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## EAST INDIA (EXAMINATIONS).

RETURN to an Address of the Honourable The House of Commons,  
dated 19 July 1859;—for,

“RETURNS of the Names of the EXAMINERS appointed to Examine the CANDIDATES who presented themselves, on the 10th day of May last, 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, Places of Education, and the Names of the CIVIL ENGINEERS to whom they were respectively articled Pupils for Three Years :”

“Of the MARKS which were assigned on each Subject to every Candidate, whether successful or otherwise :”

“And, of the EXAMINATION PAPERS on each Subject.”

India Office, }  
1 August 1859. }

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

### NAMES OF EXAMINERS.

Rev. Jonathan Cape, A.M., F.R.S., Professor, Military College, Addiscombe.

George Preston White, Esq., C.E.

Captain J. Ouchterlony, Madras Engineers, Professor, Military College, Addiscombe.

### ENGINEER ESTABLISHMENT.

NAMES of CANDIDATES in Order of Merit.	Age.	Place of Education.	Names of Civil Engineers to whom they were respectively Articled.	NUMBER OF MARKS ALLOTTED.				
				History and Geography.	Mathematics.	Civil Engineering.	Surveying and Levelling.	TOTAL.
<i>Successful :</i>								
Mr. W. W. Culcheth	19	No information was required of the Candidates on this head.	Messrs. Law & Blount	21	193	213	180	607
• " P. J. Flynn	21		Mr. F. Malcolmson	17	192	175	187	571
• " W. S. Howard	19		James Pilbrow	12	88	310	115	525
• " J. Hair	19		" Neil Robson	19	139	170	179	507
• " E. Martin	22		" — Martin	2	28	305	114	449
• " A. Brind	20		" H. Conybeare	35	46	273	81	435
• " F. D. Campbell	20		" Charles Greaves	26	161	80	160	427
• " A. Richardson	21		Messrs. Fox & Henderson	22	106	185	98	411
• " S. W. Nugent	20		Mr. Samuel Roberts	29	66	185	125	405
• " E. V. Vernon†	19		" J. Vernon	35	107	130	133	405
• " E. Compton	21		" G. W. Stevenson	35	88	150	129	402
• " H. Roberts†	21		{ Messrs. Beyer, Peacock & Co. }	-	139	149	112	400
• " C. J. Rodham	21		" Brassey & Co. - }	15	74	180	116	385
• " R. Tyndall	21		Mr. G. A. Dean	5	77	138	134	354
			" Samuel Roberts					
<i>Unsuccessful :</i>								
One Candidate	-	-	-	18	36	85	92	231

\* Although these candidates did not obtain the prescribed number of marks, they were appointed on the strong recommendation of the Examiners.  
† These candidates do not appear to have been regularly articled.

10 MAY 1859.

## ENGLISH AND INDIAN HISTORY AND GEOGRAPHY.

1. NAME the kings of the house of Stuart; state the period during which they sat on the English throne; also the causes of the introduction and rejection of their family.
2. To what leading events in English history are the terms Reformation, Rebellion, Restoration, and Revolution severally applied?
3. In what war was England engaged during the reign of Anne? Name the principal battles.
4. Mention the chief sea-ports on the south coast of England. From which does the overland mail start? Also trace its course to Aden.
5. Enumerate the British possessions in Asia.
6. Mention the principal rivers of British India; and give a brief sketch of the course of each.
7. Where are the following places situated,—Goa, Mooltan, Peshawur, Moulmein, and Galle?
8. Who were Hyder Ali and Tippoo Saib? and what was the end of the latter?
9. Where is the Punjaub? State anything you know respecting its inhabitants.
10. Who were the Pindarrees? and what was the great difference between them and the Mahrattas?

## EUCLID.

1. Define a superficies, a scalene triangle, and an oblong; and state when lines are said to be parallel.
2. To bisect a given straight line.  
Hence, from the vertex of a triangle, to draw to the base a straight line, which shall exceed the less of the two sides, as much as it is itself exceeded by the greater.
3. Any two sides of a triangle are together greater than the third side.  
Hence, prove that the difference of any two sides of a triangle is less than the third side.
4. Parallelograms on the same base, and between the same parallels, are equal to one another.  
If the two diagonals be equal, all the angles of the parallelograms are right angles.
5. To describe a square on a right line.
6. To describe a square equal to any number of given squares; and likewise a square equal to the difference between two given squares.
7. If a straight line be bisected, and produced to any point; the rectangle contained by the whole line thus produced, and the part of it produced, together with the square of half the line bisected, is equal to the square of the straight line which is made up of the half and the part produced.  
Hence, prove that the rectangle contained by the sum and the difference of two lines, is equal to the difference of their squares.
8. The angle at the centre of any circle is double of the angle at the circumference upon the same base, that is, upon the same part of the circumference.  
Hence show that the angle formed within a circle by the intersection of two chords, is the half of the angle at the centre, standing upon the sum of the intercepted arcs.
9. To

9. To bisect a given circumference, or a given arch of a circle.
10. In a right-angled triangle, if a perpendicular be drawn from the right angle to the base, the triangles on each side of it are similar to the whole triangle, and to each other.  
Hence, to divide a straight line into two parts, so that a given straight line shall be a mean proportional between them. Show the limits within which this problem can be done.
11. To find a fourth proportional to three given straight lines.  
Explain how this problem may be applied to the reduction of scales, plans, and maps.
12. To draw a straight plane perpendicular to a plane from a given point above it.

ALGEBRA.

1. Simplify the expressions :  

$$[(a^3 \times a^3 \div a^3)^2]^3, \quad \frac{a}{a+b} + \frac{b}{a-b}, \quad \text{and } x - a + y + \frac{a^2 - ay + y^2}{x+a}.$$
2. Multiply  $(a^3 - 3a^2b + 5ab^2 - 3b^3)$  by  $(a - 2b)$ ; and divide the result by  $(a^2 - 3ab + 2b^2)$ .  
Solve the equations :
3. 
$$x - \frac{1}{3} - \frac{2x}{3} - \frac{x}{4} + \frac{1}{4} = \frac{x}{5} - \frac{1}{5}.$$
4. 
$$\sqrt{x} - 1 = \frac{1}{\sqrt{x} - 1}.$$
5. 
$$\left. \begin{aligned} x + \frac{1}{y} &= 4 \\ y + \frac{1}{x} &= 1 \end{aligned} \right\}$$
6. Find the greatest common measure of  $x^4 - x^3 - 9x^2 + 7x + 14$ , and  $x^3 - 2x^2 - 5x - 6$ ;  
also the least common multiple of  $x^3 - a^3 - ax(x - a)$ ,  $x^2 - a^2$ , and  $(x + a)^2$ .
7. Extract the square root of  $\frac{x^2}{y^2} + \frac{y^2}{x^2} - \frac{x}{y} + \frac{y}{x} - 1\frac{1}{2}$ .
8. Sum the Arithmetical Progression  $\frac{4}{6}, \frac{5}{6}, \dots$  to 9 terms; and insert three Geometrical means between  $\frac{1}{8}$  and 32.
9. Write down the number of permutations of  $n$  things taken 4 together; and deduce from this expression the corresponding number of combinations.
10. Expand  $(2a^2 + 3b^2)^5$  by the Binomial Theorem.
11. A and B are travelling along the same road from the same place; A goes 9 miles in 2 hours, and B 16 miles in 3 hours, starting 1 hour later than A: where will B overtake A, and how long will each have travelled when they reach this point?
12. A mercer sold a piece of cloth for 24 l., and gained as much per cent. as the cloth cost him: what was the price of the cloth?

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

##### MECHANICS AND HYDROSTATICS.

1. Explain what is meant by the *Parallelogram of Forces*.  
*Ex.* Two forces which are equivalent to 30lbs. and 40lbs. act upon a point and are inclined to each other at an angle of  $90^\circ$ ; find the magnitude and direction of a third force which will keep the point at rest.
2. Prove the proposition for finding the resultant of two parallel forces acting in the same direction upon a rigid straight line.  
A weight of 200 lbs. is hung on a pole 4 feet long, the ends of which rest on the shoulders of two men; how much of this load is borne by each man, the weight hanging 6 inches from the middle?
3. Prove that if a body be placed upon a horizontal plane, it will be sustained or not according as the perpendicular to the horizon drawn through the centre of gravity falls within or without the base.  
Show also that the higher the centre of gravity of a body is, *cæteris paribus*, the more easily it is overturned.
4. Prove the method of finding the centre of gravity of any system of bodies considered as points from a given plane.
5. Prove that in the lever, the power and weight are in equilibrium; when acting to turn the lever in opposite directions, they are inversely as the perpendiculars from the fulcrum upon the directions of the forces.  
The arms of a bent lever, CA, CB, are equal, and make an angle at C of  $135^\circ$ . What weight placed at the extremity B will balance 6 lbs. suspended at A, CA being horizontal?
6. Find the relation between the power and weight on the inclined plane.  
A power of 5 lbs. acting parallel to a plane supports a weight of 10 lbs.; required the inclination of the plane to the horizon, and the pressure upon the plane.
7. Explain the principle of *virtual velocities*; and prove that this principle is true in a system of pulleys, where the same string passes round all the pulleys, and the parts of the string between the pulleys are parallel.
8. In a simple isosceles truss roof, it is required to calculate the tension of the tie-beam. Also show that the steeper the roof is, the less is the horizontal thrust.
9. In the equilibrium of an arch, find the relation between the weight of the arch, the horizontal thrust at the crown of the arch, and the pressure on the pier.
10. In the direct impact of two bodies, "action and reaction are equal and opposite," or the momentum gained by one body is equal to the momentum lost by the other. By what experiments is this proved?
11. If an imperfectly elastic body impinges upon an immoveable plane, to determine its motion after impact.
12. If a body be moved from a state of rest by a constant accelerating force, the space described from the beginning of the motion is as the square of the time.  
*Ex.* A heavy ball was observed to fall freely through 100 feet in the last second of time; required the height from which it fell.
13. Explain the principle of the governor of a steam-engine; and find the position of the slider, when the angular velocity is known.  
The length of the rods is two feet, and they revolve once a second; find the angle which the rods make with the vertical.
14. If materials be raised by means of the wheel and axle, to determine the accelerating force,—1st, when the weight of the wheel and axle is neglected, and, 2dly, when this weight is taken into consideration.
15. Explain

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15. Explain the fundamental property of fluids; and show by what experiments this may be demonstrated. Hence prove that the surface of every fluid at rest is horizontal.

16. The pressure of a fluid on any surface is equal to the weight of a column of 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.

What is the pressure against the base of a cone filled with fluid? Why does this differ from the *weight* of the fluid, and how is this difference explained?

17. When a body is either partly or wholly immersed in a fluid, it is pressed upwards by a force equal to the weight of the fluid displaced.

Explain how this principle is applied to finding the specific gravities of bodies.

18. Prove that the density of the air is proportional to the force that compresses it.

19. To determine the law by which the density and elasticity of the air diminish as the height above the surface of the earth increases; and hence explain how the heights of mountains may be determined by the barometer.

20. Explain the principles of the hydraulic press.

*Ex.* In raising the Britannia tubular bridge, the pressure communicated by two steam-engines was 9,000 lbs. on the square inch. The moveable piston was a cylinder 20 inches in diameter. Required the whole pressure supported by the piston, and the height of a column of water of the same base, equivalent to this pressure.

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ENGINEER ESTABLISHMENT.

Name of Candidate

Date

SUBJECT:—PRACTICAL ENGINEERING.

*Question 1.* Make a working drawing with the dimensions noted of a travelling crane, sufficiently strong to carry a weight of 10 tons.

2. Make a plan, elevation, and section, for a bridge to carry a road over a railway, in 30 feet cutting, the slopes being  $1\frac{1}{2}$  to 1.

3. Make an estimate and specification of the above.

4. Make a design for a bridge in a 30 feet embankment, to carry a railway over a river 50 feet wide, its greatest depth 10 feet.

5. Mention some of the uses and applications of the hydraulic ram.

6. Explain the nature, uses and application of Mitchell's screw piles, and mention under what circumstances you would recommend their employment.

7. Describe some of the methods employed for forming foundations under water.

8. Make a design for a retaining wall 25 feet high, in a stratum of plastic clay and figure on the dimensions and batter.

9. Explain the mode of setting out a railway curve with the chain only.

10. State the kind of permanent way you would recommend for a railway for ordinary passenger and goods traffic, giving the weight of rail per yard, and number of sleepers to the mile.

11. Make an estimate for a mile of such railway, including ballast, sleepers, fencing; adopting your own data.

12. Describe some of the peculiarities of a few of the most important viaducts

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ducts executed in stone, iron, brick, giving the proportion which the span bears to the piers.

13. Give the rule for calculating earthwork by the prismatic formula.
14. Draw out a general specification for the brickwork, ashlar rails, sleepers, &c., employed in the construction of a railway.
15. Explain the mode adopted by Mr. Brunel for laying the foundation of the centre pier of the Albert Bridge at Saltash.
16. Mention some of the circumstances which would principally guide you in adopting stone, brick, timber, or iron in constructing bridges and viaducts.
17. State under what circumstances you would use a suspension bridge in preference to any other kind of viaduct.
18. Design a wrought-iron roof 30 feet span and figure on the dimensions.
19. Describe some of the peculiarities of the roads over the Simplon and St. Gothard, and explain the mode adopted for obtaining easy gradients.
20. How is concrete made? and state some of its applications and uses.
21. State some of the cases when you would employ hoop-iron in brickwork.

In addition to the above questions, the Candidates were subjected to an oral examination, and were required to produce certified drawings and designs.

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ENGINEER ESTABLISHMENT.

Name of Candidate

Date




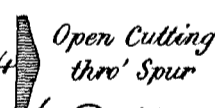

SUBJECT :—LAND SURVEYING.

*Question 1.* A perpendicular shaft is sunk 380 yards up the side of a hill, which slopes at an angle of  $26^{\circ} 30'$  with the horizon; and it is desired to connect with it an old adit or gallery, driven in horizontally from the foot of the hill on an irregular course. In order to ascertain in what direction to drive, so as to extend the adit up to the shaft I dialled or surveyed along its course with a circumferenter and chain, and the following were the results :

58 yards, $74^{\circ} 19'$ S. W. ⊙ 4	to end of adit. to lamp against solid rock at end of adit.
75 yards, $27^{\circ} 57'$ S. W. ⊙ 3	to ⊙ 4. to lamp at bend.
64 yards, $59^{\circ} 32'$ N. W. ⊙ 2	to ⊙ 3. to lamp at bend.
51 yards, $86^{\circ} 26'$ N. W. ⊙ 1	to ⊙ 2. to lamp placed at forward bend of adit. mouth, or entrance of adit.

I also took from the mouth of the adit (⊙ 1), the correct bearing of a flag placed at the mouth of the shaft on the hill side, and found it to be  $87^{\circ} 30'$  S. W.  
Required

*Questioning entries extracted from a Field Book.  
in Ink by the Candidate.*

6	400 yards	15	
	200 "	10	Forest
	12° N.E.	15	
	⊙ 10		to sign post of Inn at foot of hill
6	450 yards		
20	300 "		
	27° 10' N.E.		to ⊙ 10 by road
	⊙ 9		
	368 yards	4	
to Obelisk	250 "	26	Road
to single	130 "	12	
			to Obelisk on hill
	48° S.E.		to ⊙ 9 by road on road
	⊙ 8		
	415 yards.	12	
	316 "	14	Road Winds down hill
	120 "	16	
	24° N.E.		to ⊙ 8 down slope
	⊙ 7		
to single	324 yards	4	
	80° N.E.		Open Cutting thro' Spur to ⊙ 7
	4° N.W.		
	7° S.E.		bearing along range on summit of hill range
	⊙ 6		
	525 yards	12	
	380 "	30	Road
	200 "	45	
	23° N.E.		to ⊙ 6 on summit
	⊙ 5		



Required the bearing on which the adit or gallery must be prolonged to reach the shaft, and the distance to be excavated.

2. A railway tunnel has to be constructed through a spur of a range of hills, and to expedite the operation, as well as for the purpose of ventilation, three shafts are to be sunk from the surface of the spur at equal distances apart, so as to cut the line of the intended tunnel, which is to have a rise of 1 in 100.

Having the necessary instruments at your disposal, describe the course you would adopt to ascertain the points at which the sinking of the shafts should be commenced, and the depths at which you would begin to drive outwards to form the tunnel, as also to ascertain the proper direction to drive in, so that the excavation, which would thus be commenced at eight different points (viz. at either extremity of the tunnel, and outwards from each of the three shafts), should present one continuous line. Draw an illustrative diagram, and assume any data which may appear desirable.

3. (See Diagram.)

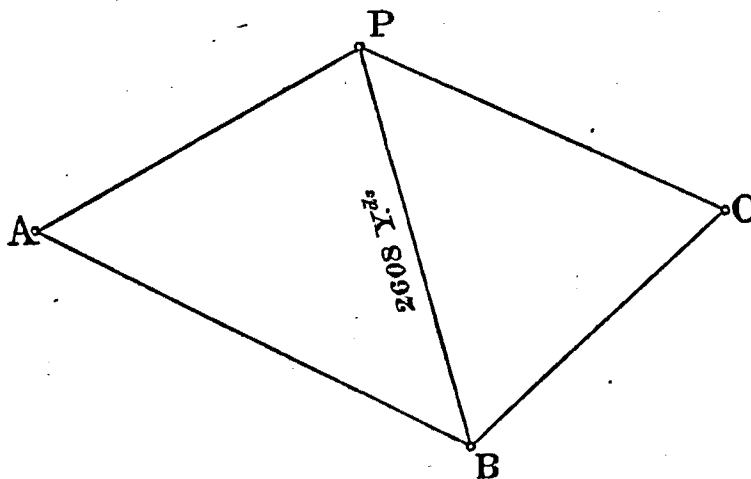
ENGINEER ESTABLISHMENT.

Name of Candidate

Date

SUBJECT:—LEVELLING.

Question 1. It is desired to ascertain if water can be brought from a lake at A, to supply barracks erected at C, from which the point A is not visible.



The nature of the intervening ground rendering the ordinary process of levelling with the spirit level and staves too tedious, a theodolite is employed. P and B are trigonometrical hill stations of a recent survey, in the course of which the distance P B has been computed, and found to be 2,608 yards. The theodolite is set up at A B and C, and the following angles are measured :

Station.	Telescope directed on	Readings in Azimuth.	Readings in Altitude.
A	P	Zero.	25° 30' elevation.
	B	77° 25'	
B	A	Zero.	
	P	40° 30'	
	C	79° 55'	
C	B	Zero.	27° 15' elevation.
	P	93° 45'	

From the above data it is required to compute the difference of level between A and C.

2. Describe the ordinary spirit level (Dumpey or Y), its adjustments, and the mode of effecting them.

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3. Draw a section of ground according to the annexed extract from a field book, employing—

a scale of 200 yards to 1 inch for horizontal measurements,  
and ditto 10 feet to 1 inch for vertical ditto.

The "reduced levels" are to be filled in, in ink, in the column left blank.

Number of Station.	Back Sight.		Forward Sight.		Reduced Levels, in Feet.	REMARKS.
	Distance, in Yards.	Reading on Staff, in Feet.	Reading on Staff, in Feet.	Distance, in Yards.		
1	231	7.21 (No. 1.)	11.38	195	50.00* —	* Datum line assumed 50 feet below the first back staff.
2	156	0.76	7.19	184	—	
3	104	9.41	3.87	192	—	
4	212	10.31	6.22	163	—	
5	189	6.27	11.04	144	—	
6	217	2.36	4.14 (No. 12.)	171	—	
Difference of level between staff No. 1 and No. 12 - - -					+	feet (?)

+ To be filled in by the Candidate.

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Name of Candidate

Date

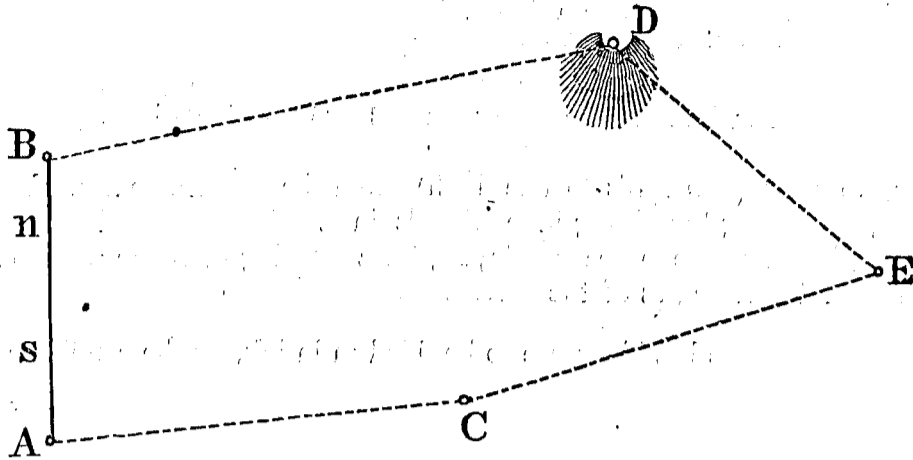
SUBJECT:—TRIGONOMETRICAL SURVEYING.

Question 1. Desiring to make an isolated survey of a tract of country, a base A B was carefully measured on slightly undulating ground, the measurements being as follows :

A to S 1,140 yards, on a rise of 2° 26',  
S to N 2,380 " " a fall of 1° 52'  
N to B 1,551 " " a level.

Three stations were then fixed upon C, D and E, of which C and E were marked by poles on nearly level ground, while D was noted by a solitary tree on an inaccessible rock, rising 155 feet above the surrounding plain. Angles were then measured with a theodolite from A, B, C and E, as follows :—

Station.	Telescope directed on	Reading of Vernier of Horizontal Limb.
A	B	Zero.
	D	41° 11' 20"
	C	72° 18' 10"
B	D	Zero.
	C	58° 14' 35"
	A	111° 30' 45"
C	D	Zero.
	E	42° 18' 40"
E	C	Zero.
	D	51° 7' 10"



Required the correct length of the sides D E and C E, and the computation of the intermediate triangulation.

2. At sea, in a large steamer, measuring 282 feet in length on the upper deck, two rocks were discovered ahead, their summits just appearing above water, apparently about 150 yards apart. Desiring to ascertain the correct distance between them, the captain steamed on as near as safety would permit, and brought to when between 400 and 500 yards distant from the danger. He and his chief mate then made angular observations with sextants, by means of which the distance was correctly ascertained.

Describe the method adopted: assume angles supposed to have been measured, and compute the distance between the rocks accordingly.

3. Two buoys, m and n, have been anchored at some distance apart off the head of a straight pier or jetty, running perpendicularly out from a line of coast, and 305 yards in length. Wishing to ascertain their exact distance apart, I measured the requisite angles from the seaward extremity (A) of the pier, and also from the shore extremity (B) as follows:—

STATION.	Telescope directed on	Reading of Vernier of Horizontal Limb.	REMARKS.
A	Magnetic North.	Zero.	
	m	69° 20'	The westernmost buoy.
	n	99° 58'	The easternmost buoy.
B	B	199° 10'	Shore extremity of the pier.
	Magnetic North.	Zero.	
	A	19° 10'	Shore extremity of the pier.
	m	41° 55'	Buoy.
	n	66° 18'	Buoy.

From the above data it is required to compute the relative distances of the buoys from either extremity of the pier, the distance m, n, at which they are moored apart, and the distance of each from the nearest opposite point of the shore line.

*N. B.*—A diagram is to be drawn to scale (100 yards to an inch), exhibiting the correct position of the buoys, pier, and coast, with reference to the magnetic meridian.

4. A pagoda, built on an isolated rock, is situated near the middle of a deep and rapid river, whose course is due north and south, crossed by a bridge 1,850 yards in length. The eastern abutment of the bridge is 1,690 yards distant from the pagoda, and the western abutment 1,274 yards. Proceeding along the bank of the river from the western abutment, I measured carefully



ADMISSION TO ENGINEER'S ESTABLISHMENT (EAST INDIA). 11

the operations you would undertake for this purpose, and a list of the instruments and appliances which you would require, to enable you to carry them on.

7. Describe the principal adjustments of the theodolite, and the method by which they are effected.

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(True copies.)

*W. T. Thornton*, Secretary,  
Public Works Department.

India Office,  
1 August 1859.

EAST INDIA (EXAMINATIONS).

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RETURNS of the Names of EXAMINERS appointed to examine the CANDIDATES who presented themselves on the 10th of May last 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 on each Subject.

(*Mr. Longfield.*)

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*Ordered, by The House of Commons, to be Printed,  
2 August 1859.*

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