me, your most humble servant, for writing a few lines to you about the late examination in chemistry for the science and Art department of which you are the examiner, I your humble servant was one of the students that was examined at the Manchester Mechanic Institution, and I was informed yesterday the 12th that you have been so good as to give me a second class, well I most heartily thank you Sir, but still I should have been much better pleased had it been a first class, for I can assure you Sir I have been a student of chemistry for 4 or 5 years and I think that if the examination had been practical I should have been first. For I am a great lover of chemistry and by dint of management I have got a very nice Laboratory together though I have a very

large family of six children, I can assure you Sir that I have gone almost without dinner many a time so that I should have money to fit up my Laboratory with and buy a few old books on chemistry. For I have worked very hard at the science for some years, but Sir I happen to be one of those men who has had to work very hard from being a child and have got no Education as you will see by this and my examination papers. * * * * but I can assure you Sir I shall not give up the study for I love it and I shall make it my life's study. but I am sorrow to say that I do not think I shall ever go in for another examination as I see I do not stand any chance on account of my want of Education. * * * * so hoping that you will not take this note amiss and that you will pardon me if I have said anything wrong as do not think I shall ever trouble you again as I see it is no use of me going in for examination as I do not think you have good data for judging who is the best man under the present system of examinations.

SIR, Jermyn Street, June 17, 1871.
IN reply to the questions proposed, I have to state:—

1st. I think a considerable amount of good is done by the South Kensington System, and I approve of the different grades. The system necessarily gives the pupils an idea of the meaning and use of various branches of science which otherwise they would probably have no means of attaining.

2nd. The term practical is rather vague. If it means, in my branch, whether or not the pupils are taught practical geology in the field, I would say, that as a general rule, they are not. If it means whether or not they are well taught, I reply that most of the classes are fairly well, and some of them very well taught.

3rd. There is undoubtedly a considerable amount of "cram." I judge of this by the set phrases by which, in some classes, certain questions are answered. I have not, however, any means of judging, when such answers are correct, that the pupils do not understand the meaning of these answers.

4th. To the fourth question, there is no means of testing the fitness of a candidate to become a teacher, excepting the correctness and style of his answers. I make a point of valuing all such papers myself, and I observe that few of these candidates pass. Persons who "go in" for this office are often very ill qualified for it. It seems to me that often the fact that they are ignorant, and ill-educated, is the reason why they consider themselves likely to be qualified for the office of teachers.

5th. Undoubtedly bad spelling, bad writing, and bad grammar prove that many of the pupils are very young persons, and others, perhaps older, have been very ill educated.

In the annual reports sent to South Kensington, these circumstances are generally commented on by me.

From year to year there has, on the whole, been progressive improvement. This year the improvement has been very marked.

I have, &c.
ANDREW C. RAMSAY.

J. Norman Lockyer, Esq.

SIR, Jermyn Street, June 23, 1871.
I HAVE the honour to reply to the questions put in your letter of the 15th inst. with reference to the examination of the South Kensington Department.

1. The results for 1871 go far to confirm the opinions which I expressed to the Royal Commission when examined in 1870 (2290-2298). I believe that much good has resulted in the mining districts, where the subjects of mineralogy and the principles of mining form legitimate matter for study; but a sorry exhibition of unsuccessful "cram" has been produced by candidates from certain localities, and especially by a large proportion of those who have competed for "scholarships" and "exhibitions."

Of the different grades, the "elementary" has generally been the best in its results; the "advanced" has done very well in mineralogy, but in the paper on mining it has in only a few instances been very good, though, as it seems to me, nevertheless, valuable from its fostering habits of observation. The "honours" grade has with me been a total failure, and is, I think, for several reasons undesirable to maintain.

2. The evidence, as to the teaching, is, I think, that for the elementary grade it has, as a rule, been good. In the "advanced" papers I have had, on the one hand, more guessing, on the other, very good results of personal experience brought before me.

3. To some extent the system of "cram" must be endorsed in this and other written examinations, but I believe that so far, with the exception of candidates eager to amass marks for "scholarships," it has not been excessive.

4. The passing in the advanced papers is, to my mind, but an insufficient test of fitness to become a teacher. Terse-ness, sufficiency of information, and facility in drawing the requisite diagrams, come out distinctly in the papers, but either the presence or absence of some of these qualifications might be greatly made up for by other qualities, to judge of which personal knowledge would be needed.

5. The bad spelling and ungrammatical language of some of the papers are in most cases the simple result, with young persons, of a very insufficient amount of common schooling. The sound is often accurately followed, as when a candidate described ventilating "operations with a currant of are." Sometimes it results apparently from false reading, as a man referring to nitro-glycerine as a "viscous liquid." Most of the bad spelling has been associated with the poorest papers. But, on the whole, the answers have been better in these respects than might have been expected.

The numbers for 1871 have been as follow:—

Mineralogy.		Principles of Mining.	
Elementary—1st class	- 17	- - - -	1
" 2nd class	- 9	- - - -	11
" not passed	- 10	- - - -	15
Advanced 1st class	- 2	- - - -	1
" 2nd class	- 7	- - - -	16
" not passed	- 2	- - - -	8
Honours - - - -	- 0	not passed	- 2

I have, &c.
WARINGTON W. SMYTH.

SIR, IN reply to your letter of the 15th June 1871, I beg leave to submit the following answers to the questions which it contains, which have been furnished, at my request, by two of the gentlemen (Dr. Rutherford, Professor of Physiology in King's College, and Dr. Foster, Praeceptor in Physiology in Trinity College Cambridge, and Examiner in Physiology and Comparative Anatomy in the University of London), who assisted me in the examinations of this and last year:

"Question 2. The papers do not afford any strong evidence of the teaching having been practical. Occasionally, and, perhaps, more especially in the papers of this year, the answers show that the candidate has actually seen the things which he describes; but, as a whole, the teaching must still be regarded as chiefly bookwork.

"Question 3. There is abundant evidence, every year, of cramming. There are certain kinds of gross cramming (when, for instance, answers to questions thought likely to be put are committed to memory, and when, therefore, the same answers will be given almost *verbatim* by all the members of one class) which can very easily be detected and punished. It is possible, by judicious framing of the questions, to defeat attempts at cramming, to a considerable extent. But it is probable that in this, as in all other examinations, a very large amount of cramming will go on in spite of all efforts to prevent it.

"Question 5. Every year it is apparent, from the style of the handwriting and from the character of the answers, that a very large number of the papers sent in are worked by very young persons, in fact, by mere children.

"Question 4. No written examination can ever be an adequate test of fitness to become a teacher. At the very best, a written examination can be no more than a means whereby to judge a candidate's general knowledge of the subject; but, so far as a written examination is a test at all, the advanced paper in Physiology affords a fair test whether candidates do or do not possess a sound knowledge of the elements of the subject.

"Question 1. Making full allowance, in all these unsatisfactory aspects of the examinations, we are still strongly of opinion that the good which is being done by them is very great. The answers in the elementary stage clearly prove that hundreds of young persons are annually becoming acquainted, if not in a wholly practical, yet in a fairly sound manner, with the elementary facts and principles of Physiology.

The answers in the advanced stage show, as distinctly, that a large number of young artisans and other young persons in a similar station of life are yearly acquiring very considerable physiological knowledge. The answers in this class are, perhaps, on the whole, superior to such as would be given by an average medical student, and the

instruction. It is, therefore, an object to be aimed at, the founding of institutions in which teachers should be instructed in the use of apparatus sufficiently cheap, simple, and effectual, to be introduced with profit into class instruction.

I would here remark that although no scheme of education in physics is even approximately complete without illustrative experiments, an able teacher, even in the absence of apparatus, can do a great amount of good. It is possible, by the judicious use of the blackboard and chalk, and of simple models, to convey clear conceptions of various parts of physics, so clear, indeed, that, should the pupil afterwards witness the experiments, he shall witness that of which he had previously an accurate, though, it may be, an incomplete conception. Indeed, even where apparatus exists, the performance of experiments ought to go hand in hand with this diagrammatic exposition.

3. The third question has reference to the prevalence of "cram." This word I find differently interpreted, but I take the significance of the word to be knowledge, which bears some such relation to the mind as undigested food does to the body. This interpretation excludes the idea that all knowledge of experimental science, which does not embrace the experiments themselves, is necessarily "cram." For, as I said before, by proper descriptions, diagrams, and models, clear conceptions may be conveyed, and the mind of the pupil exercised in a salutary manner. On the other hand, I hold that pernicious "cram" may co-exist with the performance of experiments; for experiments may certainly be conducted in such a way as to address the senses without laying any real hold upon the intellect.

Judged by this standard, the amount of "cram" revealed in the recent examination is greater than it ought to be. Many teachers evidently set before themselves, as the main object of their efforts, the bettering of their own pecuniary estate; and a good number of them appear to entertain the notion that this end is more likely to be gained by increasing the number of candidates than by aiming at more excellent instruction. Of the 7,000 pupils recently examined in physics, many ought never to have appeared at all. Their incapacity must have been known to their teachers, provided the teachers themselves be not utterly incapable. Some method, I think, ought to be devised which should not only deprive such teachers of any advantages expected to arise from mere numbers, but which should also subject them to a definite penalty for the perfectly fruitless trouble and expense which they entail upon the Department of Science and Art.

The detection of "cram" must depend upon the sagacity of the examiner; a thorough insight of the working of the pupil's mind is here essential, and it is for this express reason that I have sought the co-operation of gentlemen experienced in teaching as well as distinguished in science.

4. With regard to the fitness of candidates to become teachers, it is no easy point to decide. Knowledge and teaching power are not necessarily the same. The latter implies the former, but the former does not imply the latter. Teaching power is, to some extent, a question of character, which is but imperfectly revealed by a written examination. Still, the chances undoubtedly are that the youth who expresses himself in writing with clearness and straightforwardness, will also prove efficient as a teacher.

5. I think the bad spelling may, for the most part, be traced to the more youthful candidates. Still, cases now and then arise in which knowledge, sound in quality and considerable in amount, is found associated with defective spelling. This defect, however, is a great nuisance, and ought to be stringently dealt with.

While commending much of the work accomplished by the teachers, and recognising, in this examination, many creditable results, I think it ought to be the aim of the Department to employ the less satisfactory returns with a view to lessening the incompetence or neglect which these returns imply.

I have, &c.

To the Secretary of the
Royal Commission on Science.

JOHN TYNDALL.

Royal College of Chemistry,

June 21, 1871.

SIR,
In reply to the queries which you have addressed to me at the request of his Grace the Duke of Devonshire, I have to state that—

First, I consider the South Kensington System of examination to be of great service in stimulating the teaching of experimental science throughout the country, and although much of that teaching is necessarily of an imperfect character, owing to the defective training of the

instructors, yet, on the whole, it contributes to the diffusion of scientific knowledge to probably a greater extent than is done by all the other means of scientific instruction put together. In my visits to various parts of the country, during the past three years, as one of Her Majesty's Commissioners for the Prevention of the Pollution of Rivers, I have been much impressed by finding science classes, in connexion with the Department, in many out-of-the-way places, where youths and working men, connected with mining and manufacturing industries, were receiving instruction. In most of these places the instruction could not be given without some such assistance as that afforded by the Science and Art Department.

With regard to the value of the examination in the different grades, I consider that, at present, the elementary and advanced stages are of the most importance, the honours stage having, as yet, in chemistry at least, attracted but few competitors. Persons coming up for the elementary examination appear to have been taught, for the most part, from books, or from lectures very imperfectly illustrated, but, during the past year, the instruction has become more practical, owing to the operation of the "laboratory grant" minute. Pupils attempting the advanced stage papers exhibit, in the examination just held, a much greater proficiency in experimental or practical knowledge than was the case in former years, and a large proportion of the papers in this stage are of a very satisfactory character.

Second. In the elementary stage, the evidence afforded as to the practical nature of the teaching is, as just mentioned, somewhat feeble, whilst in the advanced and honours stages it is strong and conclusive, proving that much sound practical instruction has been imparted to the candidates coming up in these stages.

Third. In preparing pupils for the elementary stage, there has undoubtedly been a good deal of "cramming," but, in the early stages of instruction in science, there is always a considerable amount of information, such as laws, nomenclature, notation, &c., which must be acquired by mere effort of memory, as distinguished from observation and experiment, and I am, therefore, not disposed to look with utter disfavour upon a certain amount of what may be termed "cram" in the earlier stages of scientific instruction. Our whole system of literary and arithmetical education is so largely founded upon cram, that I fear we must not expect, for some time to come, so much attention to be paid to observation and experiment as is desirable.

Amongst the pupils attempting the advanced and honours papers, the evidence of cram is by no means wanting; nevertheless, they also give unmistakable evidence of a fair amount of knowledge acquired from observation and experiment.

There is but little difficulty in detecting "cram" in the chemical examination papers, and nothing would be easier than to frame all the questions so that "cram" would be entirely useless, or nearly so, to the candidate, but, for the reasons already given, I do not consider this desirable. A certain number of anti-cram questions are always set, and by the avoidance of these questions the crammed candidates are immediately recognised.

Fourth. I do not think that passing in the advanced papers is a sufficient guarantee of the fitness of a candidate to become a teacher. Nevertheless, at present, the choice lies between these men and others with still slighter qualifications.

Fifth. I do not think that badly spelt and ungrammatical papers afford conclusive evidence that they are the work of young persons, because I have repeatedly had letters from adult candidates exhibiting such defects; as, for instance, one I received on the 14th inst., from which I append some extracts.

I have, &c,

E. FRANKLAND.

J. Norman Lockyer, Esq., F.R.S.

APPENDIX.

COPY OF LETTER FROM ADULT CANDIDATE.

I am sure you will pardon me, your most humble servant, for writing a few line to you about the late examination in chemistry for the science and Art department of which you are the examiner, I your humble servant was one of the students that was examined at the Manchester Mechanic Institution, and I was informed yesterday the 12th that you have been so good as to give me a second class, well I most heartly thank you Sir, but still I should have been much better pleased had it been a first class, for I can assure you Sir I have been a student of chemistry for 4 or 5 years and I think that if the examination had been practical I should have been first. for I am a great lover of chemistry and by dint of management I have got a very nice Laboratory together though I have a very

A large number of the schools under the Department of Science and Art seem to be adapted for young persons. At any rate, a large proportion of the candidates for examination has always consisted of young students, many of them very little acquainted with the use of language, and very little or very badly taught in the common rudiments of education. In many cases the spelling and writing are exceedingly bad, and a certain per-centage of the candidates has been rejected at once as not deserving a single mark. This per-centage has decidedly diminished, while the number of candidates has largely increased each successive year.

The arrangement of the candidates into classes has been changed from time to time, but since 1867 there have always been two papers, and since 1869 a third or honours paper. At first the work done for the advanced paper indicated little more knowledge and no more teaching than that for the easy paper, and the result was that very few candidates passed the examination. The standard for this paper has, notwithstanding, been steadily raised, and in spite of this the per-centage of candidates has been increased. It is intended that none, or at any rate very few candidates from science schools, should attempt the advanced paper without having already passed in the easy paper at a former examination. I have always endeavoured to make sure that no one should pass in the advanced paper without at least as much accurate knowledge as would secure a first class in the easy paper. I find, however, that the per-centage of passes in the advanced paper as well as of first classes in the easy paper is increasing.

To obtain a first class in the advanced paper, which would be equivalent to a certificate as to fitness for teaching, I require in all cases some really good answers, and the absence of any gross error throughout the paper.

1. As a general reply to your first inquiry, I may say that whereas a few years ago the subject of physical geography had not entered into general education, and was hardly recognised in schools for the middle classes, there have been this year nearly 9,000 candidates for examination from the science schools, of whom at least one half have at any rate some producible knowledge of the subject, while probably 20 per cent. (say 1,800 young persons, many of whom propose to be themselves teachers) are really fairly instructed in the elements of physical geography, and may be supposed to take a certain amount of reasonable interest in it as a science, and will be in a position to follow it up if occasion requires.

2. The best evidence of the practical nature of teaching is to be found in the general intelligence indicated in the answers, as contrasted with the mere repetition of a form of words taught from a book. On the whole, I think, there is an improvement in this respect, but I am inclined to suspect that the style of teaching is generally bad, or, at least,

unsatisfactory, and that few teachers have learnt how to teach. Beyond all doubt there are many schools in which the teacher has no clear and distinct knowledge of the subjects he professes to teach, and in many cases the instruction in physical geography evidently has not been preceded by any instruction in the elements of descriptive geography. In the examination of this year, a large number of candidates had no clear notion of the meaning of latitude and longitude.

3. That the mere learning a subject by rote and having the faculty of answering questions correctly without any exercise of the intellectual faculties is very common, and is to some extent fostered by the examination system, there can be no doubt. It is not very difficult to test it by examination, but very difficult, indeed, to award to it its proper value. But the memory must be stored by facts, before the judgment is matured, and it is not easy to say where this system should stop. The intelligence of the teacher is really the only safeguard against the evil effects of "cram," as thus limited.

4. I have already pointed out that the nature of the advanced paper, and the amount and kind of information required to pass in the first class, afford reasonable grounds for granting a certificate that shall justify teaching. At the same time, it is certain that some may slip through who are not really fit, on account of the difficulty of determining, where no mistake is made, how much of an answer given is really understood. Even among the candidates for honours, a considerable number are only able to answer questions by rote, but in such cases they are never classed, although some may be allowed to pass. The result of the honours examination certainly shows an increasing number of students who really distinguish themselves, and will probably become admirable teachers.

5. In my remarks at the commencement of this letter, I have pointed out that a large number, but not I believe an increasing per-centage of the candidates, may be concluded to be very young, from the style of writing, the badness of the spelling, and the ignorance of grammar. At the same time, it is very difficult to judge, from appearances, whether these faults arise from actual youth, or whether they are due to the slowness with which elementary education is attained by grown-up persons who have been entirely neglected in this matter when young.

In conclusion, allow me to say, that I shall be most happy to give any information in my power to the Commissioners, and that I regret having been prevented by pressing engagements from giving evidence on a former occasion.

I have, &c.
D. T. ANSTED.

J. Norman Lockyer, Esq.

APPENDIX XVIII.

COMPARISON of the FEES of STUDENTS and the PAYMENTS on RESULTS in SCIENCE SCHOOLS under the Science and Art Department.

The following table gives the total amount paid to Teachers on results, the total amount of fees, and the proportion of fees to each *l.* of State payments on results.

	Fees.	Payments.	Amount of Fees to <i>l.</i> of Payments.
England and Wales - - -	£ 3,588	£ 12,694	£ s. d. 0 5 7½
Scotland - - - -	795	987	0 16 1½
Ireland - - - -	329	5,187	0 1 3½

J. F. D. DONNELLY,
Capt. R.E.
29 Nov. 1871.

best are above the standard required for the first M.B. pass at the University of London.

I have only to add, that I entirely concur in the opinions of Dr. Foster and Dr. Rutherford.

I am, &c.,
T. H. HUXLEY.

MY LORD DUKE, June 29, 1871.

As I have only this morning completed my examination of the answers to the Metallurgical questions of the Department of Science and Art for 1871, it was not possible to send an earlier reply to the letter addressed to me at the desire of your Grace, dated June 15th. I proceed to reply to the questions contained in that letter as follows:—

1. On the whole my opinion is favourable.
2. This question is somewhat ambiguous, as I do not correctly understand what is meant by "the practical nature of the teaching," in reference to the exposition of the principles of a manufacturing art, such as metallurgy. If it means whether the teachers employed by the Department have shown practical acquaintance with metallurgy, so far as may be inferred from the character of the answers of their pupils, I should say that, while some appear to be pretty well informed, others appear to be quite the reverse. I have noticed special blunders, stated in almost the same words, in many of the papers.

3. I am of opinion that there is a large amount of "cram," and *bad* cram, too.

4. I hold that the qualifications suitable for an efficient teacher cannot be decided, in any case, from the examination papers of students. Personal qualifications are, in my judgment, as essential to success as intellectual ones. I certainly would not venture to rely upon the evidence afforded by the "advanced papers," in judging of the qualifications of a teacher intended for an advanced class.

5. "The badly spelt and ungrammatical papers," on my subject, seem to be the work mainly of uneducated artizans.

I have, &c.
JOHN PERCY.

His Grace the Duke of Devonshire, K.G.,
&c. &c. &c.

SIR, June 20, 1871.

IN reply to your letter of the 15th inst., asking me to answer certain questions with reference to the examination papers under the Department of Science and Art for 1871, I have to state:—

1. My experience is limited, as the subjects in which I examine are among the least popular, and are taken up by comparatively few candidates: 227 in navigation, and 87 in nautical astronomy. Since the system has been in operation I have remarked a great improvement in the quality of the answers, and at the last examination there were few which betrayed great ignorance, and were, for the most part, confined to those which were worked not by regular pupils of instructors recognised by the Department, but by apparently self-taught persons who were candidates for prizes and medals. I should certainly say that the system of examination by the Department of Science and Art is the only incentive in this country to the study of navigation and nautical astronomy *theoretically* as well as *practically*, all other examinations embracing the practical part only. The different grades operate in rendering the instruction sounder, by giving a strong inducement to the teachers to give more time and attention to the principles than they would otherwise give. I have no doubt, that much of the improvement I observe in the papers examined by me arises from the Department requiring every candidate to pass in the elementary grade before attempting the more advanced.

2. My questions are half theoretical and half practical, and it would be difficult to say which are, on the whole, better answered. Certainly I have no reason to complain that the practical work is neglected, perhaps in these subjects, which I presume are taken up by persons about to embrace a seafaring life, the practical work, which will also tell in the Board of Trade examination, would naturally be that which would tend to occupy most attention, almost to engross it, if means were not taken to prevent it. This was certainly the tendency several years ago, but, judging from the last papers, this is now corrected.

3. Several years ago, there were great attempts to "cram" the candidates, but this is difficult in such subjects as I examine in, in which a want of grounding is sure to betray itself, and I have no reason to suspect much attempt at "cramming" now.

4. No examination will or can be made a test of the fitness of a man to teach, but, short of that aptness, which

can only be tested by experience, I think that a man who obtains a first class in the advanced grade shows that he possesses sufficient knowledge to teach, if he also possesses the aptitude in the same way that a wranglership or first class at the Universities tests only the knowledge, but not the teaching power of the person to whom it is awarded.

There can be no doubt that some of the teachers of the youths whose papers I examine are excellent instructors, wherever they have acquired their knowledge and skill.

5. As my subjects, especially nautical astronomy, require a fair previous knowledge of some branches of mathematics, I should not expect very young boys to attempt them. I have known cases, in former years, when boys of 11 and 12 have been presented for examination, but these were, almost without exception, failures. I have reason to believe, from internal evidence, that the papers worked by the majority of the students at the regular schools, are the papers of lads of 13 or 14. There is plenty of mis-spelling and crudeness and bad arrangement, mixed, for the most part, in real and genuine knowledge. I have said that there is a numerous class of evidently older candidates who do not profess to be regular students, whose passing involves no payment to teachers, who are merely candidates for prizes or medals. Their work is, for the most part, conspicuous by its incompleteness and betraying a want of grounding, a great proportion of the failures this year has been in this class.

I am, &c.
JOSEPH WOOLLEY.

J. Norman Lockyer, Esq., F.R.S.

Royal School of Mines,
June 23, 1871.

SIR, IN reply to your letter I beg to submit the following answers:—

1. I have formed the opinion that the South Kensington System of Examination has been of the greatest value in advancing general education. The recurrence of authoritative examinations has stimulated both teachers and their pupils as nothing else would have done, and I am convinced that the influence of the examiners has wonderfully extended the spread of scientific information.

2. The papers enable the examiner to discriminate pretty accurately between the good and bad teachers. I consider that the examinations have already improved the instruction by rendering it more practical.

3. In the subject in which I examine it is not possible to cram with any success.

If examiners were more careful in framing their questions, I believe that the danger of giving high marks to those who have not shown any power of reasoning, and who are merely crammed for examination, would be quite inconsiderable.

4. I consider that the list of marks affords an imperfect test of the fitness of the candidate to become a teacher, but I am sure that an examiner can form a reliable judgment upon the probable merit of the candidate, by observing the style and method of his answers. I have often noticed evidence of the greatest clearness of thought and expression in papers which have not obtained the highest marks.

5. I am unable to reply to this question. I have met with some candidates entirely unfit for examination, and with others who were evidently good mechanics, though not competent to express themselves grammatically, or to write correctly.

I have, &c.
J. Norman Lockyer, Esq. T. M. GOODEVE.

SIR, 33 Brunswick Square, June 1871.
To the communication I have had the honour to receive from you at the instance of Her Majesty's Commissioners on Science, I beg to reply as follows:—

In the subject of physical geography, of which I have been one of the examiners in the Department of Science and Art since 1867, and have held five examinations, the number of candidates has increased steadily and very rapidly, and in the present year amounted to 8,800. The subject being one that had not been taught in ordinary schools, but which is certainly very valuable, as including many facts of general interest and involving sound and philosophical deductions, and a fair exercise of the reasoning powers, is, perhaps, exceptionally adapted to illustrate the advantage or disadvantage of the South Kensington System.

APPENDIX XIX.

MINUTE of the LORDS of the COMMITTEE of the PRIVY COUNCIL ON EDUCATION on the INSTRUCTION given in the SCHOOLS OF SCIENCE receiving aid from the Science and Art Department.

Science Form, No. 466.
South Kensington, November 1871.

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF COUNCIL ON EDUCATION, SOUTH KENSINGTON.

At South Kensington the 24th day of November 1871.

By the Right Honourable the Lords of the Committee of Her Majesty's most Honourable Privy Council on Education.

My Lords consider the question of the instruction given in the Schools of Science receiving aid from the Science and Art Department.

2. It appears desirable that the instruction of Students in Science, after they have completed the course of the ordinary Elementary School, should be carried on more methodically than is at present the case, and that they should not attempt to grapple with the more advanced forms of Science until they have received sound and practical instruction in those subjects which constitute the groundwork of all the Physical Sciences.

3. To this end, the course of instruction specified below has been prepared as adapted both to Secondary Day Schools and to Night Classes.

4. It will depend on circumstances, especially if the student can only attend Night Classes, how many subjects he can take up in one year. It must, therefore, be understood that the course should not only comprise the subjects named below, but also that they should be taken in the order in which they are stated.

5. The terminology used is that of the Science and the Art Directories. The Syllabus of subjects there given states precisely what is included under each head. And it is assumed that, before commencing the following course, the student will have been made acquainted, in the Elementary School, with the elements of Arithmetic, and the primary conceptions of Physical Science.

COURSE OF INSTRUCTION.

First Year.

Mathematics (Subject V. First Stage).
Freehand Drawing (2nd Grade Art).
Practical Plane Geometry (2nd Grade Art).
Elementary Mechanics, including the physical property of liquids and gases (Subject VI. First Stage).
Physics: Acoustics, Light and Heat (Subject VIII. First Stage).

Second Year.

Chemistry, Inorganic (Subject X. First Stage), with practical work.
Physics: Magnetism and Electricity, frictional and voltaic (Subject IX. First Stage).
Mathematics (Second Stage and (if possible) Fourth Stage, Subject V.)
Practical Geometry (Plane and Solid), Subject I. First Stage.
Animal Physiology (if possible) (Subject XIV. First Stage).

The student should also, during the first and second year, work at Mechanical Drawing as provided for in the Art Directory, Stage 23a.

Third Year.

The work of this year must depend so much on the student's aptitude, and the progress he has made in the preceding course, that it is impossible to lay down the subjects for the third year's course with any definiteness. It is essential that before continuing his course, or commencing new subjects, he should have a sound knowledge of the first stage of Mathematics, Elementary Mechanics, Physics, and Chemistry; that he should have such a knowledge of Practical Geometry and Mechanical Drawing as to be able to draw and read simple plans, elevations, and sections with readiness, and that he should have sufficient facility in Freehand Drawing to make clear and neat explanatory diagrams.

6. When these subjects have been mastered, the student should, while continuing his studies in Mathematics, take up the first stage of Animal Physiology, if he has not already done so. He will then be in a position to specialise his studies with advantage in one of the following groups according to his requirements, taking up, for instance,—

1. Physics and Chemistry and Metallurgy.
2. Theoretical and Applied Mechanics, Steam, and Machine Construction and Drawing.
3. Theoretical and Applied Mechanics, and Building Construction and Drawing.
4. Biology.
5. Geology, Physical Geography, Mineralogy, and Mining.

The student may also with advantage continue his Freehand Drawing and Practical Geometry.

N.B.—The foregoing course is framed to lay the foundation of a thorough and systematic scientific training. It must however be understood that this course, though strongly recommended for all those who can devote sufficient time to go through it, in no way supersedes or does away with the power of holding special classes in different subjects for those who have not these opportunities, of diminishing the aid at present offered to such classes.

The fact of the course being intended as a systematic training will also explain the omission of certain subjects which are not to be considered unimportant because they find no place in the course. Thus, Systematic Botany will be found of very great use as a preliminary to the study of Natural Science. As such, it may be taught in Elementary Schools before this course is commenced. But further than that, it cannot be considered a step in a systematic course till the student takes it up as a portion of Biology in his third year. In the same way, Physical Geography is a subject which may with great advantage be studied in all schools, and is especially adapted for students who cannot go through a systematic course. The first elements of Physical Geography, treating broadly the outlines of Physical Science and describing its objects, should, as stated above, be taught as an introduction to its systematic study. But, Physical Geography in its general sense covers so wide a field, embracing to a greater or less degree so many branches of science, that it does not fall into a systematic course of training in science, though as a means of imparting highly valuable general information, as distinct from a systematic training, it may be strongly recommended.

7. With a view of aiding and encouraging Schools organized to give the foregoing courses of instruction, the following payments will be made irrespective of the general payments offered under the Science Directory.

8. In day schools, 10s. on account of each pupil who attends the full course of instruction, is present during 250 attendances of the school, and passes in one of the subjects of study laid down for his year.

9. Provided that, (1) the time table of the school is in accordance with the foregoing Minute and has been approved by the Department; (2) not more than two attendances are counted in one day; and (3) payment is not made on account of the same pupil for more than three years.

10. In night schools, 5s. on account of each pupil who attends the full course of instruction, is present during 75 attendances of the school, and passes in one of the subjects of study laid down for his year.

11. Provided that, (1) the time table of the school is in accordance with the foregoing Minute and has been approved by the Department; (2) not more than one attendance is counted on one evening; and (3) payment is not made on account of the same pupil for more than three years.

12. The school claiming this aid must be properly organized as a Science School. The grants cannot be claimed on account of classes held in a school already receiving State aid from the Education Department, Whitehall or the Commissioners of National Education, Ireland.

By order,
HENRY COLE, Secretary.

ANALYSES OF EVIDENCE.

ANALYSES OF THE EVIDENCE

NOW REPORTED ON.

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Delivers 60 lectures on mining, and 40 on mineralogy, to School of Mines' students, 365.

South Kensington.

Removal of School of Mines to, would be a choice of two evils. Were certain classes held at South Kensington, there would be some, but not insuperable, inconvenience, 403-406. Certain professors would acquiesce in removal; no serious objection against it has been raised, 420-422.

University College.

Boarding-hall for students in connexion with, 513, 514.

26060.

RAMSAY, PROFESSOR, LL.D., F.R.S. (Index of his Evidence.)

Accommodation for Science Purposes.

No want of, as regards School of Mines, 667.

Office room wanted for the Geological Survey; proposals that have been made. Stoppage of work for want of room, 669-674, 695.

More room wanted for geological specimens in museum, 670. The museum would suffer, even if the School of Mines' lecture-halls, laboratory, &c. were appropriated to Survey purposes, 677.

The present Survey offices were originally intended for the museum, 678.

Agriculture.

Farmers are becoming aware of the importance of geology with regard to soils, 754.

Associates of the Royal School of Mines. See *Royal School of Mines' Students.**Black Board.*

Every teacher of geology should be able to illustrate his teaching with chalk and a black board, 619.

Cambridge University.

Geology has been well taught at, by Professors Sedgwick and Stokes, 687.

A practical mining student might qualify at Cambridge, with the advantage of Professors Sedgwick and Stokes' teaching in geology and physics; but there is no professor of mining there, 713.

Canada.

Many gentlemen from, have attended the courses of the School of Mines, 656. The directors, former and present, of the Geological Survey of Canada, were both trained on the British Survey, 757 (*additional remarks*).

Cape of Good Hope.

The former conductor of the Geological Survey of the Cape was trained on the British Survey, 757 (*additional remarks*).

Chairs of Science.

No special chair of geology in Scottish universities, 686.

Defective teaching from geology forming a branch only of natural history chair, 687.

Professor Huxley's chair in Jermyn Street is Natural History and Palæontology; the latter an essential subject in a school of mines, 691.

See *Endowment*.

Chemistry.

An ultimate reference to practical chemistry would not affect the character of the School of Mines, 734.

Is taught in every laboratory; and competent teachers are plentiful, and turn out a large number of able young men, 748.

Want of a practical chemist on the Geological Survey; the School of Mines' professors of chemistry and metallurgy not being bound to do work for the Survey, 751-753.

Children.

Some of the candidates in geology appear to be mere children, 569, 576.

Geology may be taught to children at an early age, 605.

Desirability of imparting theoretical knowledge of geology to children, 631.

Civil Engineering.

The School of Mines' courses would be desirable for a person intending to follow civil engineering, 750.

Coal.

Valuable service rendered to coal-mining industry by Geological Survey, 703-706. Unless theoretic science can apply means of ventilation, a great quantity of coal will never be won, 707, 708.

Government has ordered the Geological Survey to re-survey all the coal-fields on maps of six inches to a mile, 754.

Colonies.

Many of the former students of the School of Mines and officers on the English Survey have been engaged in the geological surveys of the colonies, 741.

Cornwall.

Memorial from mining people in, to Government, to establish a mining institution, 702.

Cramming.

This practice is shown in Department examinations in geology, 569. Evidences of cramming are pointed out, 632.

De la Beche, Sir Henry.

Attention of, called to want of office accommodation for Geological Survey at Jermyn Street, 674.

RAMSAY, PROF.—cont.

Denbighshire.

Desire of mining proprietors in, to have geological maps on the six-inch scale, 754.

Devon.

Memorial from mining people in, to Government, to establish a mining institution, 702.

Drawing.

Candidates in geology seem to have no notion of drawing, 621.

Elementary Education.

Want of, shown by many candidates in geology, 569.

Elementary Schoolmasters.

They might be able, in addition to their ordinary daily duties, to teach geology with somewhat satisfactory, though imperfect, results, 614.

Endowment of Chairs of Science.

The sciences taught at the universities do not remunerate the professors; fees are insufficient. To get good men there should be an endowment of chairs, 687, 688.

It would be better to endow chairs, first in independent institutions, and if found insufficient, Government might establish new ones, 689.

A professorship of mining might be endowed in University College, &c., if the man and the money could be got, 727; but it would be difficult to establish a mining school with the means and appliances in Jermyn Street, 728, 729.

Engineering Students.

Obliged to attend geology course at King's College, 687.

England.

Geology is better taught in England than in other parts of the United Kingdom, 590.

Progress of the Geological Survey in. The Ordnance Survey has only been finished this year, 754.

Exhibitioners of the School of Mines.

Are sent by Government, after a difficult Department examination. Their abilities correspond with what might be expected, 661.

Flintshire.

Desire of mining proprietors in, to have geological maps on a six-inch scale, 754.

Fossils and Rock Specimens.

Department candidates in geology show little evidence of having been taught from, 602, 615.

Children should be taught geology by the use of, 600.

Gould, Mr.

Directed the Geological Survey of Tasmania. He was trained in the School of Mines and on the British Survey, 757 (*additional remarks*).

Geological Maps, Sections, and Specimens.

The way to acquire a practical knowledge of geology is to work over the country with geological maps and sections in hand, 626, 627.

Want of room for exhibition of geological specimens in Museum of Practical Geology, 670.

Geological Survey of the United Kingdom.

Witness has the direction of the Geological Survey of England and Wales, 668.

Want of office room for, in Jermyn Street, 669, 670.

Proposals to meet the difficulty. Stoppage of work for want of room. Greater space allotted to Survey offices in Scotland and Ireland, 671-674.

If the School of Mines' lecture-halls, laboratory, &c. were appropriated to Survey purposes, the museum would still suffer, 677.

The present Survey offices were originally intended for the museum, 678.

If School of Mines were removed, museum and Survey wants would not be supplied, without building; the rooms being ill-adapted as they stand, 679, 680.

Late rapid increase of surveyors, to hasten the entire Survey, 696, 697. When in London they are obliged to work at home and so are under no superintendence, 698.

The Geological Survey was founded in 1834, 700.

Great advantages to miners derived from the published maps of the Geological Survey. Valuable services rendered to the Coal Commission by the Survey, 703-706.

The Survey has often given advice with respect to water supply *et ceteras*, 706.

The best collections in the museum were made by the experienced officers of the Survey, 730, 731.

RAMSAY, PROF.—*Geological Survey, &c.*—cont.

The School of Mines was established in connexion with the Museum of Practical Geology, not with the Geological Survey, 731.

The Survey difficulty would be met by additional space, and not by separation from the other establishments, 732.

Want of a practical chemist attached to the Survey; professors of metallurgy and chemistry in School of Mines not bound to work for Survey, 751-753.

Detailed statement of the progress of the Geological Survey, 754.

Witness highly approves of the re-survey on a six-inch scale, 755.

The insufficiency of the one-inch map will be remedied in time; but the Survey cannot move from one place to another on account of fresh ground being opened by miners, 756.

The School of Mines and the Geological Survey have formed an important school of geologists, who have been engaged in distant countries. Instances cited, 757 (*additional remarks*).

Opinions of Signor Sella and M. Marcou quoted, showing their high estimation of the British Geological Survey, 757 (*additional remarks*).

Geology.

The Department examinations extend a knowledge of geology, although not in a very satisfactory way, 569.

Gradual increase of candidates for examination in geology to 1067, 571. Considerable improvement shown last year, but not this year, 576.

Teachers of geology should have a special training. The teaching is very unsatisfactory in a great part of the United Kingdom, 590.

Geology may be taught to children at an early age, and might be part of a household education, 605, 606. It cannot be taught properly from books, 613.

Geology might be taught by masters of elementary schools, &c. with somewhat satisfactory results, 614, 622.

The geology of their own neighbourhood should be taught to pupils, along with the leading facts of the science, 617-620.

Better hope of good instruction in geology from secondary schools than from most science classes, 623.

Geology should be practically learned, with maps and sections, in the field; but the mind can be prepared to appreciate by lectures, 626-629.

A theoretical knowledge of geology is desirable, even if the practical knowledge be not attained; but, without the latter, no one can teach geology in the highest style, 630, 631, 636, 637.

Anyone may attend the courses in geology at the School of Mines, 640. Many who have so attended have since become distinguished as geologists, 650.

Want of room for exhibiting geological specimens at Jermyn Street, 670-674, 677, 678.

Geology embraces so many sciences, that the more a man knows of them the better; he should be allowed to get his information at the universities, or elsewhere, 682-684.

Defective teaching of geology in Scotland, through the subject forming only a branch of the natural history chairs, and some of the professors not being good geologists, 686.

Geology has been well taught, though not well remunerated, in the universities and colleges of England; remuneration from fees insufficient; endowment of chairs is necessary to get good men, 687-689.

Paleontology is an essential subject in a school of mines, 691.

The number of surveyors has lately been largely increased to hasten the progress of the Geological Survey, 696, 697.

The Geological Survey was commenced in 1834, 700. The maps have been of great service to mining industry, to the Royal Coal Commission, and in connexion with water supply of towns, 703-706.

The best practical teaching is the highest theoretical teaching in geology, 709.

The teaching of geology in the universities (Cambridge excepted) would not lead to such practical results as the teaching in the School of Mines, 710-712.

Those who have entered for geology at School of Mines have been rarely found deficient in preliminary education, 715.

The School of Mines' course comprises 36 or 38 lectures on theoretical geology, the students being sometimes taken for an excursion, 722-724.

RAMSAY, PROF.—cont.

Government.

Students sent to School of Mines by Government after a difficult examination at South Kensington, 661.

Representations to Government on account of want of space for Geological Survey offices in Jermyn Street, and proposition to purchase certain property adjacent, 671-674.

Memorialized by mining people in Cornwall, Devon, &c. to establish a mining institution, 702. Established the School of Mines, 739, 744.

Has ordered the Geological Survey to re-survey the coal-fields on maps of the six-inch scale, 754. Witness highly approves of this, 755.

Government Grants in aid of Science.

Saving effected by plucking ignorant pupils, and preventing the teachers getting money for them, 579, 582.

There is as much money spent upon the Geological Survey, and as many officers engaged, as is desirable; but a practical chemist is much wanted, 751.

Honours.

There is an honours' class for geology in Department examinations. Last year candidates were all plucked; this year three passed, 573.

Huxley, Professor.

His chair is Natural History and Palæontology, the latter subject being essential in a school of mines, 691.

India.

Officers of the Indian army attend the lectures on geology, &c. at School of Mines, 656.

Many former students of the School of Mines have been engaged in the Geological Survey of India, 741. The director of the Survey of India was formerly an officer on the English Survey, 757 (*additional remarks*).

Iron-mining Industry.

Valuable assistance rendered to, by Geological Survey, 703.

Jamaica.

The former director of the Geological Survey of Jamaica was a pupil of the School of Mines, 757 (*additional remarks*).

King's College.

Excellent geological teaching has been given at, by Sir Charles Lyell and Professors Phillips, Ansted, &c. More remunerative than University College, by reason of the engineering students being compelled to attend geology, 687.

Lectures (on Geology).

The number given on theoretical geology by witness at University College was about 25; at School of Mines now 36 or 38, 718-724. With an endowment at the former place, the same kind of course might be given as at the latter, 720, 721.

Perhaps 50 persons may have attended the day course on geology at School of Mines, 725, 726. There are also courses in the evening, one of which is for working men, at 6d. for six lectures, 725.

The lectures on geology at the School of Mines are the same as those the lecturer might give in a university or college, 733.

After every lecture on geology at the School of Mines witness stays to answer questions, and considers that plan better than any ordinary examination, 735.

Logan, Sir William.

Established and formerly directed the Geological Survey of Canada. He was trained on the Survey of Britain, 757 (*additional remarks*).

London.

Some good might be effected by bringing teachers of geology to a training college in London, 612, 628.

Manufactures.

Witness considers a highly scientific education not essential for the majority of common-place manufactures, 747, 750.

Maps of the Ordnance and Geological Surveys.

The maps of the Geological Survey have been of great service to mining industry, 703-705.

Progress of Ordnance and Geological Survey maps of England and Scotland, 754.

The more scientific geological maps are, the more useful they are, 756.

High opinion of Signor Sella and M. Marcou respecting the Geological Survey maps of Britain, 757 (*additional remarks*).

RAMSAY, PROF.—cont.

Marcou, M.

High opinion of, quoted, respecting the work of the Geological Survey of Britain, 757 (*additional remarks*).

Meeting of Science Teachers.

Held at Liverpool to condemn the severity of the Department examiners, 635.

Metallurgy.

Many applications have been made to School of Mines for persons to fill positions in copper and iron works, &c.; and many students of the school have gone into such establishments, with good salaries, 742.

Professor of metallurgy in School of Mines not bound to work for Geological Survey, 751, 752.

Mining.

If a school were situated in a mining district, the teacher should be able to explain the geology of that district, 619.

A good number of persons interested in mining have sent their sons to the School of Mines, 657, 658, 666., The subjects taught in the School of Mines have always had relation to mining and practical matters, 690.

Important assistance to mining industry rendered by the Geological Survey, particularly with respect to coal and iron, 703-706.

Unless theoretic science can apply means of ventilation to mines of great depth, a large quantity of coal will never be won, 707, 708.

The School of Mines' geological instruction is more valuable to a mining student than that of the universities, &c., Cambridge excepted, 710-712.

There is no professor of mining at Cambridge, nor (witness thinks) in any institution in Great Britain, except the School of Mines, 713, 740.

A professorship of mining in University College, &c. might be established, 727. But it would be difficult to obtain the means and appliances there are in Jermyn Street, 728, 729.

The School of Mines was established after memorials addressed to Government by representatives of mining interest of Great Britain, 737.

A good number of former students of the School of Mines are engaged in mining industry, 741, 742.

The Geological Survey are re-surveying the coal-mining districts on maps of the six-inch scale, 754-756.

Murchison, Sir R. I., Bart.

Attention of, called to want of office accommodation for Geological Survey at Jermyn Street, 674.

Pressed by the authorities to go on more quickly with the Geological Survey, 696.

Museum of Economic Geology.

It was founded in 1838, 699. (See *Museum of Practical Geology*.)

Museum of Practical Geology.

Want of room for geological specimens in, 670.

If the School of Mines' lecture-halls, laboratory, &c. were appropriated to Survey purposes, the museum would still suffer, 677.

The present Survey offices were originally intended as a part of the museum, 678.

The Museum of Economic Geology (the precursor of the Museum of Practical Geology) was founded in 1838, 699. The collections were first deposited in Craig's Court, afterwards in present museum. The School of Mines was established in connexion with the museum, not with the Geological Survey, 731.

Natural History.

Defective teaching of geology in Scotland, through its being included in the natural history chair, 686.

Professor Huxley's chair in School of Mines is Natural History and Palæontology; the latter an essential subject in a school of mines, 691.

Oldham, Professor.

Director of the Geological Survey of India. Was formerly an officer on the Survey of Britain, 757 (*additional remarks*).

Ordnance Survey.

Has only been finished in England this year, and is still behind in Scotland, 754.

Oxford University.

Geology has been well taught at, by Professors Buckland, Strickland, and Phillips, 687.

Palæontology.

An essential subject in a school of mines, 691.

Practical Instruction.

Geology cannot be properly taught, except by a teacher who has had practical experience, 590, 613.

RAMSAY, PROF.—*Practical Instruction*—cont.

Very little evidence of practical instruction shown by candidates in geology at Department examinations, 601, 602, 615, 616.

Children at an early age might begin to learn geology by aid of specimens, &c., 606.

A teacher of geology should be competent to instruct students in the geology of their own neighbourhood, 617-620.

Practical knowledge of geology may be obtained by working over a country with maps and sections in hand, 626, 627, 629.

Theoretical instruction in geology is valuable, if practical instruction be not attainable, 630, 631, 636, 637.

Most of those who attend the lectures on geology at the School of Mines have a practical end in view, 656. The teaching has always related to mining and other practical matters, 690.

No good practical instruction which does not involve high theoretical instruction, 709.

The geology taught in the universities (Cambridge excepted) would have less practical results than the teaching of the School of Mines, 710-712.

Royal Coal Commission.

Important service rendered to, by Geological Survey, 703-705.

Royal School of Mines.

Witness is professor of geology in, 638. Is perfectly satisfied with the present regulations of his department, and does not recommend any alteration, 651, 652.

No entrance examination in, for general students. Approval of this system, 663-665.

No inconvenience in, for want of room, 667.

If the lecture halls, laboratory, &c. of, were appropriated to the Survey offices, and the present Survey offices also retained, the museum would still suffer, 677.

Even if School of Mines were removed there would not be room for museum and Survey purposes without building, 679, 680.

It was founded as a school of mines; the subjects taught have special relation to mining and other practical matters; and it resembles the continental schools of mines, 690-694.

Professor Huxley's chair in, is Natural History and Palæontology; the latter subject essential in a school of mines, 691.

It was founded in 1851, 701. Mining people from Cornwall, Devon, &c. memorialized the Government for its foundation, among them being Sir Charles Lemon and Mr. John Taylor, 702.

Operations of, not independent of the aid to be derived from the resources of experimental science, 707-709.

The teaching of geology in the universities (with the exception of Cambridge) would not lead to such practical results as that of the School of Mines, 710-712.

About 36 or 38 lectures form the course on geology, 719. Students are sometimes taken for an excursion. The lectures are on theoretical geology, 722-724.

It would be difficult to establish a mining school with the means and appliances at Jermyn Street, 728, 729. The School of Mines was established, with all the advantages accruing from the Geological Survey, the museum, and the mining collections in connexion with it, 731.

The difficulties of the Geological Survey would be relieved by more space, and not by the separation of the establishments, 732.

The lectures on geology at the School of Mines are the same as might be given in a university, 733. Examinations are all written, 735. After each lecture witness stays to answer questions, which he conceives better than an ordinary examination, 736.

Its character would not be affected by an ultimate reference to practical chemistry, 734.

The School of Mines arose out of the representations of a powerful commercial interest, 737-739. The Government considered the establishment of the school fully justified, 744. Established because there was not that combination of lectures existing elsewhere, 738.

Witness thinks there is no professor of mining in any other institution in Great Britain, 740.

Many applications are made to School of Mines for persons to fill positions in copper and iron works, &c., 742.

Combination of studies at, is desirable for a person intending to follow civil engineering, 750.

The professors of metallurgy and chemistry in, are not bound to do work for the Geological Survey; a chemist is wanted for the Survey, 751-753.

RAMSAY, PROF.—*Royal School of Mines*—cont.

Distinguished geologists who have conducted colonial geological surveys, and who were formerly students in the School of Mines, or officers in the Geological Survey of Britain, 757 (*additional remarks*).

Royal School of Mines' Students.

Students desirous of becoming associates must attend the lectures on geology. Others may also attend, 639, 640. The number attending is not large, 641.

The course is comprised in one year, and students take it in their second year, 641-643.

They are examined at the close of the course; formerly three times, but now only once, 644, 645. Others who attend the course may undergo examination; the younger ones do, 646, 647.

Many of the students are middle-aged, and even old, 648, 649.

Many who have entered for associateship have passed high examinations, and become distinguished, 650, 653. Others who have voluntarily attended have written good papers on geology, &c., 654.

Some attend for their own gratification; most have a practical end in view. Gentlemen home from India, &c. attend, that they may apply the information they gain on their return, 655, 656.

The Turkish Government, Italy, Canada, the United States, &c. have sent students, 656.

A great number have been sent from mining districts; these more frequently come as associated students, 657, 658, 666.

Some students have become teachers; one of them, Mr. Blanford, is professor of geology in Calcutta, 659, 660.

There are some who enter after a difficult examination at South Kensington; these show ability, 661, 662.

There is no entrance examination for general students. Approval of this system, 663-665.

All do not enter the school to learn mining specially, but to attend the courses generally, 692-694.

Gain more practical results in geology than those who attend courses at universities, &c., 710, 711. Cambridge excepted, 712.

Have rarely entered in geology without sufficient preliminary education, 715.

About 36 or 38 lectures on geology are given, 719. They are theoretical lectures, but the students are sometimes taken for an excursion, 722-724.

Perhaps as many as 50 may have attended the geology course, 725, 726.

Many former students are employed in mining industry, and in geological surveying in India, &c.; some have grown rich by the knowledge they obtained at the School of Mines, 741, 742.

Schools.

Desirability of imparting theoretical knowledge of geology to boys in schools, 605, 631.

Science and Art Department.

Witness has acted as examiner in geology to the Department from the beginning of the system, 567, 568.

The Department system is extending a knowledge of geology, but many teachers appear to be unqualified, and many candidates too young, 569.

Men are sent by Government to School of Mines after undergoing a difficult Department examination, 661.

Report sent to, this year, by examiner in geology, of specially bad candidates, 583.

Repeated notice to, of want of any notion of drawing, and ignorance of the strata in their own neighbourhood, shown by candidates in geology, 621.

Evidences of cramming are pointed out to, 632.

The Department knows from what schools the examination papers come; the examiners do not. Approval of this system, 633, 634.

Science Classes.

Better hope of instruction in geology from secondary schools than from science classes, 623.

Science Examination Papers (in Geology).

Many show great want of elementary education in candidates, and signs of cramming, 569. Evidences of cramming, &c. shown in, are pointed out to Department, 583-632.

Papers are tied up in numbered bundles, and do not show where candidates come from, 584. The Department knows, the examiners do not, 633, 634.

Science Examinations (in Geology).

Tend to spread a knowledge of geology; but show that some teachers are unqualified, and some candidates too young, 569, 603, 604.

Candidates increase in number; this year there were

RAMSAY, PROF.—Science Examinations, &c.—cont.

1,067. More than one half were plucked, and most of the others passed in the elementary stage; three passed with honours, 572, 573.
 Considerable improvement was shown last year, but not this year, 576.
 Where examinations show that schools are not doing efficient work, pupils must be plucked strictly, 579.
 Show that many candidates are quite unacquainted with the subject, 581. Very bad cases are reported to Department, 583.
 All the papers from, are reviewed by examiner, or by his assistant; in the latter case being checked by examiner 594–599.
 Show the instruction to be chiefly derived from books; a few only going into the field, or collecting fossils, 601, 602, 615, 616.
 In some cases the locality may be inferred from whence the papers come, by descriptions of certain districts, 610.
 Want of a knowledge of drawing, and of the geology of pupils' own neighbourhood, shown by, 621.
 Cases of cramming shown by, will always be reported by witness to Department, 632.
 There is no entrance examination for general students at School of Mines. Approval of this system, 663–665.
 At School of Mines, examinations in geology are entirely by writing. After every lecture witness stays to answer questions, and conceives that plan better than any ordinary examination, 735.

Science Examiner (in Geology).

Witness has been examiner in geology to Department since beginning of system, 567, 568.
 Great trouble entailed on, by ignorant candidates, 582.
 Report of these sent this year to South Kensington, 583.
 Examiner does not know where the candidates come from, 584. May sometimes infer it from descriptions of geology of certain districts, 610.
 Witness examines all the papers, but is allowed an assistant when they are over 1,000; he checks, and is responsible for, the work of the assistant, 594–599.
 Witness always points out to Department evidences cramming, 632.
 Does not know from what schools the examination papers come. Approval of this plan, 633, 634.
 Witness was condemned once for seventy in Department examination by a meeting of science teachers at Liverpool, 635.

Science Examiner (Assistant).

Where more than 1,000 papers, assistant allowed to chief examiner, who checks, and is responsible for, his work, 594–599.

Science Students (of Geology).

Many candidates are too young and imperfectly educated to undergo Department examination, and are crammed by their teachers, 569, 603, 604. Number of candidates, and results of examination, 571–573.
 They may come up for examination without having had any instruction from science teachers, 574.
 When bad, must be plucked strictly, 579.
 Many are quite unacquainted with the subject, 581–584.
 Are instructed from books, but in a few instances seem to have collected fossils, &c., 601, 602, 615, 616.
 Geology may be begun by children at a very early age; they should be instructed in the geology of their own neighbourhood, as well as in the leading facts of the science, 605, 606, 617–619.
 They should be taught to use the chalk and black board, 619.
 No Department candidates show any notion of drawing, or of understanding the geology of their own neighbourhood, 621.
 May learn a great deal by working over the country with maps and sections, 626–629.
 Evidences of cramming shown by, are pointed out to Department, 632.
 At King's College, the engineering students are obliged to attend geology, 687.

Science Teachers (of Chemistry).
 Competent teachers of chemistry are plentiful, and turn out a large number of able young men, 748.

Science Teachers (of Geology).
 Some appear to have got their knowledge from self-cramming, and then to have crammed their pupils, 569. This does not apply to a large proportion of institutions, 570.
 Candidates may come up without having been instructed by science teachers, 574.

RAMSAY, PROF.—Science Teachers (of Geology)—cont.

Many teachers are not qualified to instruct in geology, 577.
 Inefficient pupils must be strictly plucked, and then their teachers will get less remuneration, 579–584, 608.
 Teachers of geology should have a very special training, 590.
 Presumption that teachers send up improper candidates in the hope that they may pass, and obtain payment, 607.
 Good might be effected among a proportion of the teachers by bringing them to London for instruction, 612.
 Failures may proceed from the teacher not being aware that geology cannot be taught from books, 613.
 Masters of elementary schools might instruct in geology with somewhat satisfactory, though imperfect, results, 614.
 Specimens appear to be little used by the teachers of geology, 615.
 A teacher should be competent to instruct in the geology of his own neighbourhood, 618–620.
 Essential that the teacher should be able to illustrate his teaching with chalk and black board, 619.
 A considerable number of teachers are competent, but not as a general rule, 621.
 Teachers might acquire practical knowledge by working over the country, with maps, &c., 626, 627. But they may be prepared by lectures, 628.
 With other teachers, held a meeting in Liverpool, to condemn the severity of the examiners, 635.
 Without a practical knowledge, they cannot teach geology in the highest style, 637.
 A teacher of geology should have a knowledge of general science; rare to find a geologist perfect in any other science, 682, 683. There are establishments about the country where he could study general science, 684–686.
 No place in Scotland where teachers could be thoroughly taught geology, 686.

Scientific Education.

Not essential to the majority of common-place manufactures, 750.

Scotland.

No place in, where geology is thoroughly taught. No chair of geology at universities, it being included in chair of natural history, 686.
 Progress of the Geological Survey in. The Ordnance Survey is still far behind, 754.

Secondary Schools.

More hope of geology being properly taught by secondary schools than by most science classes, 623.

Self-instruction.

Many people (some of a very humble condition) have acquired a good knowledge of geology by self-instruction, 629.

Sella, Signor.

High opinion of, quoted, respecting the British Geological Survey maps, 757 (*additional remarks*).

Selwyn, Mr.

Director of the Geological Survey of Canada, and formerly of that of Victoria. Was trained on the English Survey, 757 (*additional remarks*).

Shuttleworth, Sir James Kay, Bart.

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Abel, Mr.

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Much better supplied with good laboratories than England, 5873.

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Germany and France better supplied with laboratories than England; they are supported by the State; good laboratories in sufficient number could not be provided in this country without assistance from Government, 5873-5875.

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Very limited at College of Chemistry for want of space; number of teachers of science who come for, their acquirements generally good; impossibility of teaching many branches for want of room, 5688-5693.

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A centralization of chemical instruction at, could only be partially carried out with advantage, some district schools being necessary; a training for the higher class of students might be available, 5778–5780.

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Successful endeavours of, in establishing a chemical professorship and laboratory in Owens College, 825.

Nicholson, Mr.

Inventor and manufacturer of magenta, a student of College of Chemistry, 5683.

Nova Scotia University.

Professors of chemistry in, trained in College of Chemistry, 5683.

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Per-centages.

Of success and failure in examinations in chemistry in 1868 and 1869, 766; in 1870, 767.

Per-centage of papers of original research in chemistry to investigators in Germany, Great Britain, &c., 5866.

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Playfair, Dr. Lyon.

Letter of, explaining circumstances of transfer of College of Chemistry to Government, 5667.

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The expense of laboratory of, might be saved by having the investigations made at proposed Training College of Science, 5768.

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Private Institutions for Teaching Chemistry.

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See also *Competition*.

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Expense of chemical analyses made for, might be saved by the proposed Training College of Science, 5772.

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None, except Whitworth scholarships, given to students who have not passed the elementary paper before taking up the advanced; the condition is proper, but restricts number of candidates, 767, 768.

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Prussian Universities.

Degrees in science not granted in, till after stringent examination, 5792.

In all Prussian universities candidates for degree of doctor of philosophy must submit a paper on original chemical research. More candidates rejected at Marburg for failure in original research than in after examination, 5868.

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Queen's College, Galway.

Professors of chemistry in, trained in College of Chemistry, 5683.

Queenwood College.

Successful teaching of chemistry in, to boys under 13, 5859.

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Professors of chemistry in, trained in College of Chemistry, 5683.

Royal College of Chemistry.

Examinations in, in 1868, 1869, and 1870; reports thereon quoted, 766, 767.

Small number of teachers who came last year to, for instruction; proposed increase in numbers next year, 778–785, 767. Of those who received instruction many had fair theoretical, but little experimental knowledge of teaching, 792.

Limited accommodation at, 784, 5683, 5688–5693, 5689. No further outlay in Oxford Street desirable; accommodation for, in Jermyn Street impossible, 5697–5700, 5721, 5836.

History of the College from its foundation to the present time; with number of students, original researches conducted there, and list of students whose subsequent career is known, 5667–5683. One third of those who have passed through the college have gained some distinction, 5684.

All its students are nominally connected with School of Mines, but many attend only the chemical course, 5685–5687.

Arrangements at, for instruction of science teachers; laboratory can only contain one third of applicants; laboratory instruction in; mental capacity and attainments of students; impossibility of teaching many important branches of for want of space; admission repeatedly refused for want of accommodation, 5688–5693.

South Kensington for the proposed chemical laboratories is a locality more desirable than convenient; the buildings there, if devoted to chemistry, would be about equal to those at Bonn, Berlin, and Leipzig, and a little superior to that at Zurich, 5701–5704.

Evening lectures, in connexion with, are held at Jermyn Street for science teachers and for working men; the former do, the latter do not, pay their expenses; no examinations connected therewith, 5705–5713.

Any extension given to, would not exercise much effect upon voluntary and self-supporting institutions; the fees at, are higher than in private institutions, and should be lowered; any impulse given to study of chemistry would be of general benefit, 5714–5720.

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Term yet to run of lease 14 years; rent paid for premises; portion let off; Mining Record Office might be transferred to present premises if the college be removed to South Kensington, 5696, 5721–5725.

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FRANKLAND, PROF.—*Royal College of Chemistry*—cont.

At the time of its establishment classes of chemistry were held at King's and University Colleges; notwithstanding, the want of such an institution was much felt; large subscriptions for, at first, 5726, 5727.

Fulfills the specific purpose for which instituted more than any other institution; students are required to devote themselves almost exclusively to chemistry, 5728-5730.

Does not at present possess one tenth of the space for laboratories proposed to be assigned at South Kensington, which would not be too large for all London, three sets of laboratories being required, 5732, 5733.

If additional assistants be accorded to, they should be capable of giving subsidiary courses of lectures, being assistant professors more than laboratory assistants, and remunerated accordingly, 5749-5751.

The Metropolitan Railway takes away much objection to South Kensington as a locality for, 5752, 5753.

Staff officers of engineers have worked at, e.g. Col. Reynolds and Capt. Hozier, 5781.

Before the opening of, not 20 students received instruction in practical chemistry in all England, except medical students, and for them the practical instruction was limited, 5782-5787.

Institutions cited with which the College of Chemistry might possibly come into competition, 5814, 5815.

Many students who come to, are beginners, 5817.

Stands in the relation of laboratory to School of Mines; time lost in passing from College to Jermyn Street, 5818, 5819.

Majority of students who have passed through, have devoted themselves to technical pursuits; brewers keep a constant stream of students, 5822, 5834.

Gross amount of fees received yearly in, 5823.

Few analyses executed in, for private account; payments for these go to the professor, 5824-5827.

The rent, fittings, &c., and one assistant supplied by Government; the library by professor and students; the expenses, when compared with Owens College at Manchester, show that it is managed with economy, 5828-5830.

Many students come to, who are destined for employment in the Inland Revenue and Indian telegraph service, 5831.

Reasons for converting it into a Government institution; no room in Jermyn Street; not self-supporting; few students in, who are not entered as pupils of School of Mines, having preference as such, 5836-5841.

The proposed nine months' course of instruction in, must be gratuitous; no security can be had that the students would not enter into trade afterwards, 5842-5846.

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Royal College of Science, Dublin.

Professors of chemistry in, trained in College of Chemistry, 5683.

Royal School of Mines.

Amalgamation of Royal College of Chemistry with, 5677-5679.

Evening lectures held at, for science teachers and working men; the first do, the latter do not, pay their expenses; are generally well attended; no examinations attached to them, 5705-5713.

All the professors of, complain of want of space, 5734. Part of new building at South Kensington might be devoted to, 5735.

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Students in College of Chemistry are entered as pupils in, and have preference as such, 5839-5841.

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Many valuable scientific processes for utilizing lean ores in English works have originated on the continent, 2392, 2393. One of these processes has been most successfully adopted, in treating refuse copper-ores, by a student of the School of Mines, 2393, 2394.

Great depression in connexion with the copper mines of Cornwall. A diffusion of scientific knowledge might lessen the difficulty, 2345–2351.

Cornwall.

Technical school in, called the Association of Miners of Cornwall and Devonshire, 2301, 2302.

Managers of mines in, are usually raised from the ranks, 2334.

School of Mines' students occasionally taken to Cornwall by lecturer, or furnished with introductions to his assistant there, 2341.

Magnitude and importance of mines in, 2343.

Copper mining in, is depressed by production of copper-ore in South America, but tin-ore has made up for it in some measure, 2345–2348.

Difficulties in working mines in, might be overcome by scientific methods, 2349.

The want of scientific knowledge in Cornwall is beginning to be strongly felt there, and is necessary at the present time, 2350, 2351.

Great efforts have been made to establish science schools in, 2361.

Many mineral owners have subscribed to the schools, but not shareholders in mines generally, 2362, 2363.

The superior class of workmen avail themselves of the mining school there, 2407. Practical work is combined with theoretical instruction, 2411. The classes are generally held in the evening, 2412–2414.

Shareholders of mines in, should be assessed for support of mining schools, 2451, 2454, 2465.

SMYTH, W. W., Esq.—cont.

Daglish, Mr.

Allusion to information obtained from, respecting contributions of employers to science schools, 2304.

Diagrams.

Less convenient than models for explaining certain pieces of machinery. Much machinery may be explained by diagrams, 7451.

École des Mines, Paris.

Is intended for mining engineers, 2378.

Receives a large sum from the State, 2463.

Economy.

In the School of Mines (as in the central school at Berlin) much economy is effected by union with the Geological Survey, 2456.

Education.

Different amount of, required by different classes of workmen, 2308.

Education of all might be conducted together to a certain point, 2309.

Comparison of English miners (managers and workmen) educationally with those of France and Germany, 2400–2402.

A more general diffusion of, desirable, so as to make individual cases less remarkable, 2409.

Practical work should be combined with theoretical instruction, 2410.

A large proportion of Cornish miners cannot read and write. Of their children, about one sixth cannot read and write, 2415.

Elementary education extended beyond 12 years of age would indispose boys to work in mines, and would injure them as workmen, 2416, 2417.

Elementary Schools.

Mining and mineralogy are not subjects for, except in certain districts, 2295–2297.

Applied subjects should not be taught in, 2305.

Employers.

Not unwilling to assist in forming science classes, 2303.

England.

Comparison of miners (managers and workmen) of England with those of France and Germany, in respect of education, 2400–2402.

Evening Classes.

In Cornwall, the classes are generally held in the evening, 2412–2414.

Attendance at, might be made compulsory, up to 16, as a condition of being allowed to work, 2418.

See *Mining Schools*.

Foreigners.

Engagement of, as managers, &c., in South Wales smelting works, 2367.

Twenty-five years ago Mr. Vivian engaged assistants from Freiberg. Men could not be got in England who had passed through the same courses, 2368.

Engaged now to a less extent. The School of Mines is now supplying managers, 2369.

France.

Schools specially for workmen in, 2377.

Frankland, Dr.

Most School of Mines' students in mining and mineralogy have previously passed through Dr. Frankland's chemical course, 2461.

Freiberg (Royal Mining Academy).

Witness formerly studied at, and has recently visited, this academy, 2324.

Engagement by Mr. Vivian of assistants from, 2368.

The academy is wholly supported by the State. A portion of the money is repaid from students' fees, but the expenses are very considerable, 2456.

Schedule of subjects taught and names of lecturers at the academy, 2467.

Geography.

A student of mineralogy should come prepared with some knowledge of geography, 2460.

Geological Survey of the United Kingdom.

Many students of Royal School of Mines employed in, 2333.

Economy effected (as in Berlin) by the union of the School of Mines with the Geological Survey, 2456.

Geometry.

A student of mineralogy should have some previous knowledge of geometry, 2460.

SMYTH, W. W.—cont.

Germany.

Schools specially for workmen in, 2379.
In colleges of, courses are frequently divided into a preliminary course, and a group of technical subjects, 2435.
See *Berlin. Freiberg.*

Glasgow.

Technical school started at, which has failed, 2302.

Government.

A scheme for establishing mining schools, authorized by Government, and sanctioned by persons of local experience, might stimulate voluntary contributions, 2448.
Little hope of this, unless Government influence is used, 2455.

Government Grants in aid of Science.

The only aid given to technical schools is by payment on results, 2300.
Continental mining academies receive a large sum from the State, 2463.

Great Britain.

Before the opening of the Jermyn Street Museum no public institution represented the mineral wealth of Britain, 2315.

Home Office.

Mining inspectors appointed by, must have had long practical experience in management of a coal mine, 2459.

Isle of Man.

Managers of mines in, are usually raised from the ranks, 2335.

Jermyn Street Institution.

Origin of the courses on mineralogy and mining given in, 2314.
Up to time of opening museum in, there was no public institution which represented the mineral wealth of Britain. Its aim and scope is different from any other, 2315.
Many foreign technical visitors have been there, 2316.
The collection has been spoken of in the highest terms by Von Cotta, Signor Sella, Professors Rockwell and Brush, &c., 2317.
Men of all classes come to it for gratuitous advice respecting minerals or mining matters, and for recommendations of experienced agents for inspecting properties at home and abroad, 2318, 2319.
Favourable opinion entertained among mining people of School of Mines in, 2320.
Position of, favourable to attainment of high scientific instruction, 2322.
Valuable technical library in, 7448.
See *Geological Survey. Royal School of Mines.*

Leuschner, M.

High opinion of English mining workmen expressed by, 2402.

Library of the Jermyn Street Institution.

A most valuable technical library there, 7448.

London.

Advantage of position of central mining school in, with regard to attainment of high scientific instruction, 2322.

Machinery.

Models more convenient than diagrams in teaching certain machinery; though much machinery may be explained by aid of diagrams, 7451, 7452.

Mathematics.

It is thought the School of Mines might dispense with teaching mathematics, there being so many places where such instruction can be obtained; but students come with small amount of preparation in that subject, 2422, 2423.

Mineralogy and Mining.

The number of candidates in Department examinations in, has increased, but not largely, 2290. Number of candidates passed and rejected in, 2293.
Interest in, is mostly restricted to certain places, 2294.
Not suited for general schools, except in special districts. Mineralogy can only be taught in schools where boys remain over 12, 2295-2297.
Great improvement in examination papers in, 2298.
Tendency to localize study of, shown in some examination papers; this applies less to mineralogy than to mining, 2310, 2312, 2395, 2396.
Origin of lectures on, given at Jermyn Street, 2314.
List of students who have been examined in, in the School of Mines, 2333.
26060.

SMYTH, W. W.—*Mineralogy and Mining*—cont.

Qualifications of students in mining cannot be ascertained by the Department examinations, 2352-2354.
School of Mines' students should enter with some practical knowledge of mining, and also of general science, 2433, 2434.
Mining needs practical observation; mineralogy requires some previous knowledge of geometry, algebra, geography, and chemistry, 2460.
School of Mines' students of, usually come well prepared in chemistry, having passed through Dr. Frankland's courses, 2461, 2462.
For teaching, at South Kensington, rooms would be required for lecture specimens, for a large and well-arranged collection of minerals and specimens illustrating the occurrence of minerals in rocks, or models, mining plans, &c., 7441-7447.
Either the British Museum collection of minerals should be near the school, or a large collection formed there, 7447.
Besides the School of Mines' collection, students derive great advantage from studying the British Museum mineralogy specimens, which are arranged on a totally different system, 7444-7447.
See *Mining.*

Miners (Managers and Workmen).

Many School of Mines' students have of late become managers of mines, 2369.
Compared with those on the continent, our managers are inferior in general acquirements, but often make up for it in energy and practical knowledge; while our workmen are superior in practical knowledge and skill, 2400, 2401.
The energy of our managers would not be diminished if they were better instructed, 2402.
High opinion of M. Leuschner respecting English mining workmen, 2402.
On economical considerations, our managers should be educated, 2403.
Education of managers by a central school would be a slow process; but advanced secondary instruction placed within their reach would be most beneficial, 2404, 2405.
The superior class of workmen would be likely to avail themselves of instruction brought within their reach. The Cornish mining school is confirmatory of this, 2406, 2407.
While the better educated men remain rare cases, they are likely to forego handwork, and become clerks, &c. Secondary schools would correct this, 2407, 2408.
The proportion of workmen who cannot read and write is large; of children, the proportion is about one sixth, 2415.
Boys kept at school beyond 11 or 12 years of age would be indisposed to work in mines, 2416. If their schooling were extended to 13 years, they would suffer materially as workmen, 2417. Night schools might be made obligatory up to 16, as a condition of being allowed to work, 2418.
Should have scientific instruction in the locality where the mines are. This might be given in secondary schools, 2437.

Mines.

Many School of Mines' students have of late obtained position of manager of, 2369.
General science instruction for miners should be given in locality of mines, 2437.
Assessments on, might be made for establishing science schools, 2449-2453, 2464, 2465.
In Prussia, mines are not much worked by, but minerals are taken under lease from, the Government; a large staff being required. Most students of mining schools get appointments connected with mining, 2326-2328.

Mining.

Was added as a separate branch of examination in 1861, in consequence of an application to the Department from certain ex-students of Jermyn Street, who taught it in the country, 2291, 2292.
Number of candidates passed and rejected in, 2293.
Small number of candidates accounted for by the interest in mining being confined to certain districts, the different requirements of different districts, and difficulty in obtaining proper teachers, 2294.
Not a subject for general schools, except in certain districts, 2295-2297.
Improvement in examination papers, and tendency shown to localize the study, 2298, 2310, 2312, 2313.
Origin of lectures on, given at Jermyn Street, 2314.
Models illustrative of, in Jermyn Street Museum, 2315.

SMYTH, W. W.—*Mining*—cont.

Jermyn Street institution resorted to for gratuitous information on mining matters, 2318.

In metalliferous mine districts, managers are usually raised from the ranks; in colliery districts, engineers take pupils into their offices. This is why School of Mines' students have seldom become managers of mines, 2334, 2335.

Great advantage to School of Mines' students from lecturer's connexion with mining, 2340.

Acquaintance with science of, highly important in selection and working of mines, 2344.

Students of mining or other technical subjects cannot properly be tested by Department examinations, 2352-2354.

Difficulty of giving science instruction in outlying mining districts, 2358-2360.

Greater intercommunication between different mining districts is much wanted, 2395, 2396.

Diversity of practice in mining in different districts, 2397.

The rule-of-thumb prevails in many districts, 2398.

This is prejudicial to safety. Danger of prevalent custom of making plans upon the magnetic, instead of the true meridian, 2399.

The study of, needs practical observation, 2460.

Space required for a professor at South Kensington, 7441-7447.

See *Cornwall. Staffordshire. Mineralogy and Mining, &c.*

Mining Engineers.

Objections of, to allow courses of School of Mines to be substituted for an apprenticeship, 2424.

Mining Inspectors.

No connexion between, and School of Mines. Before appointment they must have managed a coal mine for a certain number of years, 2457, 2459.

Mining Record Office.

In connexion with Geological Survey, &c., of great value to School of Mines' students, 2341.

Mining Schools.

Allusion to mining schools in Cornwall, Glasgow, &c., 2301, 2302.

Tendency in certain of them to localize their studies. This can only be corrected by keeping them in connexion with a central establishment, 2310.

Great efforts have been made in Cornwall to establish, 2361.

Mineral owners, but rarely shareholders in mines, have subscribed to these schools, 2362, 2363.

One has been talked of for Swansea, 2364.

Should correspond with requirements of various classes of workmen, 2376. This is the practice in France, Germany, &c., 2377-2379.

The second-grade mining schools should be largely supported by voluntary contributions, 2383. Indifference of mine owners in this matter, 2384.

The assistance given by South Kensington to, was unknown till lately to many of the leading mine owners, 2386.

No mining or metallurgical district on the continent of equal extent to North and South Staffordshire is without a mining school, 2388, 2389.

Secondary schools in their own localities more adapted to managers and workmen than a central school, 2404, 2405.

Superior workmen would avail themselves of these institutions, 2406.

They would check the present tendency of the best men to leave their handiwork, and become clerks, &c., 2407, 2408.

In the mining schools in Prussia and in Cornwall practical work is combined with theoretical instruction, 2411.

In Cornwall the classes are generally held in the evening, 2412; the students having been working practically during the day, 2412-2414.

General and underground surveying should be especially taught in, 2420, 2429.

If established in mining districts, apprenticeships could be combined with theoretical courses, and underground surveying might be thoroughly taught, 2428, 2429.

If several were established at once, teachers would be difficult to be got; but, if done at intervals, the difficulty would disappear, 2430-2432.

If a scheme, authorised by Government, and sanctioned by persons of local experience, were put before mine proprietors, &c., voluntary contributions might be expected, 2447, 2448.

SMYTH, W. W.—*Mining Schools*—cont.

If voluntary aid were not forthcoming, an assessment on mining property might be made. In some districts pressure would be indispensable, 2449, 2454, 2465.

Little hope of establishing, without Government influence is brought to bear upon the districts, 2455.

In Prussia they are endowed by the State, 2456.

In Cornwall and the Newcastle district there is a great feeling for establishing mining schools, 2465, 2466.

Mining Schools (Continental).

Curriculum of, generally more extensive than our own, 2325.

In Prussia, with a mining population about half our own, there are two mining academies, nine mining schools, and nine preparatory schools. Full list of same, 2325.

Most of the students in, get appointments in mines, 2327, 2328.

Good technical training given in, 2329. Intended for students who have passed through other schools, 2330.

Moderately stiff examination for entering, 2331.

In Prussia, they are mostly separate from, and intended for students who have passed through, the polytechnic schools, 2330.

The central schools or academies receive a large sum from the State, 2463.

Models.

More convenient than diagrams for teaching certain pieces of machinery; though much machinery may be explained by diagrams, 7451.

Museum of Practical Geology.

Up to the time of opening this museum, there was no public institution which represented the mineral wealth of Britain, 2315.

Newcastle.

Recent attempt to get up science classes at; but, in consequence of an alteration in payments by Department, its success is doubtful, 2302.

There is a great feeling in favour of establishing science classes in the Newcastle district; many persons would probably subscribe, 2465, 2466.

North of England Institute of Mining Engineers.

Active part recently taken by, respecting the establishment of a mining school, 2385.

Payments on Results.

The only State aid given to technical schools, 2300.

Physics.

School of Mines' students should have a knowledge of physics before coming up for mining, 2434.

Polytechnic Schools.

Mining schools in Prussia not connected with, but intended for students who have passed through, polytechnic schools, 2330.

Practical Instruction.

Practical knowledge generally possessed by English managers and workmen of mines, 2400, 2401.

In education, practical and theoretical work should be combined; this is done in the mining schools of Cornwall and Prussia, 2410, 2411-2414.

School of Mines' students generally learn the practical part of their business after leaving the school. A few come prepared with practical knowledge, which is desirable, 2336, 2337. They are occasionally taken to Cornwall by mining lecturer, or furnished with introductions to managers there, 2341.

Importance of a knowledge of underground surveying, which must be practically acquired in the mine, 2420, 2421.

Technical instruction, even when unaccompanied with real practice, is an advantage, 2438, 2439.

Practical experience in management of a coal mine must have been had by all Government mining inspectors, 2459.

Practical observation is essential for the study of mining, 2460.

Prussia.

Twenty mining schools in. List of the same, 2325.

Excellent technical training in these schools, 2329, 2379.

Mines in, not much worked by, but minerals taken under leases from Government; a large staff being required, 2326.

A large proportion of mining students in, get appointments in mines, 2327, 2328.

In the mining schools of, practical and theoretical work are combined, 2411. These schools are endowed by the State, 2456.

SMYTH, W. W.—cont.

Royal School of Mines.

Favourable opinions respecting the school are generally entertained by men connected with mines, 2320.
It is in a good position as a central school, in respect of the higher scientific instruction which may be expected at head-quarters, 2322.
It labours under the disadvantage of being a new institution, 2372. A school of the kind requires two or three generations to get known, 2373.
To educate mining managers in, would be a slow process, 2404.
There should be a class in, for general and underground surveying, 2420, 2421.
Mathematics have not been taught in, there being so many places for obtaining such instruction, 2422.
Objections of mining engineers to allow courses of, to be substituted for apprenticeships, 2424. It would be important if the courses could be combined with apprenticeship; this has been done in a few cases, 2426, 2427.
Chemistry may be considered as a preliminary subject in, 2434, 2446.
If the courses in, were confined to purely technical instruction (and to a certain extent that plan is now adopted), though it might give a slight check at first, the supply of students would not be limited by it eventually, 2440-2445.
Economy is effected (as in Berlin) by union of the School of Mines with the Geological Survey, 2456.
Mining inspectors are in no way connected with, 2457.
Remark made by witness that he could not remain a teacher at School of Mines if the school were removed to Kensington, 7440.
Amount of space which would be required for the professor of mineralogy and mining if the school were removed to South Kensington, 7441-7447.
See also *Jermyn Street Institution.*

Royal School of Mines' Students.

List of those who have passed examinations in mineralogy and mining, with positions subsequently attained by them. Satisfactory nature of the list, 2333.
Not many are managers of mines. Reasons given for this, which are of different kinds in different mining districts, 2334, 2335.
They generally learn after leaving the school the practical part of their business, 2336.
A few have come prepared with practical knowledge, and it would be better if more came so prepared, 2336, 2337.
A larger number of, may be expected, when advantages of the school become better known, 2338.
There has been a larger attendance of practical men the last few years, 2339.
Great advantage to the students that they should be brought in contact with the lecturer, 2340.
The connexion of the school with the Geological Survey and Mining Record Office, and position of the lecturer with respect to the mines of the Prince of Wales and those under the Woods and Forests, is of great value to the students, 2340.
They occasionally accompany the lecturer to Cornwall, or are furnished with letters to his assistant there, 2341.
Many have become managers of mines, &c.; positions formerly held by foreigners, 2369.
One is now engaged, under Mr. Siemens, in applying regenerative furnaces to steel-making, at Landore, 2370.
They enter mostly with small amount of preparation in mathematics, 2422, 2423.
Desirable for mining students to have some practical knowledge of mining, and acquaintance with general science, before coming up for the applied portions, 2433-2435.
The supply of mining students would not eventually be limited if courses were confined to technical instruction, 2440-2445.
Do not obtain post of mining inspectors; a certain number of years' practical management of a coal mine being essential for this office, 2458, 2459.
Most of those coming up for mineralogy are well prepared in chemistry previously by Dr. Frankland, 2461, 2462.
Necessity of having a well-arranged collection of minerals for, 7442-7444.
At present, the students of mineralogy, besides the Jermyn Street collection, have the advantage of studying, in the British Museum, a collection arranged upon a totally different system, 7447.

SMYTH, W. W.—cont.

Science and Art Department.

Assistance given by, to mining schools, unknown till lately to many leading miners, 2386.
See *South Kensington. Science Examinations, &c.*
Science Classes. See *Mining Schools.*
Science Examinations.
Increased number of candidates in Department examinations in mining and mineralogy, 2290.
Mining was added, in 1861, as a separate branch of, 2291, 2292.
Qualifications of pupils in mining or other technical subjects cannot be satisfactorily ascertained by Department examinations, 2352-2354. Care on examiners' part may somewhat counteract the difficulty, 2355.
Vid voce examinations in mining would be difficult to conduct, on account of the outlying position of the districts. The teaching in these districts is still more difficult, 2356-2360.

Science Examination Papers.

Great improvement in character of, with regard to mineralogy and mining, 2298.
Show a tendency in some places to localize studies, 2310, 2312, 2313. Certain of them bear evidence of having come from the neighbourhood of Wigan, 2375.

Science Instruction. See *Mining Schools, &c.*

Science Teachers.

It is difficult to get proper teachers of mining, 2294.
Can make a better income by remaining in large towns than by going to mining centres, 2302.
If large local colleges were erected there would be a difficulty at first in getting teachers, 2430-2432.

Secondary Schools. See *Mining Schools.*

Siemens, Mr.

His manager is a former student of the School of Mines, 2370.

South America.

Copper-ore of, has seriously depressed Cornish mining diffusion of scientific knowledge might lessen the difficulty, 2345-2351.

South Kensington.

If the School of Mines were removed to, witness had stated that he could not remain a teacher, 7440.
Opinion respecting amount of accommodation at, which would be required for a professor of mineralogy and mining, 7441-7447.
For mineralogy at, either the British Museum collection should be in a place near the School of Mines, or there should be space for a full and well-arranged collection of minerals accessible to students. There should also be space for a collection of specimens of mineral lodes, models, mining plans, and a scientific library, 7444-7447.
See *Science and Art Department. Science Examinations, &c.*

Staffordshire.

There is no mining or metallurgical district on the continent of equal extent to North and South Staffordshire without a mining school, 2388, 2389.
Minerals there are daily increasing in value. Special necessity for economy of working, 2390, 2391.
Waste in working the thick coal there, 2391, 2452.
Diversity of practice in mining operations between Staffordshire and the North of England districts, 2397-2399.
In point of economy, it is most essential that more science should be brought to bear upon the mining industry of Staffordshire. An assessment for that purpose desirable, 2452, 2453.

Surveying.

A class for, should be introduced at the School of Mines. Importance of a knowledge of underground surveying, which must be practically acquired in the mine, 2420, 2421.

Technical Instruction.

Excellent in Prussian mining schools, 2329.
Students' attainments in, cannot properly be tested by Department examinations, 2352-2354.
Is an advantage, even when unaccompanied with real practice, 2438, 2439.
If School of Mines were confined to, the supply of students would not eventually be limited by it, 2440-2445.
See *Mining Schools, &c.*

SMYTH, W. W.—cont.

Technical Schools.

Much wanted for teaching mining and mineralogy, 2299. Government aid not given to, except in payments on results, 2300.

Particulars of, at Glasgow, Cornwall, Newcastle, &c., 2301, 2302.

Difficulty of always separating, from primary ones. In some instances they might be taught by same master, 2305, 2306.

Mining school attached to a trade school at Bristol, 2306, 2307.

See *Mining Schools*, &c.

"Times."

Remarks of witness on a letter in the "Times," containing statements implying personal motives, 7440.

Trades' School.

Mining school attached to a trades' school at Bristol, 2306, 2307.

Truro.

Technical school at, 2301, 2302.

Vienna.

Proposed establishment of a central mining school at, 2325.

Vivan, Mr.

Formerly obliged to engage assistants from Freiberg, because men who had passed through the same courses could not be got in England, 2368.

Wales.

In West Wales managers of mines are usually raised from the ranks, 2335.

Managers, &c. of smelting works in South Wales have been formerly engaged from the continent, 2367, 2368. This occurs less frequently; the School of Mines is now supplying managers, 2369.

Wigan.

Allusion to examination papers bearing evidence of having come from the neighbourhood of Wigan, 2375.

MURCHISON, SIR RODERICK I., BART., K.C.B.
(Index of his Evidence.)

Accommodation for Science Purposes.

Desirable to enlarge Jermyn Street institution by addition of two houses in Jermyn Street; one house specified, 2472, 2473.

A small additional space would satisfy the professor of metallurgy, 2472, 2473, 2476, 2492.

More laboratory room is desired in Oxford Street by professor of chemistry, to instruct a larger number of persons, 2476, 2477.

It would not be necessary to pull down and rebuild the additional buildings suggested for Jermyn Street institution, 2492.

Office room urgently wanted by the geological surveyors, to construct their maps, &c., 2492.

Artizans.

600 artizans attend the evening lectures in Jermyn Street; the abolition of which lectures would be an ungracious act, 2472.

Ballarat Mining School. See *Victoria.*

Canada.

A mining school, in connexion with the Geological Survey and Museum, is being projected in Canada, entirely upon the Jermyn Street plan, 2471.

Chemistry.

No school of mines complete without a chemist, 2473

Additional space, at College of Chemistry, has been desired by both the past and present professor, to instruct a greater number of persons, 2477.

Chemical analyses are required to be made during the progress of the Geological Survey; more should be done in that direction than has as yet been practicable, 2481, 2482.

Cole, Henry, Esq., C.B.

Allusion to Mr. Cole's memorandum in 1868, on removal of School of Mines, 2469, 2470, 2474-2476, 2483, 2485.

Columbia College Mining School. See *New York.*

Council of Professors of Royal School of Mines.

Their opinion has not been taken officially on the proposed removal of the school, 2480.

Donnelly, Captain, R.E.

Allusion to his evidence and memorandum, in 1868, respecting removal of School of Mines, 2469, 2484.

MURCHISON, SIR R.—cont.

Frankland, Dr.

Rock specimens are occasionally analyzed by, for Jermyn Street institution, 2473, 2482.

Desire of, for a larger laboratory, to instruct a greater number of persons, 2476, 2477.

Has always made analyses of Survey rock specimens when requested, 2482.

His opinion cited, that if the College of Chemistry were removed to South Kensington it might still be carried on as heretofore in conjunction with School of Mines, 2488.

Geological Survey of the United Kingdom.

Witness is director-general of the Geological Survey, and director of the Royal School of Mines, 2468.

Suggestion that houses in Jermyn Street be taken for Survey and Mining Record Offices, and for the professors who require more space, 2472, 2473.

A chemist to analyze rock specimens is essential during the progress of the Survey; more should be done in that direction than has yet been found practicable, 2473, 2481, 2482.

The Survey must have a palæontologist, 2473.

The Geological Survey is a great and progressing national institution, 2473.

Space for geological surveyors to construct their maps, &c. is urgently needed, 2492, 2493.

Harvard College Mining School. See *Massachusetts.*

Hofmann, Professor.

Rock specimens were occasionally analyzed by, for Jermyn Street institution, 2473, 2482.

Would have liked increased space in College of Chemistry to instruct a greater number of persons, 2477.

House of Commons Select Committee, 1868. See *Samuelson, Mr.*

Jermyn Street Institution.

Want of space in, would be met by adding two houses in Jermyn Street; one suitable house pointed out, not necessary to pull down and rebuild, 2472, 2473, 2492.

Advantage of the size and central position of the lecture-theatre in, which enables 600 artizans to attend the courses, 2472.

The institution has worked efficiently for nearly 20 years, and nothing but disadvantage could be attained by breaking down one branch of it, 2473.

See *Accommodation, Royal School of Mines, &c.*

Laboratories.

The School of Mines' professors of natural history and physics might have laboratories by adding two houses in Jermyn Street. Only a small additional accommodation is required by the professor of metallurgy, 2472, 2473, 2476, 2492.

The professor of chemistry would like more laboratory accommodation to instruct a greater number of persons, 2476, 2477.

Lectures to Working Men.

Through the size and central position of the lecture-theatre in Jermyn Street, 600 artizans are enabled to attend the courses. The abolition of these lectures would be an ungracious act to working men, 2472.

Allusions to witness's statement respecting the voluntary delivery of these lectures by the professors, 2486, 2487, 7472.

Massachusetts.

The School of Mining and Practical Geology at Harvard College has been established on the plan of the Royal School of Mines, 2471.

Metallurgy.

An essential branch of a school of mines, 2472, 2473.

A small additional accommodation in Jermyn Street would satisfy the professor of metallurgy, 2472, 2473, 2476, 2492.

Metropolitan College of Science (proposed).

The School of Mines will always serve its legitimate purpose if not commingled with other public teaching; but a great polytechnic school would be of importance in a general scheme of national education, 2473.

Mining Record Office.

Suggestion to provide a house in Jermyn Street for, together with Geological Survey, 2472, 2473.

Museum of Practical Geology.

Chemist and palæontologist essential officers in, 3473.

New York.

The School of Mines at Columbia College, New York, has been established on the plan of the Royal School of Mines, 2471.

MURCHISON, SIR R.—cont.

Palæontologist.

Essential in a school of mines, 2473.

Percy, Dr.

Only small additional accommodation in Jermyn Street required by, 2472, 2473, 2476.

Royal College of Chemistry.

More laboratory room in, desirable, to instruct a greater number of persons; but the chemical instruction given is enough for the wants of the School of Mines, 2476, 2477.

Dr. Frankland's opinion cited, that if the College of Chemistry were removed to Kensington it might still be carried on in conjunction with the School of Mines, 2488.

The College of Chemistry was removed from Jermyn Street for want of space; though more convenient if under same roof as School of Mines, the latter has gone on remarkably well since the separation, 2491.

Royal School of Mines.

Witness is director of the Royal School of Mines, 2468.

Protests against the scheme for breaking up the school, 2469. The abolition of the School of Mines, after nearly 20 years of successful teaching, would be a retrogressive step in the cultivation of science, 2471.

Instances cited of School of Mines forming a model for similar institutions in Canada, America, &c., 2471.

The addition of two houses in Jermyn Street to the institution, for physics and natural history laboratories, and a small increase of space for professor of metallurgy, would meet wants of School of Mines, 2472, 2473.

Were such laboratories not built, and some of the teaching removed, the School of Mines might still be retained in Jermyn Street, if additional house-room were provided for Geological Survey and Mining Record Offices, 2473, 2476.

Chemist and palæontologist essential officers in, 2473.

Is a public institution which will always serve its legitimate purpose, if not commingled with other public teachings, 2473.

The opinion of the Council of Professors of, as to removal of school, has not been taken officially 2480.

The College of Chemistry might be carried on in conjunction with the school, even if the college were removed to Kensington, as stated by Dr. Frankland, 2488.

It would be more convenient to have the College of Chemistry under the same roof as the School of Mines, but since the separation the School of Mines has gone on very well, 2488-2491.

Samuelson, Mr.

Allusion to Mr. Samuelson's committee, before which evidence was given respecting proposed removal of School of Mines, 2469, 2470, 2474, 2475, 2483-2485.

South Kensington.

Protest against removal of School of Mines to South Kensington, 2469-2473.

The School of Mines will always serve its legitimate purpose, if not commingled with other public teachings; but a great polytechnic school at South Kensington would be of importance in the scheme of national education, 2474.

Dr. Frankland's opinion cited, that if College of Chemistry were removed to South Kensington it could be carried on in conjunction with School of Mines as heretofore, 2488.

Victoria.

School of Mines now being established at Ballarat on the Jermyn Street plan, 2471.

BROUGH, LIONEL, Esq. (Index of his Evidence.)

Accidents in Mines. See *Mines*.

Age of Mining Students.

Those training for viewers go underground at 16 or 17 years of age, 2536.

Apprentices to Viewers. See *Miners*.

Artizans. See *Miners*.

Assessment for Science Purposes.

Approval of a fair tax on coal or wages to increase scientific education, 2619-2623, 2648-2650.

Belgium.

Mining engineers in, get high scientific education, but have less practical knowledge than those of Britain, 2599, 2628-2630.

BROUGH, LIONEL, Esq.—Belgium—cont.

More accidents, in proportion to coal worked, in Belgium than in Britain, 2631.

Natural mining difficulties in Belgium greater than in Britain, but there is less fire-damp, 2632-2635, 2638.

System of ventilation perfected in Belgium, &c. before England, 2639-2645.

Bristol.

Not a great centre as regards mining operations, 2618.

Bristol Mining School.

In south-western mining district there are managers who have been educated in Bristol mining school, but none from Royal School of Mines, 2498, 2525.

Excellent sub-officers produced from, 2498, 2499.

No Government stipend for, now; the school rendered good service, but was discontinued for want of funds, and embodied in the trade school, 2499-2505, 2507-2510, 2515, 2516, 2626, 2627.

There would have been a better attendance if the school had been situated in Wales; most of the boys were Welsh, 2510.

Plan of Royal School of Mines' classes followed by, 2515. The classes held in, now, bear no comparison to the mining classes formerly held, 2516, 2517.

The education given in, was not sufficiently high for managers, 2522.

None utterly ignorant came to the school; there were about a dozen real miners, 2559-2561.

Mining schools should be formed on the plan of, 2580. Fees, &c. at, 2581-2584.

Difficulty of carrying on such a school, 2617, 2618.

Cardiff.

A better locality than Bristol for a mining school, 2510.

Coal and Collieries. See *Mines*.

Colliery Viewers. See *Miners*.

Contributions for Science Purposes.

Withdrawn from Bristol and Glasgow mining school by colliery proprietors, 2502, 2507-2510, 2626, 2627.

Difficulty of supporting science schools by local contributions, 2617.

Cost of Mining Schools. See *Mining Schools*.

Dowlais.

Great amount of wages paid in; cost of a mining school would be an inappreciable per-centage on wages within the district, 2588-2591.

Durham.

Plan of mining education in connexion with the University, proposed by Mr. Nicholas Wood, 2506.

High education and large salaries of colliery viewers in Durham, 2544, 2647.

Education of Miners. See *Miners*.

England.

High education of viewers in north of England. Loss of life in mines less there than in Wales or Lancashire, 2544-2549.

Ventilation of mines was perfected on the continent before England, 2639-2645.

Fees.

Of students, in science schools; difficult to collect, 2626, 2627.

Glasgow Mining School.

Excellent men for sub-officers produced from, 2499.

Mining schools might be found on plan of, 2580.

The school dropped off from nonpayment of fees and withdrawal of contributions, 2626, 2627.

Government.

Stipend of, withdrawn from Bristol mining school, 2499-2504.

Could not be expected to support mining schools in all the kingdom, 2578.

Difficulty of supporting science schools, even when Government aid depends on continuance of contributions, 2617.

Government would be justified in making a fair tax on coal or wages for purpose of scientific education, 2619-2623, 2648-2650.

Lancashire.

Loss of life in mines less in north of England than in Lancashire; higher education of viewers in the north, 2544-2549.

Managers, Viewers, &c. of Mines. See *Miners*.

Mathematics.

A mining course should include mathematics, 2520, 2521, 2523.

Though not taught in School of Mines, useful men have come from there, 2524.

BROUGH, LIONEL, Esq.—cont.

Merthyr.

A better centre for a mining school than Bristol or Tredegar, 2510, 2568. It would accommodate a mining population of 200,000, 2567-2570.

Enormous amount of wages paid in; cost of a mining school an inappreciable per-centage on the wages, 2587-2591.

Salary of master for proposed school at, 2625.

Metallurgists.

In south-western mining district there are no metallurgists from School of Mines acting as managers, 2498.

Miners (Managers and Workmen).

No managers in south-western mining district who have been educated at School of Mines, 2498. Reasons assigned for this, 2525-2530.

Excellent men for sub-officers produced from mining schools of Bristol and Glasgow, 2498, 2499, 2502.

Many managers are well-educated men; many the reverse, 2506.

Better education wanted for our viewers; proposition of Mr. Nicholas Wood, 2506.

Many students went from Wales to Bristol mining school; schools would have been better in their own districts, 2510-2512.

Subjects desirable to be taught to young working miners, to enable them to become overmen, 2517-2519.

Higher subjects necessary to be taught to viewers, 2517, 2520-2524. They should undergo their curriculum first, and then work underground, 2531, 2538.

The viewer class are educated as such; occasionally overmen become viewers, 2532, 2533. Those training for viewers go at 16 or 17 into the pit, and never after are able to have a university education, 2534-2536, 2610-2613. They are usually ignorant of the sciences bearing upon mining, 2537. Attendance at a school of science during apprenticeship would be desirable; previous collegiate education better, 2614-2616.

A higher scientific education essential for economical working of mines and safety of life, 2539, 2545-2547. Northumberland and Durham said to possess the best educated viewers, 2544.

Were viewers scientific men, they would like their under-officers to possess a knowledge of science, 2549-2551.

Viewers not favourable to mining schools, 2553. Proprietors, &c. see necessity for science, 2554, 2555.

Recklessness of miners would be checked by advanced education, 2556, 2557.

None utterly ignorant came to Bristol school; about a dozen students were real miners, 2559-2561.

A mining population of 200,000 would be accommodated by a mining school at Merthyr, 2567-2570.

Overmen should be educated in schools of the grade of those at Bristol and Glasgow, 2579, 2580.

Education for viewers only to be got in universities, 2581.

Vast amount of wages paid to, in Wales, 2587-2590.

In witness's district, workmen would be glad of instruction in science, and are sufficiently numerous to constitute classes, 2594, 2595.

High scientific education of Belgian mining engineers, but they have less practical knowledge than those of Britain, 2599, 2630.

National loss of coal in Staffordshire, which might have been avoided if viewers had been better educated, 2600-2602.

Surveying conducted by miners with reference to the magnetic instead of the true north, 2606-2609.

Wages of men might be taxed to increase education, 2620-2622, 2648-2650.

Instances of good results shown by viewers of scientific education, 2636, 2637.

Educated viewers are sometimes passed over by lessees on the score of economy, 2646.

Viewers get high salaries, especially in Northumberland and Durham, 2647.

Mines.

Witness is inspector of coal and ironstone mines in south-western Britain, 2494-2497. No managers of mines in this district from Royal School of Mines, 2498, 2525-2530.

Essential subjects of education for managers and workmen of mines, 2506, 2517-2524.

Proprietors of collieries withdrew subscriptions from Bristol and Glasgow mining schools, 2499, 2502,

Dom. 2507-2510, 2626, 2627.

All scientific knowledge especially essential for managers of reser-

vey collieries, 2524, 2526, 2603-2605.

BROUGH, LIONEL, Esq.—*Mines*—cont.

Greater economy in working mines, and safety of life, would result from higher scientific education, 2539, 2545, 2546.

Instances of colliery proprietors possessing scientific attainments, 2540.

Loss of life, in proportion to quantity of coal, less in the north than in Wales or Lancashire, 2546; more lost by fall of materials than fire-damp, 2547.

Necessity for scientific knowledge seen by proprietors of mines, 2554, 2555.

Owners of mines in Wales and Monmouthshire have spoken of establishing a mining school, but it has not been taken up, 2576, 2577.

In economy of working, in mines, the cost of a mining school would be repaid, 2592.

The future deep working of mines will involve high scientific attainments as to ventilation, &c., 2596-2599.

National loss of coal in Staffordshire, which scientific knowledge might have prevented, 2600-2602.

Explosions in mines might be lessened by more knowledge of science, 2603-2605.

Danger of surveying mines with reference to the magnetic and not the true north, 2606-2609.

Scientific education of the highest importance in mining, 2613.

A tax might be made upon produce of mines, &c. to extend scientific education, 2619-2623.

More accidents, in proportion to coal worked, in Belgian, than in British mines, 2631. Natural difficulties greater in Belgian than in British mines. Less fire-damp, 2632-2635, 2638.

Ventilation system perfected in Belgium, &c. before Britain, 2636-2645.

Mining Proprietors, Lessees, &c.

Subscriptions of, withdrawn from Bristol and Glasgow mining schools, 2499-2505, 2507-2510, 2626, 2627.

Would not employ a viewer who had not been practically educated underground, 2530.

Instances of scientific knowledge possessed by lessees of collieries, 2540.

Necessity felt by, for more scientific teaching, 2554, 2555.

A science school for Wales and Monmouthshire has been spoken of by owners, &c., but not taken up, 2576, 2577.

Waste and accidents might be lessened if lessees were better educated in science, 2602, 2605.

Approval of a tax on, for increasing scientific education, 2619-2623, 2648-2650.

Economy of, sometimes militates against appointment of scientific viewers, 2646.

Mining Schools.

Those of Bristol and Glasgow have produced excellent sub-officers, 2499. The schools dropped off, from non-payment of fees, and withdrawal of contributions, 2626, 2627.

Want of one in Wales, 2510-2512.

None now in south-western mining district, 2514.

Subjects desirable to be taught in, for viewers and workmen, 2517-2524.

Viewers not favourable to mining schools, 2553. Proprietors, &c. of mines see necessity for scientific teaching, 2554, 2555.

One at Merthyr would accommodate the mining population of Wales, 2567-2570.

A school for Wales and Monmouthshire centre has often been suggested, 2576, 2577.

The more schools like Royal School of Mines the better; but, to educate overmen, Bristol and Glasgow schools might form models, 2578-2580.

No difficulty in getting teachers for secondary schools, 2581.

Teachers of, should be well paid, to ensure good men, 2585.

Cost of mining schools would be an inappreciable percentage on amount of wages paid in a district, 2585-2591, 2618. The education would repay the cost, 2592, 2593.

In witness's district, men would be glad to get instruction at, 2594.

Desirable if attendance at a school of science were a necessary part of training of a viewer's apprentice; previous collegiate education better, 2614-2616.

Difficulty of supporting local mining schools, 2617, 2618.

A tax upon coal or wages desirable, to increase education, 2619-2623, 2648-2650.

A teacher of a large school ought to receive 250*l.* or 300*l.* per annum, 2624, 2625.

Difficulty of getting the fees for, 2626, 2627.

BROUGH, LIONEL, Esq.—cont.

Monmouthshire.

Mining school for Wales and Monmouthshire suggested, but not carried out, 2576, 2577.

Newport.

A better locality than Bristol for a mining school, 2510.

Northumberland.

High education and large salaries of colliery viewers in, 2544, 2647.

Practical Instruction.

Colliery viewers must have been practically brought up underground, 2530.

Practical knowledge of Belgian mining engineers inferior to that of British miners, 2630.

Royal School of Mines.

In south-western mining district, there are no managers of mines or metallurgical works who have been educated at School of Mines, 2498. The students have sought employment abroad; or not have been practical workers in collieries, which would prevent them from becoming viewers, 2525-2530.

Classes of, most appropriate for teaching; the Bristol school endeavoured to follow the plan, 2515.

Though mathematics is not taught in, useful men have come from the school, 2524.

The more schools there are like the School of Mines the better, 2578, 2579. One generation could hardly tell the value that has resulted from it, 2592.

Science (generally).

It should be taught; not acquired by excessive study by young people after the labour of the day, 2540.

Improved state of scientific education in Staffordshire, 2543.

Science Classes and Schools. See Mining Schools.

Science Teachers.

No difficulty in getting teachers for secondary schools, 2581.

Teachers of mining schools must be well paid, to ensure good men, 2585.

Staffordshire.

Improvement of scientific education in, 2543.

Great national loss of coal there, which might have been avoided by scientific knowledge, 2600-2602.

Surveying. See Mines.

Swansea.

A better locality than Bristol for a mining school, 2510.

Tredegar.

Great mining centre of south-west district, 2564.

A mining school at Merthyr would accommodate Tredegar, 2568.

Ventilation of Mines.

The future deep working of coal mines will involve high scientific attainment as regards ventilation, &c., 2597-2599.

System of ventilation perfected in Belgium, &c. before Britain, 2636-2645.

Wages.

Cost of science school would be an inappreciable percentage on wages in such a district as Merthyr, 2586-2591.

A tax on miners' wages might be made, to extend scientific education, 2619-2623, 2648-2650.

Wales.

A mining school located in Wales would have had more support than that at Bristol, 2510.

Loss of life in mines, in proportion to amount of coal, less in north of England than in Wales, 2546.

The mining population of Wales would be accommodated by a mining school at Merthyr, 2567-2570.

A school for Wales and Monmouthshire centre has often been suggested, but not carried into effect, 2576, 2577.

Great amount of wages paid in Wales; to which cost of mining schools would be an inappreciable percentage, 2587-2590.

Belgian mines less fiery than those of Wales, 2638.

Wood, Mr. Nicholas.

Plan of education for colliery viewers proposed by, 2506.

THOMSON, THOMAS, Esq., M.D., F.R.S. (Index of his Evidence.)

Age of Science Students.

Many of the rejected Department candidates in botany, probably young children. Exceptional case, of a girl of eight, who passed in the elementary stage, 4896.

THOMSON, THOMAS, Esq.—cont.

Botany.

Witness was formerly in charge of Botanic Garden at Calcutta; and has acted as Department examiner in vegetable physiology and systematic botany for seven or eight years, 4880, 4881.

Sound knowledge of botany shown by a fair proportion of candidates, and higher standard reached during the last few years. Last year an exception, on account of the change of system, 4883, 4884, 4906.

About 500 candidates offered themselves last year, 4886. Many teachers of botany are incompetent, having no practical knowledge, 4888-4893.

In the medical schools there are botanical lectureships, but there are no classes anywhere for training teachers of botany, 4895.

Ages of rejected candidates in botany probably less than those who have passed. One girl of eight passed in the elementary stage, 4896.

No other science can be so well taught to young children, 4897. Vegetable physiology is not adapted to children, 4898.

Examinations in systematic botany are conducted by means of living specimens, 4899-4901.

Teachers must have passed the first class of the advanced stage, 4904.

Remuneration for teaching botany is so small, that masters get their information from books, instead of studying it in places where it can be properly learned, 4907.

Formerly there was a special examination of teachers of botany. Witness prefers the old system, 4908-4918.

There has been a gradual improvement in the teaching of botany, but it might have been greater if the old system had been attended to, 4919.

It is illusory to teach botany, in evening winter classes, from books, and without specimens, 4921-4929. It should be taught in the fields, in the summer, 4930. It would be well to confine botanical classes to the spring and summer months, 4931.

Vegetable physiology may be taught at any time, and no one should be allowed to study that subject until he had passed in systematic botany, 4931.

Systematic botany could not be properly taught, in winter, and without specimens, by schoolmasters engaged during the day in elementary teaching, 4932.

It is the first branch of natural science which can be taught with ease to children, and may be made most attractive, 4933, 4934, 4936.

Systematic botany should be taught first, and vegetable physiology later, 4935.

Allusion to Professor Huxley's opinion as to the high value of the study of botany, 4936.

Cramming is as easy to detect in botany as in other subjects; but there is no objection to botany on the ground of its being liable to cramming, 4937-4939.

A microscope is of great advantage in teaching botany, 4940, 4941.

There are about 30 or 40 teachers of elementary botany connected with the Department, 4944.

Calcutta.

Witness has had charge of Botanic Garden at Calcutta, 4880.

Children.

A girl of eight passed in the elementary stage in botany, 4896.

Botany can be taught better than any other branch of natural science to young children; but not vegetable physiology, 4897. It might be introduced with advantage into elementary schools, 4933, 4934, 4936.

Cramming.

Many of the candidates trust to cramming; but that practice varies under different teachers, 4888.

Most of the rejected have been probably prepared by cramming from books instead of being taught from living specimens, 4902, 4903, 4925.

Can be detected by an examiner in botany, &c. Remarkable instance of cramming investigated by the Department, where 30 or 40 papers were found to have been dictated and learned by rote, 4937, 4938.

No objection to botany on the ground of its being liable to cramming, 4939.

Elementary Schools.

Masters of, have neither time nor means of properly studying botany, 4907, 4937.

Botany might be taught with advantage to children in elementary schools, 4933, 4934.

THOMSON, THOMAS, Esq.—cont.

Herbarium.

An herbarium would be an insufficient substitute for real practical teaching of botany, 4922.

Huxley, Professor.

Opinion of, quoted, as to the high value of botany as a means of mental cultivation, 4936.

Medical Schools.

In all the schools there are botanical lectureships, but not specially for training teachers of botany, 4895.

Microscope.

Except for the very elementary stage of systematic botany, a microscope is a requisite for every science teacher, 4940, 4941.

Plants.

Living plants are sent for description in systematic botany examinations, 4893, 4899–4902.

In vegetable physiology, plants were not used in the special examination of teachers formerly held; 4908, 4909.

An herbarium is an insufficient substitute for living specimens in practical teaching, 4922.

Practical Instruction.

Deficiency of teachers in practical knowledge of botany, 4888–4893. Specimens for teaching botany can always be got in the summer, 4897, 4930.

Department candidates appear generally not to have been taught from living specimens; by aid of which, and in the fields, botany should be taught, 4902, 4903, 4921–4931.

An herbarium is an insufficient substitute for real practical teaching from living specimens, 4922.

Science and Art Department.

Witness has acted under, as examiner in botany, for seven or eight years, 4881.

Considerable good effected by Department system, 4882–4884.

Witness's suggestion to Department, that no one should study vegetable physiology until he had passed in systematic botany, 4931, 4935.

Remarkable case of cramming investigated by Department, 4937.

There are about 30 or 40 teachers of botany connected with the Department, 4944.

Science Classes.

There are none in London or elsewhere for training teachers as instructors in botany, 4895.

Science Examination Papers (generally).

The written papers are the only means by which examiners come in contact with candidates, 4882.

The schools whence the papers come are not known to the examiner, 4894.

Science Examination Papers (in Botany).

A considerable amount of sound knowledge of botany shown by the papers of a fair proportion of candidates, 4883.

Many of the papers show cramming, but that practice varies under different teachers, 4888, 4903.

The writing and spelling of most rejected papers show the candidates to be probably young children, 4896.

Great difficulty in setting a paper in botany sufficiently comprehensive to test all students, 4916.

Remarkable instance of cramming discovered in 30 or 40 papers, 4937.

Science Examinations (generally).

The Department system has done considerable good, 4882.

The higher examinations can now only be passed by those who have succeeded in the lower; approval of this system, 4884, 4885.

There was formerly a special examination for teachers; now they have merely to pass the highest grade of the ordinary examinations, 4891, 4892, 4908.

Science Examinations (in Botany).

Much sound knowledge and improvement shown by Department candidates in botany during the last few years, 4883, 4884.

The change of system last year, that no one be allowed to pass the higher who has not passed the lower examination, prevents a definite opinion of the result being formed at present, 4884, 4885.

There were 500 candidates for the botany examinations last year, 4886.

No special examination now for teachers of botany, &c., 4891, 4892, 4908.

Living plants are sent for description in systematic botany examinations, 4893, 4899–4902.

THOMSON, THOS., Esq.—*Science Examinations, &c.*—cont.

A fair proportion of candidates show they have been taught from living specimens. Most of the rejected have probably been taught only from books, 4902, 4903.

In the special examination for teachers formerly held, they were examined with specimens for systematic botany, but not for vegetable physiology, 4908, 4909. The certificate was given formerly for botany separately, which included the two sections, vegetable physiology and systematic botany, 4912–4914.

Great difficulty at present in setting a paper for examinations sufficiently comprehensive to test all candidates, 4916.

Preference given to the old system of examination, 4917, 4918. Examinations have shown a gradual improvement in the teaching of botany, but it might have been more rapid if the old system had been attended to, 4919.

Witness's suggestion to Department, that students should pass in systematic botany before studying vegetable physiology, 4931.

Science Examiners (generally).

Difficulty of their forming an opinion of the Department system, through not coming in contact with pupils, or being able to ascertain their after career, or amount of information retained by them, 4882, 4887.

Approval of examiners' recent plan, that no one should pass the higher who had not passed the lower examination, 4884, 4885.

Examiners do not know the schools whence their papers come, 4894.

Science Examiners (in Botany).

The examiner has only the control of a general examination over the attainments of a teacher of botany. There is great difficulty in setting a paper to test these attainments, 4916.

An examiner can as easily detect cramming in botany as in other subjects, 4937.

Science Students (generally).

Examiners not coming in contact with students, except by their written papers, have no means of tracing their after career, 4882, 4887.

A student who has passed in the first class of the advanced stage may now become a teacher of the subject in which he passes, 4915, 4916.

Science Students (of Botany).

A fair proportion show a sound knowledge of botany, 4883. They have been improving year by year, 4884. There were about 500 candidates in botany last year, 4886.

Many of them trust to cramming; but that practice varies under different teachers, 4888.

Allusion to paper containing the age of passed candidates. Many of the rejected were probably young children. One girl of eight years of age passed in the elementary stage, 4896.

They are required to describe living botanical specimens, 4899–4902.

Most of the rejected have probably been taught from books instead of from living specimens, 4902, 4903.

There is great difficulty now in setting a paper to test all classes of candidates, 4916.

No means of knowing by whom the rejected candidates were taught, 4920.

Are probably taught from books instead of from living specimens, in the winter. Objections to this, 4921–4929.

Suggestion of witness to Department, that students should not study vegetable physiology until they had passed in systematic botany, 4931.

Science Teachers (generally).

Examiners are not acquainted with either teachers or pupils, 4887.

They are not separately examined now, but merely have to pass the highest grade of the ordinary examination in every subject they undertake to teach, 4891, 4892, 4904, 4905, 4908.

Every teacher should possess a microscope, 4940.

Science Teachers (of Botany).

Cases of cramming vary with the teachers, 4888.

Many undertake to teach botany without a competent practical knowledge, 4889, 4890.

Teachers have now merely to pass the highest grade of the ordinary examination in each subject they teach, and the examiner cannot test their qualifications, as he could under the old system, 4891, 4892, 4904, 4905.

THOMSON, THOMAS, Esq.—*Science Teachers, &c.*—cont.

There are no classes in existence for training instructors in botany, 4895.
 Rejections are greatly due to the teacher not having been properly taught, 4903.
 Remuneration of teacher so small that there is no inducement to study botany where it could be properly taught; and teachers of elementary schools have neither time nor means of studying the subject, 4906, 4907.
 In the special examination of, formerly held, specimens were used for systematic botany, but not for vegetable physiology, 4908, 4909.
 In the former examinations they received a certificate for botany separately, including the two sections of vegetable physiology and systematic botany, 4912–4914.
 A student who has passed in the first class of the advanced stage may now become a teacher of botany, 4915, 4916.
 Value of a microscope to science teachers, 4940, 4941.
 There are about 30 or 40 teachers of botany connected with the Department, 4944.

Summer.

Specimens for teaching botany can always be got in the summer, 4897. Pupils should be taught at that season, 4930.

Vegetable Physiology.

Should not be taught to young children, 4898.
 Living specimens were not used in the examinations in vegetable physiology formerly held for teachers, 4908, 4909.
 Vegetable physiology and systematic botany were the two sections which teachers had to pass to gain a certificate in botany, 4912–4914.
 It may be taught at any season, 4931.

Winter.

Botany students in the country are improperly taught, from books, and in the winter, 4921–4931.

ISELIN, JOHN FREDERICK, Esq., M.A. (Index of his Evidence.)

Animal Physiology.

Should be taught in elementary schools, 5922.

Apparatus for Science Purposes.

More laboratory apparatus required now than formerly for demonstrations in chemistry, 5906, 5907.
 For teaching experimental physics not so abundant as for teaching chemistry, 5908.
 Same amount of apparatus and demonstration not required in elementary schools as in adult classes, 5921.
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