

**EAST INDIA (CIVIL ENGINEERS' EXAMINATIONS).**

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RETURN to an Address of the Honourable The House of Commons,  
dated 10 August 1860;—for,

- “ RETURNS specifying the Names of the EXAMINERS appointed to examine the CANDIDATES who presented themselves, on the 11th day of June last (and subsequent Days), for Admission to the ENGINEER'S ESTABLISHMENT and PUBLIC WORKS DEPARTMENT of *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 may have been Articled Pupils : ”
- “ Of the MARKS which were assigned on each Subject to every Candidate, whether successful or otherwise : ”
- “ And, of the EXAMINATION PAPERS on each Subject (in continuation of Parliamentary Paper, No. 135, of Session 2, 1859).

India Office, }  
18 August 1860. }

T. G. BARING.

**NAMES OF EXAMINERS.**

Rev. Jonathan Cape, A.M., F.R.S.  
Captain John Ouchterlony (Madras Engineers).  
George Preston White, Esq.; C.E.

Successful Candidates in order of Merit.

NAME.	AGE.	Civil Engineer to whom Articled.
Mr. R. G. Elwes - - - -	19	No record was kept on this point.
„ W. D. Bruce - - - -	21	
„ A. Campbell - - - -	21	
„ G. W. Owen - - - -	20	
„ G. Kilgour - - - -	21	
„ J. Denmeade - - - -	19	
„ D. Scott - - - -	22	
„ A. Penny - - - -	19	
“ J. Beauchamp - - - -	21	

## PAPERS RELATING TO EXAMINATION OF CANDIDATES FOR

NUMBER of MARKS assigned on each Subject to every Candidate, whether successful or otherwise.

Number on Examiner's List.	Mathematics.	Surveying and Levelling.	Civil Engineering.	TOTAL.	Number on Examiner's List.	Mathematics.	Surveying and Levelling.	Civil Engineering.	TOTAL.
1	303	222	305	830	15	147	183	200	530
2	279	207	310	796	16	125	138	230	493
3	235	226	300	761	17	129	179	180	488
4	177	213	315	705	18	51	132	290	473
5	167	202	295	664	19	75	135	250	460
6	180	160	290	640	20	74	132	240	446
7	152	192	285	629	21	104	141	200	445
8	175	151	280	606	22	83	170	180	433
9	176	154	275	605	23	63	130	220	413
10	146	179	270	595	24	72	57	230	359
11	161	160	270	591	25	16	41	150	207
12	196	127	265	588	26	119	25	60	204
13	157	154	260	571	27	20	33	50	103
14	118	158	280	556	28	8	66	80	174

## EXAMINATION PAPERS.

JUNE 1860.

## ARITHMETIC.

1. DIVIDE the sum of  $\frac{3}{5}$ ,  $\frac{7}{8}$ ,  $\frac{9}{10}$  and  $\frac{7}{12}$  by the difference between  $\frac{1}{3}$  and  $\frac{3}{8}$ , and bring the result to a decimal; also reduce each of the given fractions to a decimal, and deduce the same result.
2. Find the sum of  $\cdot 175$  of a ton,  $166$  of a cwt., and  $\cdot 244$  of a quarter, as the decimal of a ton; and reduce it to lower denominations.
3. Find (by practice) the cost of a lodging for 116 days, it being let at  $17\ s. 6\ d.$  a week.
4. A contractor purchases 70 horses, at  $45\ l.$  a piece: 9 of them die during the execution of the contract; 5 are injured at different times during the same period, and sold for  $9\ l.$ ,  $15\ l.$ ,  $13\ l.$ ,  $11\ l.$  and  $16\ l.$  respectively. At the completion of the contract the remainder are disposed of for  $33\ l.$  each. What balance does this leave to be covered by the value of their work?
5. If 3 tons 15 cwt. are carried on a railway 72 miles at  $\frac{1}{4}\ d.$  per ton per mile, and afterwards 32 miles farther on another line where the goods charges are higher by 50 per cent., what will the whole carriage amount to, 1 s. per ton cartage being charged for removing the goods from one line to the other?
6. A man has property in 3 parishes of the annual value of  $1,750\ l.$ ,  $2,136\ l. 5\ s.$ , and  $5,928\ l.$  respectively, and the rates in these several parishes are  $1\ s. 5\ d.$ ,  $2\ s. 8\frac{1}{2}\ d.$ , and  $1\ s. 10\frac{1}{2}\ d.$  in the pound; what amount of net income does this leave him?
7. Find (by duodecimals) the solid content of a block of marble 6 ft. 8 in. wide, 4 ft. 10 in. high, and 15 ft. 6 in. long.
8. Find the *Simple Interest* on  $1,854\ l. 15\ s. 4\ d.$  for 219 days, at  $4\frac{1}{2}$  per cent. per annum; and name the amount of which this result would be the discount for 1 year 73 days at the same rate.

9. £. 5,000

9. £. 5,000 of Bank Stock, paying  $8\frac{1}{2}$  per cent., is sold out at 226, and the amount reinvested in Consols at 95; what effect does this produce on the owner's income?

10. If a lb. (Troy) of standard silver be coined into 66 s., to find the difference between the weights of half-a-crown and half an ounce avoirdupois. (N.B. 1 lb. avoirdupois = 7,000 grains.)

ALGEBRA.

1. REDUCE the following expressions to their simplest forms:—

$$\frac{\frac{3n}{2} - \frac{3n}{2}}{a - a}, \left[ \left( x^{\frac{2}{3}} \cdot x^{\frac{1}{2}} \div x^{\frac{1}{3}} \right)^3 \right], \frac{1}{x^2} - \frac{2}{x^2(x+1)^2} + \frac{2(3+2x)}{x^2(x+1)^2(x+2)^2} + \frac{1}{(x+2)^2}$$

2. Multiply  $\frac{x^2}{a^2} + \frac{a^2}{x^2} - \left( \frac{x}{a} + \frac{a}{x} \right) + 1$  by  $\frac{x}{a} + \frac{a}{x}$ , arranging the product in descending powers of  $x$ ; also divide

$$\frac{x^3}{a^3} + \frac{a^3}{x^3} - \left( \frac{x^2}{a^2} - \frac{a^2}{x^2} \right) + 4 \left( \frac{x}{a} + \frac{a}{x} \right) \text{ by } \frac{x}{a} + \frac{a}{x}.$$

3. Extract the square root of

$$(x - y)^4 - 2(x^2 + y^2) \cdot (x - y)^2 + 2(x^4 + y^4).$$

4. Show how to rationalise the denominator of a fraction when it consists of the sum or difference of two quadratic surds. Also extract the square root of  $16 + 5\sqrt{7}$ .

5. Solve the following equations:—

$$\frac{1}{3}(8 - x) + 2x - 3\frac{1}{3} = x + 6 - \frac{2x}{3} \quad \dots \dots (1)$$

$$\frac{\frac{7x}{3} - 2}{4} - \frac{5x - \frac{1}{2}}{3} = \frac{\frac{x}{4} - 2}{5} - 3\frac{1}{2} \quad \dots \dots (2)$$

$$2 \{ (x - 1)(x - 2) \}^2 + 4x^2 + 12x + 8 = (x - 1)^4 + (x - 2)^4 \quad \dots (3)$$

$$x^2 - 7x + \sqrt{x^2 - 7x + 18} = 24 \quad \dots \dots (4)$$

$$\left. \begin{aligned} \frac{x}{a} + \frac{y}{b} &= 1 \\ \frac{a}{x} + \frac{b}{y} &= 4 \end{aligned} \right\} \dots \dots (5)$$

6. Show that a ratio of greater inequality is diminished, and a ratio of lesser inequality is increased, by adding the same quantity to each of the terms of the ratio. If  $a : b :: c : d$ , prove that

$$ma + nb : pa - qb :: mc + nd : pc - qd.$$

7. If the combined increase in the imports and exports of a country be 3.6 per cent., the imports alone increasing 7.2 per cent., and the exports alone decreasing 2.4 per cent., what proportion do the imports and exports bear to one another?

8. Determine a general expression for the sum of an Arithmetical Progression. Sum the series  $3\frac{1}{7}, 3\frac{1}{3}, 3\frac{2}{7}, \dots$  to 16 terms; and insert 8 Arithmetical Means between  $1\frac{1}{2}$  and  $8\frac{1}{2}$ .

9. A person who saved every year one-third as much again as he saved the previous year had in 5 years saved 280 l. How much did he save the first year?

10. If we divide 300 l. among 12 men, 18 women, and 36 children, so that the shares of two men shall be equal to those of three women, and the share of

#### 4 PAPERS RELATING TO EXAMINATION OF CANDIDATES FOR

each woman equal to those of two children, what share will fall to each man, woman, and child?

11. If one watch loses and another gains at the rate of a minute a day, and they are both set at noon on Tuesday, what time will be indicated by the former, when the latter points to 11 P.M. on the following Sunday?

12. Show that if  $A \propto B$  when  $C$  is constant, and  $A \propto C$  when  $B$  is constant, then  $A \propto B \times C$  when  $B$  and  $C$  both vary. By means of this solve the following:—

If 10 men in 3 weeks earn 14 *l.* 5 *s.*, how long will 8 men be earning 19 *l.*?

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#### GEOMETRY.

1. EXPLAIN the meaning of the terms *adjacent angles*, *vertical angles*, and *alternate angles*. Define a triangle; and, show how many kinds of triangles there are, according to the variation both of the *sides* and the *angles*.

2. To bisect a given rectilinear angle, that is, to divide it into two equal angles.

Show how the position of the equilateral triangle used in the proof of this proposition depends on the magnitude of the angle.

3. At a given point in a given straight line, to make a rectilinear angle equal to a given rectilinear angle.

If one angle of a triangle be equal to the sum of the other two, the greatest side is double of the distance of its middle point from the opposite angle.

4. Parallelograms upon the same base, and between the same parallels, are equal to one another.

Show that the perimeter of a square is less than that of any parallelogram having an equal area; also that the perimeter of an isosceles triangle is less than that of any other equal triangle having the same base.

5. In any right-angled triangle, the square which is described upon the side subtending the right angle, is equal to the squares described upon the sides which contain the right angle.

A pond in the form of a right-angled triangle, whose longest side measures 130 yards, has two square fields situated on its two shorter sides; required the number of acres in these two fields.

6. In obtuse-angled triangles, if a perpendicular be drawn from any of the acute angles to the opposite side produced, the square of the side subtending the obtuse angle is greater than the squares of the sides containing the obtuse angle, by twice the rectangle contained by the side upon which, when produced, the perpendicular falls, and the straight line intercepted without the triangle between the perpendicular and the obtuse angle.

If the sides of a triangle measure 4, 8, 10 feet respectively, determine whether it is acute or obtuse-angled.

7. To find the centre of a given circle.

Describe a circle passing through three given points. What condition is necessary to enable us to describe a circle through four given points?

8. In a circle, the angle in a semicircle is a right angle; but the angle in a segment greater than a semicircle is less than a right angle; and the angle in a segment less than a semicircle is greater than a right angle.

Hence determine the angle in a quadrant.

9. What different properties are proved in the Third Book of Euclid with reference to the line touching a circle.

10. The sides about the equal angles of equiangular triangles, are proportionals; and those which are opposite to the equal angles are homologous sides, that is, are the antecedents or consequents of the ratios.

Hence show how to divide a right line into any number of equal parts, and explain the principle of the *Diagonal Scale*.

11. In right-angled triangles, the rectilinear figure described upon the side opposite to the right angle, is equal to the similar and similarly described figures upon the sides containing the right angle.

What previous proposition in Euclid is a particular case of this?

12. If a solid angle be contained by three plane angles, any two of them are greater than the third.

MECHANICS AND HYDROSTATICS.

1. PROVE the proposition of the *parallelogram of forces*; and apply it to find the *magnitude and direction* of a force that will keep two other forces at rest acting upon a point, which are represented by 20 lbs. and 10 lbs., and are inclined to each other at an angle of  $45^\circ$ .

2. In the *funicular polygon*, prove that the weights are proportional to the sum of the cotangents of the angles which the supporting strings make with a vertical line.

If the ends of a thread 12 feet long be fastened at two fixed points A, B, 8 feet from each other in a horizontal line, what must be the proportion between two weights, P, Q, placed at 4 and 5 feet from A and B respectively, so that they shall be in the same horizontal line?

3. If a body be suspended by any point, it will not remain at rest until the centre of gravity be in a vertical line passing through that point. Explain the difference of the stability of a body when the centre of gravity of the body is *above* the point of suspension, and when the centre of gravity is *below* it.

Hence show the method of finding the centre of gravity *experimentally*.

4. If  $a$  and  $b$  be the two parallel sides of a trapezoid, and  $h$  the line which bisects these sides, then the centre of gravity of the trapezoid is in this line, and its distance from  $a$  in this line is  $\frac{h}{3} \cdot \frac{a+2b}{a+b}$ .

5. Show how the *Roman* steel-yard, and the *Danish* steel-yard must be graduated.

6. Explain the *principle of virtual velocities*; and prove that this principle is true in the case of the wheel and axle.

7. In a roof A B C, where two stretchers D A, D C, and a king-post B D, are substituted for the tie-beam, to determine the strain upon the king-post.

8. To find the conditions of equilibrium of an arch, and the pressure exerted to overturn the pier.

9. To determine the transverse strain of any beam fixed horizontally in a wall when a weight is suspended at its extremity; the weight of the beam being neglected, and the force of cohesion of the particles of the body being supposed to be proportional to the distances to which they are removed from each other.

Hence show that a joist laid on its narrow edge ( $b$ ) is stronger than when laid on its flat side ( $d$ ), in the proportion of  $d$  to  $b$ .

10. By what experiments is it proved in Dynamics that different forces acting separately on a body generate velocities in equal times proportional to the forces?

11. Explain the meaning of the terms *hard* bodies, *soft* bodies, bodies *perfectly* and *imperfectly elastic*. In the direct impact of two imperfectly elastic bodies moving with given velocities, to determine their velocities after impact.

*Ex.*  $A = 4 B$ , and A with a velocity of 20 feet per second strikes B at rest; find their velocities after impact, 1st, when the bodies are perfectly elastic; and, 2d, when the force of elasticity is  $\frac{1}{2}$  of the force of compression.

12. If a circle be situated in a vertical plane, the times of descent down all chords

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chords drawn through the highest or lowest points are equal; and the velocities acquired in falling down them are proportional to their length.

13. A pendulum which vibrates seconds at the Equator, when carried to the Pole gains five minutes a day; find the proportion of the equatorial and polar gravity.

14. Explain what is meant by centrifugal force; and find its amount when a body describes the circumference of a circle uniformly with a given velocity.

What additional weight would a body have at the Equator, if the earth ceased to move about its axis, its diameter being 7,924 miles?

15. What is the fundamental property of fluids? By what experiments was it supposed that water was *not* compressible? and in what way has it been proved that all fluids are compressible?

16. The surface of every fluid at rest is horizontal or perpendicular to the direction of gravity:

Hence show that, in levelling, the depression is equal to eight inches in a mile. What is the depression in three miles?

17. The pressure of a fluid on any surface is equal to the weight of a column of the fluid whose base is the surface pressed, and height equal to the depth of the centre of gravity of that surface, below the surface of the fluid.

Required the pressure in lbs. against the lower half of a sluice-gate 10 feet square, placed vertically in water, the upper side of the gate coinciding with the surface of the fluid. Find also the centre of pressure of this surface.

18. Explain Sykes's and Nicholson's hydrometer; and show how they are applied to find the specific gravities of bodies.

19. What is meant by the *metacentre* of a body? Determine when the equilibrium of a body is *stable*, *unstable*, or *indifferent*.

Each of the eight pontoons used in floating the Britannia tubular bridge was a parallelopiped 98 feet in length, 25 feet in breadth, and 11 feet in height; required their combined power of floatage, supposing that the weight of each pontoon was 200 tons.

20. By the observations of Humboldt on the mountain of Quindiu, the altitudes of the barometer and thermometers were as follows:—

Station.	Height of Barometer.	Attached Thermometer.	Detached Thermometer.
Level of the Pacific Ocean	<i>Inches.</i> 30·036	77°54'	77°54'
Top of the mountain	20·0713	68	65·75

To find the height of Quindiu.

MENSURATION.

1. How many square yards does the triangle contain, of which one angle is  $45^\circ$  and its containing sides 25 and 21·25 feet?

2. How many acres are there in a triangle whose three sides are 49 chains,  $50\frac{1}{2}$  chains, and 25 chains 70 links?

3. What is the content of the eight-sided figure  $ABCDEFGH$ , the diagonal  $AE$  being taken as a base, and the perpendiculars drawn from the angular points to  $AE$  on one side are

$$Bb = 294, \quad Cc = 142\cdot5, \quad Dd = 224?$$

Also the perpendiculars drawn to the base on the other side of  $AE$  are

$$Ff = 121, \quad Gg = 195\cdot5, \quad Hh = 142.$$

The

The segments of the base are likewise as follows :—

$$Ah = 44.5, \quad hb = 124.25, \quad bg = 80, \quad gc = 41, \quad cd = 130.5, \\ df = 50, \quad fE = 52.5.$$

4. Find the area of the sector of a circle whose radius is 90 feet, and the contained angle  $50^\circ 30'$ .

5. The breadth of an irregular figure at seven equidistant places are 82, 74, 92, 102, 86, 60 and 40 feet. Find the area of this figure, the common distance being four feet.

6. Required the content of the frustrum of a cone, the altitude being 25, the circumference at the greater end being 20, and at the less end 10.

7. Required the convex surface of a spherical segment which is two feet in height, and cut off from a sphere  $12\frac{1}{2}$  feet in diameter.

8. A roof which is 24ft. 8in. by 14ft. 6in. is to be covered with lead of 8lbs. per square foot; what will it come to at 18s. per cwt.?

9. How many bricks will it take to build a wall 10 feet high, and 500 feet long, of a brick and a half thick, reckoning the brick 9 inches long, and four courses to the foot in height?

10. Required the number of cubic yards in an embankment, the transverse sections perpendicular to the axis being trapezoids whose dimensions were as follows :—

Horizontal lines at top . . 22; 21.9; 21.6; 21.6; 21.8; 21.6; 22 feet.

Horizontal lines at bottom 46; 46.9; 47.6; 50.2; 52.4; 55.2; 62 feet.

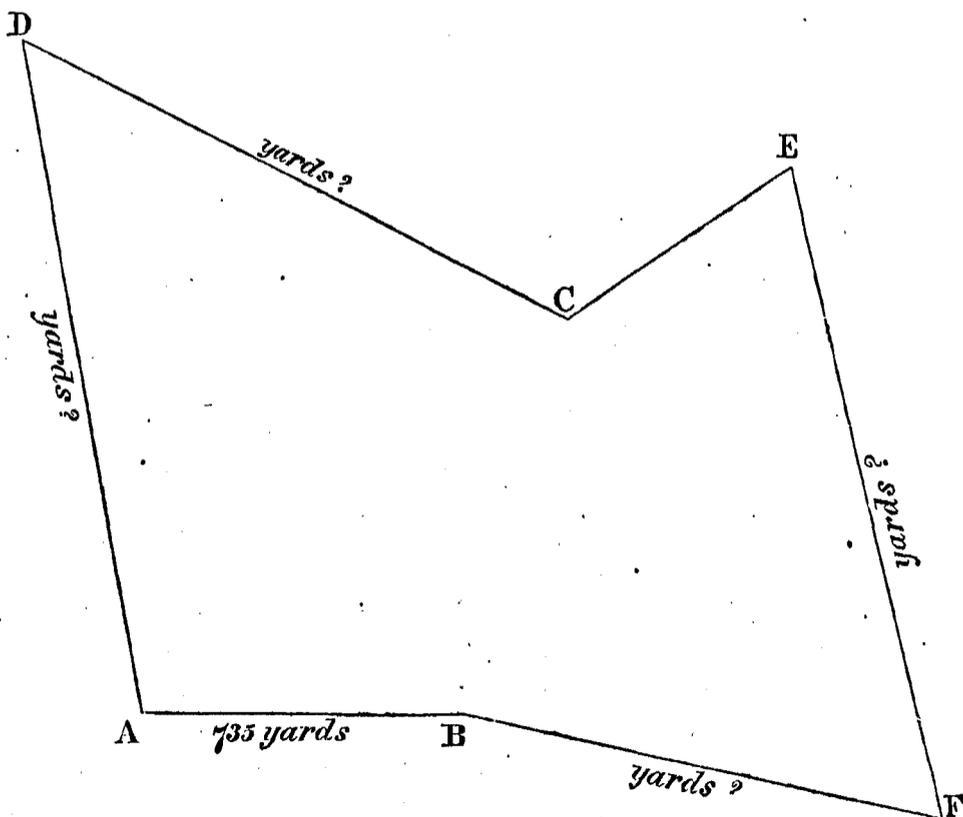
Perpendicular heights . . 6; 6.3; 6.6; 7.2; 7.8; 8.4; 10 feet.

Also the common distance between two transverse sections was 50 feet.

TRIGONOMETRICAL SURVEYING.

Question 1. A base, A B, having been measured on level ground = 735 yards, stations for a trigonometrical survey were established at D, C, E and F; and a theodolite having been set up at A, and subsequently at C and E, observations were made as entered below. Required the length of the sides of the triangles thus constructed, and prove the correctness of B F by working it by two different triangles B C F and B E F.

Note.—The distances ascertained are to be legibly written in ink on the lines representing them in the diagram.



OBSERVATIONS at Station A. :

Telescope directed on	Reading of Arc.	Deduced Angle.
D Chimney of house - - - - -	20° 10 20	
C Flag staff on hill - - - - -	78° 52 5	
B Ditto at end of base - - - - -	121° 15 20	

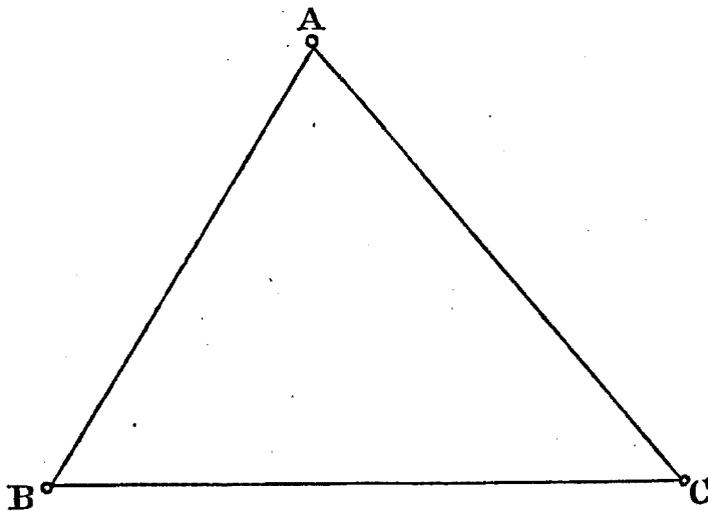
OBSERVATIONS at Station C. :

E Flag-staff - - - - -	210° 22 35	
F Church steeple - - - - -	293 56 5	
B Flag-staff - - - - -	346 59 5	
A Ditto - - - - -	22 5 5	
D Chimney - - - - -	89 31 5	

OBSERVATIONS at Station E. :

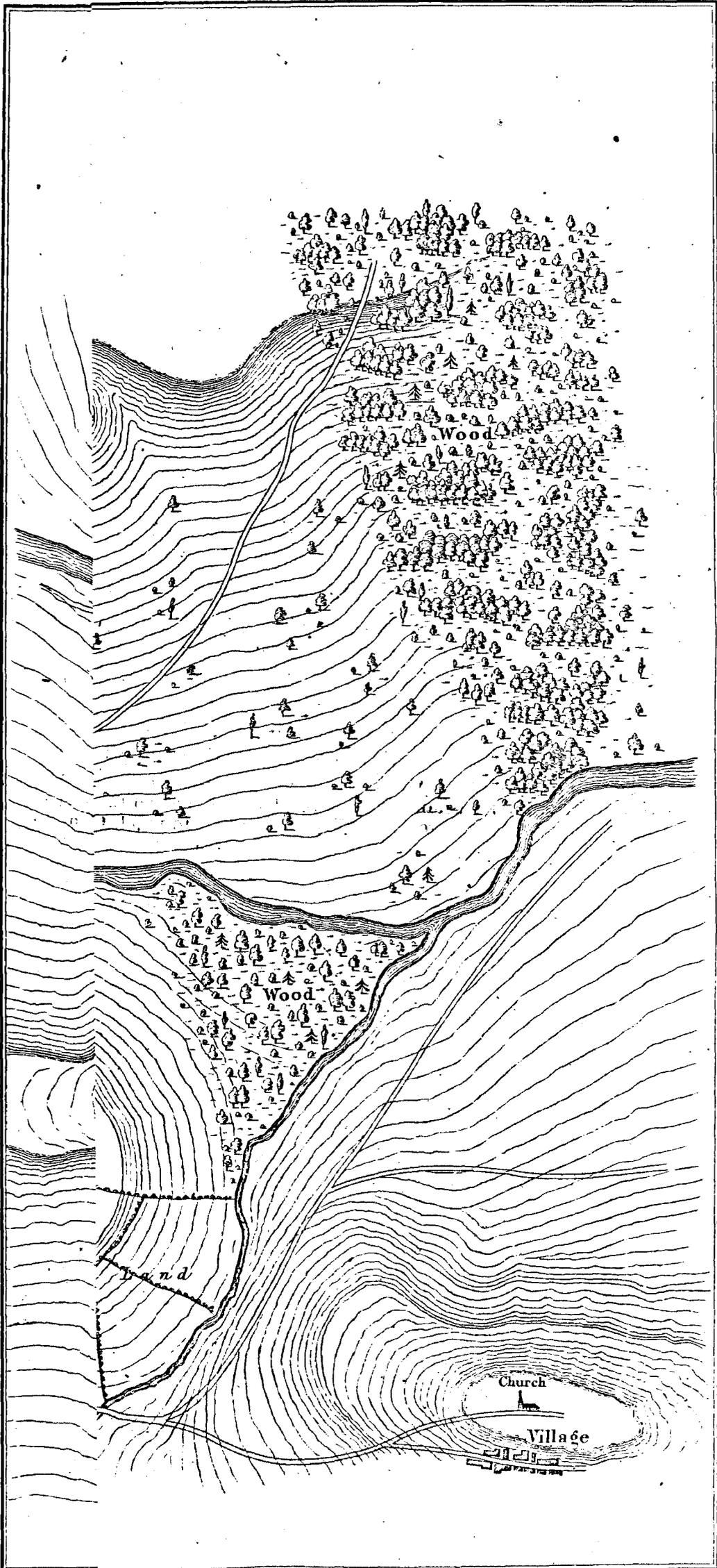
F Church steeple - - - - -	295 40 15	
B Flag-staff - - - - -	341 20 0	
C Ditto - - - - -	7 4 45	

2. In the diagram A B C, the distances A B and A C are known, as resulting from previous triangulation, viz., A C 7,215, and A B 6,242 yards. No angular instrument being available, the distance B C was accurately measured on ground which was found to slope regularly at an angle of  $9^{\circ} 51'$  with the horizon, the length measured being 7,460 yards. Required, the measure of the angles A B and C.



3. Desiring to ascertain the height of a castle wall having an inaccessible dry ditch in front, I set up a theodolite on the edge of the ditch, and measured the angle of elevation to the top of the wall,  $25^{\circ} 1'$ , and the angle of depression to the foot of the wall,  $15^{\circ} 59'$ . I then moved backwards from the ditch a distance of 30 yards, by correct measurement, and setting up the theodolite again took the angle of elevation to the top of the wall,  $11^{\circ} 30'$ . Required, the total height of the wall, and the width of the ditch, both by computation, and by measurement on a figure drawn to scale. A scale of 10 yards to one inch will prove a convenient proportion.

4. Describe the process called "traversing" with theodolite and chain. Compile an imaginary field-book of work performed in traversing from a point as A fixed by triangulation, employing for a working meridian a side A B of the same triangulation, the survey being supposed to be carried along a winding road

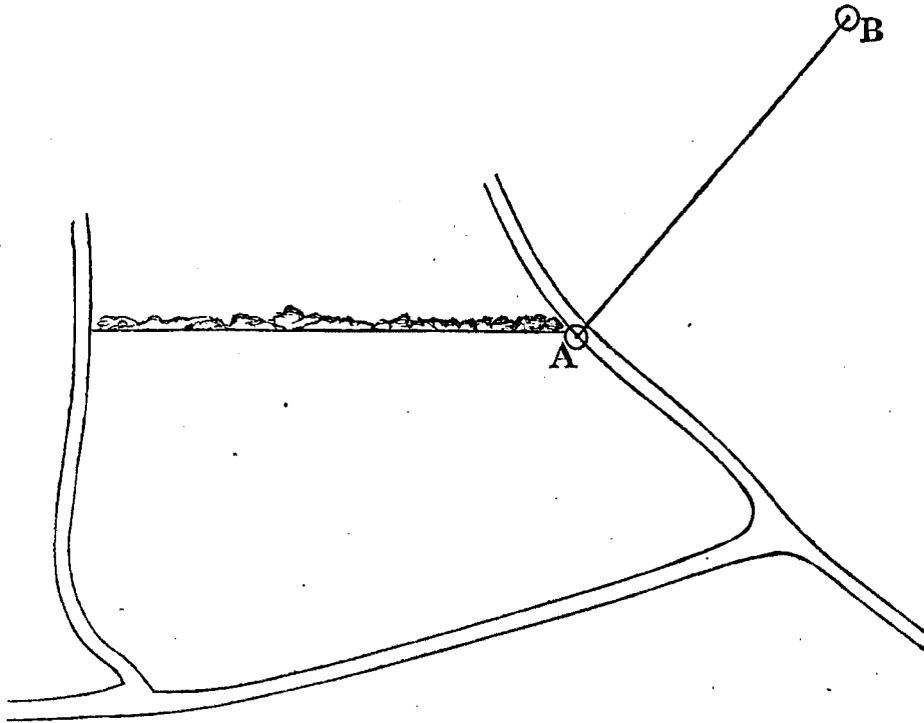


Malby & Sons, Lt

6. Ordered, by the House of Commons, to be printed, 20. Aug. 1860.

Henry Hansard, Printer.

road for some distance, and then by a hedge, or lane, back to the original starting point A.



5. Describe the adjustments of the theodolite, and the mode of effecting them.

#### LAND SURVEYING.

*Question 1.* A mining gallery is driven from a point A towards B, on a bearing of  $22^{\circ} 15'$  N.E.; but after it has proceeded 56 feet, it is resolved to direct it upon a different point C, which bears from the original starting point A,  $31^{\circ} 8'$  N.W., and is distant from it 107 feet. Required the direction or bearing which must be given to the gallery to cause it to reach C, and the distance to be driven.

(*Note.*—Computation is not necessary in this question ; find the bearing and distance by means of a figure drawn to scale, say 20 feet to one inch.)

2. Wishing to ascertain the width of a broad river whose stream ran with a mean velocity of  $2\frac{1}{2}$  miles per hour, at a point A where the direction of its channel was due east and west, I took the bearing of a tree on the opposite bank with a prismatic compass, and found it to be  $349^{\circ} 15'$  W. of N. I then threw a piece of plank into the stream, and having noted the time by a watch, I proceeded along the bank to a point where the plank passed me, when I found it had been seven minutes in floating down. Here I again took the bearing of the tree, and found it to be  $314^{\circ}$  W. of N. Required the width of the river at A.

3. The boundaries of a district having been marked at the angles by pillars, a survey is instituted with circumferenter and chain for the purpose of preparing a plan. In chaining along one line between the pillars A and B, the surveyor was interrupted by the occurrence of a large sheet of water. How should he proceed so as to determine with accuracy the distance A B ?

4. The bearing of a tree was observed and found to be  $72^{\circ} 30'$  N.E. ; but it was subsequently ascertained that a heap of iron tools had been left near the station from which the bearing had been taken, and that in consequence the needle must have been unduly deflected. Having measured on to the tree, and it being inconvenient to return to the station to take the bearing afresh, how must I proceed to correct the error ?

5. (*Vide separate Plan annexed.*)—The tract of land exhibited in the Plan, is to be surveyed with a circumferenter and chain. Describe in writing how you would proceed to execute the survey, and commence a field book, with entries of bearings and distance, if sufficient accuracy to admit of the Plan

being correctly plotted from it. The stations and chain-lines proposed may be marked on this Plan with ink.

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### LEVELLING.

*Question 1.* A line of levels having been carefully carried across an undulating piece of land A B C D, from the point A to the point D, it was ascertained that D was 3 feet higher than A; and that the highest point in the line of section B was 7 feet higher than A, while C, the lowest point, was 11 feet lower than B. The distance from A to B was 770 yards; B to C, 640 yards, and C to D, 1,080 yards.



Describe the instruments you would require, and the mode you would adopt to ascertain these differences of level. Draw a section of the ground to scale, and from it prepare a field-book with sufficient correctness to admit of a similar section being drawn by another person from the data which it furnishes.

2. Describe either the common Y or the dumpy level, and detail the adjustments which are indispensable before the correctness of observations made with the instrument can be relied on.
3. How is the theodolite employed in taking a section of undulating ground.
4. Describe the mountain barometer, and the mode of levelling by its means.
5. Describe the aneroid barometer, and the mode of levelling by its means.
6. On a level piece of ground 635 yards in length, it is required to raise an embankment for a railway with a rise of 1 in 78. Draw a section on a scale of 100 yards to 1 inch for horizontal distances, and of 10 feet to 1 inch for vertical measurements; and explain what marks you would set up on the ground to guide the workmen.

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### ENGINEER ESTABLISHMENT.

Subject—Practical Engineering.

NAME the engineer under whom you have been a pupil, and the number of years articulated. Describe the nature of the works on which you have principally been engaged, and state in what branch of the profession you have had most practical experience.

#### *Roads.*

1. Describe the leading features and particulars of any of the important lines of communication in Europe, as, for example, the great roads over the Simplon, or St. Gothard, or the Holyhead Road; and explain the means adopted for obtaining easy gradients for drainage, and for preventing injury from floods, &c.
2. Give cross sections of a road, in side cutting, on level ground, through cutting, and on embankment.
3. Name the best description of stone for road metalling, and the best periods of the year for repairing roads.
4. State the number of cubic feet to a ton of granite, limestone, Bath stone, and Portland stone.
5. Give specification and estimate, adopting your own data, for one mile of road through level clay land; for one mile over rough mountain; and for one mile through side-cutting.

*Roofs.*

*Roofs.*

6. Make a design for a wrought-iron roof of 50 feet span for a railway station, giving working drawings, with transverse sections of rafters, struts, tye-rods, with dimensions figured on and in sufficient detail to enable a contractor to execute the work.

7. Give the particulars, dimensions, span, &c., of some of the largest roofs which have been constructed in iron and wood.

8. Describe the different substances employed for covering roofs, and give comparative estimate of the weight and expense per square yard.

9. Give the particulars, dimensions, span, and peculiarities of construction of the roofs over the station of the Great Western Railway at Bristol; the New Central Station at Birmingham; the Lime-street Station, Liverpool; or any other important examples of roof construction with which you are acquainted.

*Retaining Walls.*

10. Give design for retaining walls 20, 30, and 40 feet in height, the strata being wet plastic clay, and figure on the dimensions, batter, &c.

11. In terminating a viaduct in an embankment, state the circumstances which would guide you in adopting wing walls or arches.

*Foundations Under Water.*

12. Describe the different methods employed in forming foundations under water, and give some examples.

13. Mention the kind of timber most durable for works constantly under water, and not subjected alternately to air and moisture.

14. Mention the uses and applications of Mitchell's patent screw piles.

15. Describe the method employed by Mr. Brunel for forming the foundation for the centre pier of the Albert Bridge at Saltash.

*Bridges.*

16. Design a railway viaduct to cross a river 100 feet wide, greatest depth 30 feet, and height from surface of water to formation level 50 feet.

17. Give the dimensions, span, proportions, and peculiarities of some of the principal bridges which have been constructed in iron, timber, stone, wire, brick, &c., as, for example, the bridges over the Thames at London, the Seine at Paris, and also some of the most important aqueducts and viaducts.

18. State some of the circumstances which would guide you in adopting iron, stone, brick, timber, or wire, in the construction of bridges and viaducts.

19. Explain the principles of Bollman's iron suspension and trussed bridge erected at Harper's Ferry, on the Baltimore and Ohio Railway.

20. Give the spans of the largest bridges constructed in stone, cast-iron, wrought-iron, brick, timber, wire, &c., stating the form of the arch, the versed sine, the proportion which the span bears to the abutments or piers, and comparative cost per square yard of roadway.

*Irrigation.*

21. Describe the different methods employed for irrigating land, and the countries where irrigation is most employed.

*Buildings.*

22. Make a design for a railway station of simple construction to accommodate a town of 10,000 inhabitants; give ground plan, elevation, and sections, with dimensions figured on with sufficient detail to enable a builder to execute the work therefrom; and give an estimate and specification of the cost, adopting your own prices.

12 PAPERS :—ENGINEER'S ESTABLISHMENT (EAST INDIA).

23. Give the cost per mile of some of the most important railways constructed in the United Kingdom, on the Continent, in America, and in India.

24. In countries of vast extent, like America and India, where money bears a high rate of interest, and where economy in construction is of more importance than works of a very permanent character, describe the kind of railway and permanent way you would recommend, the form of rail, the weight of rail per yard, and describe the works generally. The railway being suitable either for locomotive power or cattle draft. The railway to be constructed at the lowest cost per mile, consistent with safety and economy in working. Give the names of any railways with which you are acquainted, as illustrating your views. Give an estimate and specification for one mile of the permanent way of such a railway as you would recommend, adopting the present price of iron, timber, &c.

25. Explain the different methods employed for setting out railway curves.

26. Give the weight per yard of the rails used on some of the principal railways in this country and abroad; and describe the form of rail, chair, mode of fishing the joints, kind of sleepers employed, and comparative cost.

*Locks.*

27. Draw a plan, elevation, and section, of a canal lock, with a lift of 6 feet, and figure on the dimensions.

*Dams.*

28. Design a dam for a river 60 feet in width, greatest depth of water 15 feet, the head of water required being 5 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 the precautions you would adopt to prevent leakage, and the nature of the foundations, the bed of the river being composed of gravel. Give a specification and estimate of the expense of such a work, adopting your own data.

*Miscellaneous.*

29. Give transverse sections of the best forms of girders of cast iron, wrought iron, and boiler plate iron, and state the results arrived at from the experiments of Mr. Eaton Hodgkinson and Mr. William Fairbairn.

30. Describe the various processes employed to preserve timber against decay, and against the ravages of insects, mentioning the names of those insects most destructive to timber.

EAST INDIA (CIVIL ENGINEERS'  
EXAMINATIONS).

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RETURNS of the Names of EXAMINERS appointed to examine the CANDIDATES who presented themselves on the 11th of JUNE last, and subsequent Days, 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.

(*Mr. Longfield.*)

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*Ordered, by The House of Commons, to be Printed,*  
*20 August 1860.*

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[*Price 6d.*]

566.

*Under 3 oz.*