

EAST INDIA (PUBLIC WORKS DEPARTMENT).

RETURN to an Address of the Honourable The House of Commons,
dated 23 February 1863;—for,

- “ RETURNS specifying the Names of the EXAMINERS appointed to examine the CANDIDATES who presented themselves, since the last Return, for Admission to the ENGINEER'S ESTABLISHMENT and PUBLIC WORKS DEPARTMENT in *India* :”
- “ Of the Names of the SUCCESSFUL CANDIDATES in Order of Merit, their respective Ages, and the Names of the CIVIL ENGINEERS to whom any of such Candidates have been Articled Pupils :”
- “ And, of the MARKS assigned on each Subject to every Candidate; and of the EXAMINATION PAPERS on each Subject (in continuation of Parliamentary Paper, No. 499, of Session 1861).”

India Office, }
24 February 1863. }

W. T. THORNTON,
Secretary, Public Works Department.

(*Mr. Longfield.*)

Ordered by The House of Commons, to be Printed,
27 February 1863.

CIVIL ENGINEER EXAMINATIONS.

NAMES OF EXAMINERS.

Rev. Jonathan Cape, A. M., F. R. S.
 Captain W. H. Edgcome, R. E.
 George Preston White, Esq., C. E.

Successful Candidates in order of Merit.

| NAME. | AGE. | Civil Engineer to whom Articled, or under whom Served. |
|----------------------------|------|---|
| 1. Mr. A. J. Hughes - - - | 18 | J. Hughes, Westminster. |
| 2. „ W. Burnett - - - | 20 | J. Milne & Co., Edinburgh. |
| 3. „ R. H. Rhind - - - | 20 | Messrs. Martin & Smethurst, Manchester. |
| 4. „ F. L. O'Callaghan - - | 22 | { H. Conybeare, Westminster. Cork and Limerick Railway. |
| 5. „ E. Mansfield - - - | 22 | J. Steel & Sons, Cork. |
| 6. „ H. Rigg - - - | 19 | James Taylor & Co., Birkenhead. |
| 7. „ C. B. Roche - - - | 22 | { E. Bagot, c. E., Llanelly, S. W., C. Geoghegan, Dublin, C. B. Lane, Westminster. |
| 8. „ H. Bell - - - | 22 | London, Chatham and Dover Railway. |
| 9. „ J. M. W. Pullen - - - | 21 | Great Western Railway Works, Swindon. |
| 10. „ G. W. Jones - - - | 22 | J. Empson, c. E., Kilkenny. |

NUMBER OF MARKS assigned to each Candidate, whether successful or otherwise.

| Order of Merit. | Mathematics. | Surveying and Levelling. | Civil Engineering. | TOTAL. | Order of Merit. | Mathematics. | Surveying and Levelling. | Civil Engineering. | TOTAL. |
|-----------------|--------------|--------------------------|--------------------|--------|-----------------|--------------|--------------------------|--------------------|--------|
| 1 | 335 | 129 | 335 | 799 | 21 | 193 | 116 | 250 | 559 |
| 2 | 353 | 137 | 285 | 755 | 22 | 165 | 102 | 290 | 557 |
| 3 | 276 | 134 | 335 | 745 | 23 | 151 | 56 | 335 | 542 |
| 4 | 273 | 171 | 300 | 744 | 24 | 162 | 57 | 320 | 539 |
| 5 | 284 | 124 | 290 | 698 | 25 | 177 | 73 | 280 | 530 |
| 6 | 267 | 123 | 300 | 690 | 26 | 143 | 76 | 300 | 519 |
| 7 | 230 | 136 | 290 | 656 | 27 | 135 | 99 | 280 | 514 |
| 8 | 219 | 102 | 335 | 656 | 28 | 139 | 104 | 267 | 508 |
| 9 | 287 | 67 | 300 | 645 | 29 | 178 | 63 | 255 | 496 |
| 10 | 239 | 113 | 290 | 642 | 30 | 102 | 108 | 270 | 480 |
| 11 | 226 | 124 | 290 | 640 | 31 | 145 | 84 | 240 | 469 |
| 12 | 214 | 104 | 295 | 613 | 32 | 99 | 61 | 300 | 460 |
| 13 | 237 | 103 | 270 | 610 | 33 | 83 | 77 | 260 | 420 |
| 14 | 203 | 109 | 290 | 602 | 34 | 30 | 59 | 320 | 409 |
| 15 | 202 | 102 | 296 | 600 | 35 | 62 | 32 | 235 | 329 |
| 16 | 206 | 102 | 292 | 600 | 36 | 173 | 93 | 35 | 301 |
| 17 | 183 | 114 | 305 | 602 | 37 | 108 | 53 | 95 | 256 |
| 18 | 203 | 102 | 285 | 590 | 38 | 37 | 25 | 75 | 137 |
| 19 | 191 | 98 | 300 | 589 | 39 | 52 | 26 | 45 | 123 |
| 20 | 152 | 113 | 305 | 570 | 40 | 43 | 0 | 65 | 108 |

EXAMINATION PAPERS.

June 1862.

ARITHMETIC AND ALGEBRA.

1. FIND the value of $\frac{7}{18}$ of a guinea; and reduce $\frac{2}{5}$ of 2s. 4½ d. to the fraction of a half-crown.

2. Divide $2\frac{1}{8}$ by $\frac{3}{5}$ of $4\frac{1}{3}$, and reduce the result to a decimal; compare also the values of $\frac{1}{4}^5$, $3\frac{1}{3}$, and $\frac{2}{7}$ of $9\frac{2}{3}$.

3. A bankrupt owes 3 creditors £.400, £.300, and £.420; but his assets are only £.224. What will each creditor receive, and how many shillings in the pound will he pay?

4. If 4 men can remove 50 cubic yards of earth in 18 days, how long will 8 men be in removing 800 cubic feet?

5. Which stock offers the best interest—the Indian 5 per cents. at 109—or the Russian 4½ per cents. at 91½? And if I invest £.5,000 sterling in each of these two stocks, what will be the difference of income from the two funds?

6. Simplify the following expressions:

$$(1) \dots \frac{a+b}{a-b} - \frac{a^2-b^2}{a^2+b^2} + \frac{a^2+b^2}{a^2-b^2},$$

$$(2) \dots \frac{m-n}{mn} + \frac{p-m}{mp} + \frac{n-p}{np},$$

$$(3) \dots \left(a + \frac{ax}{a-x} \right) + \left(a - \frac{ax}{a+x} \right) + \frac{a^2-x^2}{a^2+x^2}.$$

7. Divide $a^8 + a^6 b^2 + a^4 b^4 + a^2 b^6 + b^8$ by $a^4 + a^3 b + a^2 b^2 + ab^3 + b^4$; and multiply $a^3 + b^3 + c^3 - a^2 b^2 - a^2 c^2 - b^2 c^2$ by $a^3 + b^3 + c^3$.

8. Find the greatest common measure and least multiple of

$$x^3 + x^2 + x + 1 \text{ and } x^3 - x^2 + x - 1.$$

9. Divide $8 - 5\sqrt{2}$ by $3 - 2\sqrt{2}$; and extract the square root of $14 + 8\sqrt{3}$.

10. Solve the following equations:

$$(1) \dots \frac{x}{4} - \frac{x-4}{6} = \frac{4}{3} + \frac{1}{12} (24-x),$$

$$(2) \dots x + \frac{24}{x-1} = 3x - 4,$$

$$(3) \dots x^2 - 2x + 4\sqrt{x^2 - 2x + 6} = 15,$$

$$(4) \dots 2x^2 - 3xy = 18; \text{ and } y^2 + xy = 27.$$

11. Find a 4th proportional to 100, 120.5 and 41.76; also, show that if $a : b :: c : d$; then, $pa + qb : ra - sb :: pc + qd : rc - sd$.

12. Determine the value of the sum of an Arithmetical Progression of n terms; and sum the following series, $1 + 9 + 17 + \&c.$, to 50 terms.

4 PAPERS RELATING TO EXAMINATION OF CANDIDATES FOR

13. Sum the geometric series, $3 - 1 + \frac{1}{3} - \dots$ to 9 terms; and insert 4 arithmetic means between -2 and -18 ; and also 3 geometric means between $\frac{1}{2}$ and 128.

14. Expand $(2a - 3b)^7$; and find the 5th term in the expansion of $(x - y)^{13}$.

15. A merchant made a mixture of wine at 28s. a gallon, with brandy at 42s. a gallon; and he found that by selling the mixture at 35s. a gallon, his gain amounted to 15 per cent. on the price of the wine, or 20 per cent. on the price of the brandy: in what ratio were the wine and brandy mixed together?

16. Find the time which 3 persons would take jointly to do a piece of work, which they can do separately in a, b, c days respectively.

3 June 1862.

EUCLID.

1. DEFINE *obtuse angled triangle, acute angled triangle, rhombus, segment of a circle, and sector of a circle.*

2. If from the ends of the side of a triangle, there be drawn two straight lines to a point within the triangle, these shall be less than the other two sides of the triangle, but shall contain a greater angle.

3. If a trapezium and a triangle stand upon the same base, and the trapezium falls within the triangle, the perimeter of the trapezium shall be less than that of the triangle.

4. All the interior angles of any rectilineal figure, together with four right angles, are equal to twice as many right angles as the figure has sides.

How many right angles are the interior angles of a *pentagon* and a *decagon* equal to?

5. If the square described upon one of the sides of a triangle, be equal to the squares described upon the other two sides of it; the angle contained by these two sides is a right angle.

To construct a square which shall be equal to the difference of two squares.

6. The two diagonals of a parallelogram mutually bisect each other.

Also, the sum of the squares of the two diagonals is equal to the sum of the squares of the four sides.

7. If a straight line be divided into two equal parts, and also into two unequal parts; the rectangle contained by the unequal parts, together with the square of the line between the points of section, is equal to the square of half the line.

Hence prove that the difference of the squares of two unequal lines, is equal to the rectangle contained by their sum and difference.

8. The diameter is the greatest straight line in a circle; and, of all others, that which is nearer to the centre is always greater than one more remote.

9. The opposite angles of any quadrilateral figure inscribed in a circle are together equal to two right angles.

A circle cannot be described about a rhombus.

10. If from a point without a circle there be drawn two straight lines, one of which cuts the circle, and the other meets it; if the rectangle contained by the whole line which cuts the circle, and the part of it without the circle, be equal to the square of the line which meets it, the line which meets shall touch the circle.

Hence, describe a circle which shall touch a given straight line, and pass through two given points on the same side of the given line.

10. If

10. If the angle of a triangle be divided into two equal angles, by a straight line which also cuts the base, the segments of the base shall have the same ratio which the other sides of the triangle have to one another.

11. If a solid angle be contained by three plane angles, these three angles are together less than four right angles.

12. To make a triangle equal to a given pentagon; and to make a square equal to this triangle.

5 June 1862.

MECHANICS AND HYDROSTATICS.

1. EXPLAIN the principle of the *parallelogram of forces*; and prove that if three forces acting on a point, keep it at rest, each of these forces is proportional to the sine of the angle made by the other two.

2. Four forces represented by 15, 20, 25, 30, act on a point A . The two first are inclined to the left of the line AB , at the angles 60° and 135° ; and the two others to the right of this line at the angles 30° and 90° ; it is required to find, both by construction and calculation, a force which shall keep these four forces at rest.

3. Find the centre of gravity of a triangle ABC ; and prove that three forces which are proportional to the lines GA , GB , GC , will keep the point G at rest, G being the centre of gravity of the triangle.

4. Find the distance of the centre of gravity of any system of bodies considered as points from a given plane.

5. If any number of forces P , Q , &c.; p , q , &c., acting upon the arms of a lever without weight, to turn it in opposite ways, be such that

$$P.CM + Q.CN + \&c. = p.Cm + q.Cn + \&c.,$$

C being the fulcrum, and CM , CN , &c. the perpendiculars upon the directions of these forces respectively, there will be an equilibrium.

6. In a vertical screw when there is an equilibrium, prove that the power is to the weight as the distance between two contiguous threads measured in a vertical direction to the circumference of the circle which the power describes. Also, show that the principle of *virtual velocities* is true in the case of the screw.

7. In a simple isosceles truss roof ABC , calculate the tension of the tiebeam AC . Determine also the strains on the braces drawn from the middle of AC , to the middle of BA and BC .

8. In the construction of arches, prove that the horizontal pressure is the same at every point of the arch; and that the perpendicular pressure upon each of the voussoirs is proportional to the secant of the angle which the joint makes with the vertical.

9. Explain Atwood's machine, and show how it has been applied to prove the laws of motion.

10. If an imperfectly elastic body impinges obliquely upon an immovable plane, to determine its motion after impact.

11. How long would a body be in falling down the lower half of an inclined plane, whose length is 150 feet and height 60 feet?

12. A pendulum is found to make 640 vibrations at the equator in the same time as it makes 641 at Greenwich; if a string, hanging vertically, can just sustain 160 lbs. at Greenwich without breaking, how many pounds can the same string sustain at the equator?

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13. From what height must a centrifugal carriage descend down an inclined plane, so that with the velocity acquired it may enter the interior of the circumference of a circle placed in a vertical position at its base, and just pass the top of the circumference without falling; the diameter of the circle being 12 feet?

14. Explain the fundamental property of fluids. By what experiments is this property established? Is water compressible or not?

15. If two fluids communicate in a bent tube, they will be in equilibrium, when their perpendicular altitudes above the horizontal plane where they meet are inversely as their densities.

Explain the *hydrostatical paradox* or *hydrostatic bellows*.

16. Describe Nicholson's hydrometer; and show in what respect it is superior to that of Sykes'.

What is the specific gravity of alcohol, supposing that the weight of Nicholson's hydrometer is 250 grains; and 72 grains are required to sink it to the proper depth in water, and 9 grains in alcohol?

17. Explain how the elastic force of air varies. 1st, when the density varies and the temperature remains the same; and 2dly, when the temperature varies and the density remains the same.

18. Required the pressure of sea water on the cork in an empty bottle, supposing that its diameter is $\frac{4}{5}$ ths of an inch, and that it is sunk to the depth of 600 feet.

N.B.—The specific gravity of sea water is 1.026.

19. Describe the construction and mode of working of the air-pump. Find the density of the air in the receiver after four strokes of the piston, the volume of the receiver being ten times that of the barrel.

20. Describe the mode of filling and graduating the thermometer. Explain also the different scales of *Fahrenheit*, *Centigrade*, and *Reaumur*. What degrees on the Centigrade and Reaumur's scales correspond to 100° of Fahrenheit?

INDIAN ENGINEER ESTABLISHMENT.

Competitive Examination, June 1862.

LAND SURVEYING.

1. IN measuring between two stations A and B, a very wide river intervenes, crossing the line at right angles. There is no instrument available but a 100 feet chain, which evidently cannot span the stream; show how the exact breadth of the river may be determined and the measurement continued.

2. I have a French plan in which the scale has been omitted; one of the lines on the plan however is numbered 804.584 metres, and measures exactly 2.5 English inches.

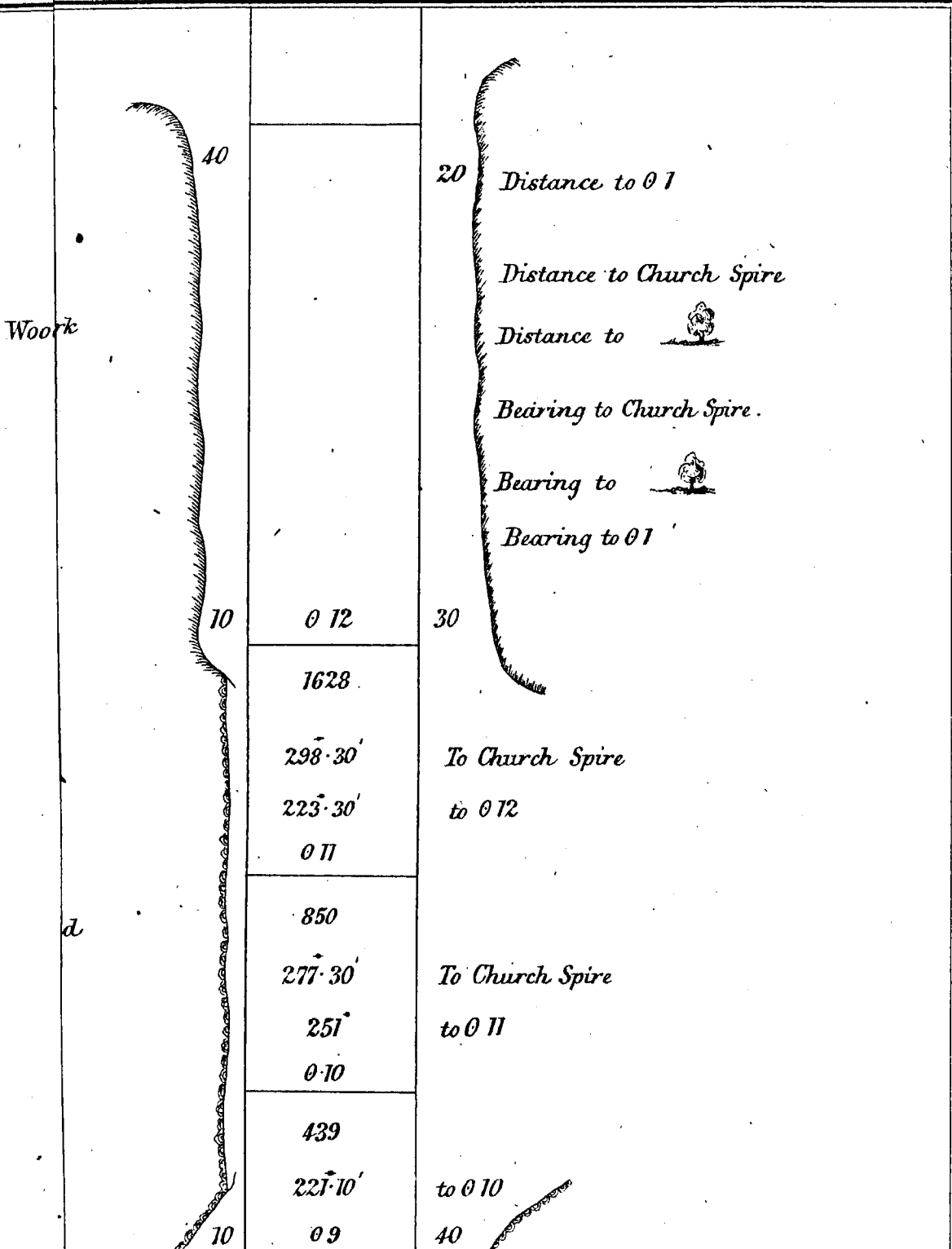
Construct an equivalent English scale to read to 10 yards.

N.B.—A yard = 0.9143 metres.

3. From the following extract taken from a fieldbook, plot the survey, on a scale of 5 chains to 1 inch.

N.B.—Fill in (with ink) the spaces left blank, and draw the scale to read to 1 link.

See lithograph.



Part of the last Example, to represent the boundary; show how you would survey it with chain in the Plan (with dotted ink lines) the lines measure - number them in the order of and calculate the area of the Estate in the order, the various operations to be performed and laying out a Line of Railway - state what you would employ and give such details as are the guidance of the workmen.

TRIGONOMETRICAL SURVEYING.

1. DESCRIBE the method of laying out a base line, and the instruments generally employed.

2. In order to compare bases measured at different elevations, it is necessary to refer and reduce them to a common standard, viz., the mean sea level. Determine the formula for the reduction, and apply it in the following example—where the base measured was 30,809·07 feet, at an elevation of 1,957 feet above the level of the sea—assuming the mean radius of the earth = 20,888,153 feet.

3. Explain the method of “traversing” with the theodolite and chain. Suppose the instrument properly adjusted at the first station for the purpose of surveying a road, and carry on the work through at least three stations.

4. What advantage does the theodolite possess over the sextant in measuring the angle between two places of different elevation?

5. The distance between two stations, A and B, (as obtained from a previous survey), was 6,230 yards, and in order to extend the survey, two other stations, C and D, were selected, whose distance apart could not be determined by actual measurement. The following angles were therefore taken with the theodolite, viz.

$$\begin{aligned} \angle A C B &= 85^{\circ} 46' & \angle A D C &= 31^{\circ} 48' \\ \angle B C D &= 23^{\circ} 56' & \angle A D B &= 68^{\circ} 2' \end{aligned}$$

required the distance C D.

6. Wanting to fix the position of a sunken rock D in the middle of a river, I took the following angles from a boat (moored exactly over the rock) to three objects, A, B, C, which were accurately laid down on my chart (A and B being on the same bank of the river, and C opposite), viz.

$$\begin{aligned} \angle A D C &= 131^{\circ} 52' \\ \angle A D B &= 110^{\circ} 12' \end{aligned}$$

required the distances A D, B D, C D, when A B = 4,516, A C = 4,809, and B C = 3,018 yards.

LEVELLING.

1. WHAT is meant by two places being on the same level? What, also, by “apparent” and “true” level? and determine the formula for the difference of these terms.

2. Describe the “dumpy,” or Gravatt’s level, and state wherein it differs from the Y level.

3. Plot a section from the following extract from a levelling field-book:—

Horizontal scale = 600 feet to an inch.
Vertical scale = 20 feet to an inch.

N.B.—Fill in (with ink) the columns “Rise,” and “Fall,” and “Reduced Levels.”

| Back-sight or Reading of Back-staff. | Fore-sight or Reading of Fore-staff. | Rise. | Fall. | Reduced Levels. | Distance in Feet. | Remarks. |
|--------------------------------------|--------------------------------------|-------|-------|-----------------|-------------------|--|
| 13·71 | 7·88 | | | | 519 | Datum assumed 100 feet below first back-staff. |
| 9·40 | 16·30 | | | | 815 | |
| 3·87 | 11·71 | | | | 600 | |
| 2·63 | 12·41 | | | | 350 | |
| 14·62 | 0·95 | | | | 480 | |
| 16·21 | 1·45 | | | | 820 | |
| 10·66 | 15·40 | | | | 360 | |
| 2·87 | 12·38 | | | | 420 | |
| 3·40 | 9·64 | | | | 530 | |

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4. Given the same section as in the last example—show how the difference of level between the extreme points may be determined with the theodolite.
5. Name the adjustments of the Y level, and explain what is meant by the “Line of Collimation.”
6. State other methods of levelling besides those performed with theodolite and spirit level, and describe the instruments employed in any one of the methods.

PUBLIC WORKS DEPARTMENT—INDIA.

CIVIL ENGINEER ESTABLISHMENT.

EXAMINATION PAPERS for Appointments for June 1862.

George Preston White, C. E., Examiner.

Note.—You are requested to write legibly, and to answer the questions as concisely as possible. Prefix the number of the question to each answer. In those cases where free-hand sketches or diagrams are used to illustrate the subject, it is requested they may be carefully executed, in order to show the Candidate's efficiency in this style of drawing. Candidates must not, during the Examination, refer to any Book or MS., nor communicate with each other; their doing so will disqualify them. Candidates are required to produce *bond fide* finished drawings, with certificate, respecting which there will be a *viva voce* examination.

DESCRIBE the course of education you have undergone, name the engineer to whom you have been a pupil, the number of years articulated, the nature of the works on which you have been engaged, and state in what branch of the profession you have had most practical experience.

Roads.

1. Draw transverse sections of a road, showing formation in sidelong ground, on level ground, through cutting, and along precipitous rocky ridges; show drains, culverts, fences, &c., and figure on dimensions, and state the quantity of metalling and other materials required per perch, and give specification and estimate, adopting your own data.
2. Describe in detail, with sketch, Mr. Telford's principles of road making, as adopted in his practice on the Caledonian and Holyhead roads; state in what does it differ from Mr. M'Adam's system; and the comparative advantages and cost.
3. Describe some of the plans which have been successfully employed for a king foundations for roads over marshes and unstable ground.
4. If required to lay out a road, suitable for a tramway for cattle draft, or for light locomotives, state what gradients and curves you would consider desirable, the nature of the bridges and other works, and what course you would adopt so as to secure the utmost economy in construction.
5. What is the tractive power required per ton on a well-formed level road, and on a railway, also on gradients of 1 in 30, of 1 in 50, and of 1 in 100, at velocities of 5, 10, and 20 miles per hour? and state the comparative cost of haulage on canals, roads and railroads, with horse and locomotive power

Railways and Tramways.

6. Describe the different methods employed for setting out railway curves, and for laying out widths on sidelong ground.

7. Describe

7. Describe the different kinds of permanent way used on some of the principal railways in this country and abroad, and sketch the different forms of rails, chairs, and sleepers, mode of fixing the joints; state the average cost per mile of the different systems, and their comparative advantages.

8. Give the average cost per mile of some of the most important railways in the United Kingdom, on the Continent, in America, and in India, and state the width of gauge employed.

9. Describe the different modes adopted for working traffic over steep inclines, and state what are the steepest gradients worked by locomotives.

10. Design a second-class railway station house of simple construction; give ground plan, elevation, and sections, with sufficient detail to enable builders to execute the work therefrom, and give a specification and estimate of the cost, adopting your own prices and data.

11. In countries of vast extent like India, where it is desirable that railways should be as cheaply constructed as possible, consistent with safety and economy in working; describe the kind of permanent way you would recommend, the nature of the bridges, the form and weight of rail per yard, the railway to be suitable either for light locomotives or cattle draft; give an estimate and general specification, and name any railway which illustrates your views.

12. Give a brief description of the locomotive engine, describing some of the most important improvements since its first introduction; and describe an economical light locomotive, suitable for moderate traffic on tramways or low-speed railways, and state the average cost.

Canals.

13. Draw transverse sections of a canal in cutting, on the surface, and on an embankment. Figure on the dimensions and slopes, and show puddle lining, towing path, &c., and describe how puddle is made, and how to prevent its cracking.

14. Describe the improvements and peculiarities of construction introduced by Mr. Telford in the Chirk and Pont-Cysylltau aqueducts on the line of the Ellesmere Canal, and by what means the employment of puddle was dispensed with.

15. If required to lay out a line of canal for navigation and irrigation: state the principal circumstances which would guide you as to the selection of the route.

16. Describe the various modes used for raising canal boats from one level to another.

17. Describe the Solani aqueduct on the Great Ganges canal, executed by Sir Proby Cautley, or any other important example.

18. Describe any canal, where great engineering skill has been displayed in its construction.

Irrigation and Drainage.

19. Describe in detail the methods employed in India and Lombardy for irrigating land.

20. Explain the general principles of the system adopted by Sir Cornelius Vermuyden for the drainage of the fens, and describe the improved system introduced by the late Mr. Rennie.

21. State briefly the principal features of the drainage of London now being carried out by Mr. Bazalgette.

Locks.

22. Make a design for a canal lock chamber, giving plan, elevation, section and specification, breadth 30 feet, length 100 feet, lift 10 feet, average depth of canal 10 feet. State what precautions you would take regarding the foundations, also describe the best form of sluice.

Submarine Foundations.

23. Describe in detail, and give sketches of, the different methods employed for forming foundations under water; state the comparative merits, applicability and advantage of each system, under the various circumstances met with in practice, and give examples.

24. State which are the best, and which are the most difficult soils to form foundations on, and explain what course you would adopt to ascertain the nature of the strata before executing a work under water.

25. Describe the mode adopted by Mr. Hodges, for forming the foundations for the piers of the great Victoria Bridge across the St. Laurence, at Montreal, Canada.

26. Make a sketch of the screw pile, and describe the various uses to which it is applied.

Bridges and Viaducts.

27. Give the dimensions, span, cost and peculiarities of construction of some important examples of bridges and viaducts of stone, brick, timber, iron and wire.

28. Describe the different forms of girder, viz. :—The trellis, the Warren, the tubular, the bow and string, and Brunel's girder; state the comparative advantages.

29. What are the circumstances which would guide you in employing cast iron, wrought iron, stone, brick, timber or wire, in the construction of bridges and viaducts?

30. Design a railway viaduct to cross a river 250 feet wide, greatest depth of water 20 feet, and height from surface of water to formation level 50 feet.

31. Make a design for a simple form of timber road bridge, 40 feet span between abutments.

32. In wrought iron trellis and boiler plate girder bridges, what proportion should the depth of the beam bear to the span?

33. Make a design for a centre, of simple construction, for a brick segmental arch of 50 feet span and 20 feet rise, and name any important example of bridge centering.

34. Give transverse sections of the best forms for girders of cast, wrought, and boiler plate iron; and state the general results arrived at from the experiments of Messrs. Stephenson, Fairbairn, Hodgkinson and Barlow.

Retaining Walls.

35. Design retaining walls of stone and brick, 20, 30 and 40 feet in height; figure on the dimensions and batter, the strata being clay.

Roofs.

36. Design a truss for a wrought iron roof of 70 feet span for a railway station; give working drawings with transverse sections of struts, tie-rods, &c., and figure on dimensions, and give sufficient detail to enable a contractor to execute the work.

Dams.

37. Design a dam for a river 100 feet wide, greatest depth of water 20 feet, head of water required five feet; give a plan of the superstructure, of the upper level, of the lower level, an elevation of a portion of the front of the dam wall and section of wing wall; state what precautions you would take to secure foundations, and prevent leakage; and give specification and estimate of the cost of the work, adopting your own data.

Strength of Materials.

38. Describe the different materials employed in building operations; state their comparative strength, and what tests you would apply to ascertain their strength, quality and fitness.

Machinery.

39. Describe the advantages of the slide rest principle, and mention some of its most important applications to machinery.

40. Describe and give a hand-sketch of a simple form of five-ton crane.

Limes, Mortars and Cements.

41. Name the different kinds of lime and cement used in building; describe their properties, and specify those which are hydraulic.

42. What constitutes the chemical difference between ordinary and hydraulic limes, and explain how artificial hydraulic limes can be made, according to the experiments of Vicat and others, where natural hydraulic limes cannot be obtained; and state what time does good hydraulic lime take to harden and set.

43. Describe how concrete is made, and mention the various uses to which it is applied.

River Navigation.

44. Describe the various means employed for improving the navigation of rivers, and describe the engineering works on the Clyde, or any other river with which you may be acquainted, showing how the navigation has been improved.

Water Supply.

45. Describe the different systems employed for supplying towns with water, and give the names of important works illustrating the subject.

46. Give the names and a short description of the different machines and engines employed for raising water; state what per centage of useful effect can be obtained respectively from overshot, breast, and undershot wheels, and from the turbine; and describe their comparative advantages, and the head of water required.

Embanking Land from the Sea.

47. Describe the means employed in Holland and other countries for embanking land from the sea and from rivers.

Miscellaneous.

48. Give the names of the eminent deceased engineers of Great Britain, and mention some of their most important and distinguished works.

49. Give the names of standard works of reference on engineering subjects, and specify those you have read.

50. Describe how bricks are made, and the various kinds employed in building, and make a diagram showing the different bonds used in brickwork, and state their comparative advantages; also explain the use of hoop iron.

51. Describe the various kinds of timber employed in building, their comparative advantages, cost, durability, quality and strength.

52. Explain the processes employed to preserve timber against decay, and against the ravages of marine and other insects; and specify the timbers most durable for works under water.

53. Make a sketch showing the best sectional forms for sewers and drains, and state the best materials for their construction.

54. Mention the uses and some of the most important applications of the hydraulic press in engineering works.

12 PAPERS:—ENGINEER'S ESTABLISHMENT, &c. (INDIA).

55. State the best kinds of stone for building purposes, and specify those most suitable for works under water, and how you would test their fitness.

56. Describe some of the most improved forms of boilers for stationary, marine, and locomotive engines, and state the amount of coke or coal required respectively to evaporate a given quantity of water.

57. There are certain subjects which can be better illustrated by maps than by description; give some examples of cases where physical maps have been employed with advantage.

58. Describe the Torpoint Steam Ferry Bridge, designed by the late Mr. Rendel, also that designed by the late Mr. Robert Stephenson, to conduct the traffic of the Alexandria and Cairo Railway across the Nile, or any simple form of steam ferry bridge or pontoon with which you are acquainted.

59. Describe the principal features and advantages of the Cornish engine.

60. Describe briefly the process of manufacturing wrought iron, cast iron, and steel; state the characteristics of good iron, and how you would test the quality.

61. Describe the strata in which coal, iron, copper, tin, and lead, are usually found; state what surface indications would induce you to think that mineral existed, and what strata are most congenial for the production of the above named minerals.

62. Describe the improvements, introduced by the late Mr. Telford, in the construction of the piers and spandrils of bridges, as adopted, for example, in the Menai Bridge.

63. Name some of the most important inventions of Watt, in connexion with the steam engine.

64. More is frequently learned by a failure than by the most complete success: illustrate this by any examples with which you are acquainted, as, for instance, state the cause of failure of the foundations of Hexham Bridge, built by Smeaton.

EAST INDIA
(PUBLIC WORKS DEPARTMENT).

RETURNS of the Names of EXAMINERS appointed to examine the CANDIDATES who presented themselves, since the last Return, for Admission to the ENGINEER'S ESTABLISHMENT and PUBLIC WORKS DEPARTMENT of *India*; of the Names of the SUCCESSFUL CANDIDATES in Order of Merit; of the MARKS which were assigned on each Subject to every CANDIDATE; and, of the EXAMINATION PAPERS of each Subject (in continuation of Parliamentary Paper, No. 499, of Session 1861).

(*Mr. Longfield.*)

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