

EAST INDIA (ENGINEERS' ESTABLISHMENT, &c.)

RETURN to an Address of the Honourable The House of Commons,
dated 30 May 1864;—for,

- “ RETURNS specifying the Names of EXAMINERS appointed to examine the CANDIDATES who presented themselves, since the last Return, for Admission to the ENGINEERS' ESTABLISHMENT and PUBLIC WORKS DEPARTMENT in *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 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. 473, of Session 1863).”

India Office, }
16 June 1864. }

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

(*Mr. Adam.*)

Ordered, by The House of Commons, to be Printed,
17 June 1864.

CIVIL ENGINEER EXAMINATIONS.

NAMES OF EXAMINERS.

Rev. Jonathan Cape, A. M., F. R. S.
Major General A. G. Goodwyn, late R. E.
George Preston White, Esq., C. E.

SUCCESSFUL CANDIDATES in order of Merit.

NAME.	AGE.	Place of Education.	Engineer to whom Articled, or under whom Served.
1. Mr. W. McCleery -	20	Queen's College, Belfast -	R. Young, Esq., Belfast.
2. „ W. Quarry -	22	Queen's College, Cork -	W. Bull, Esq., Cork and Youghal Railway.
3. „ A. B. Gatherer	18	Dollar Institution - -	J. Sang, Esq., Kirkaldy.
4. „ R. C. Anderson	19	Dollar Institution - -	R. Thornton, Esq., Edinburgh.
5. „ R. H. Tulloh -	20	Dollar Institution - -	R. Thornton, Esq., Edinburgh.
6. „ R. D. Falkiner -	21	Queen's College, Galway	S. Roberts, Esq., Galway.
7. „ J. M. Algie -	22	Trinity College, Dublin -	{ W. R. Le Fanu, Esq., Dublin, Messrs. Cotton & Flemyng, Dublin.
8. „ W. F. Heath -	21	Not stated - - -	J. C. Burne, Esq., Dublin.
9. „ C. H. Ringwood	22	Trinity College, Dublin -	J. Price, Esq., Midland Great Western Railway, Ireland.
10. „ H. W. Hughes -	18	Not stated - - -	J. Hughes, Esq., Londonderry.

NUMBER of MARKS assigned to each Candidate.

	Mathematics.	Civil Engineering.	Surveying and Levelling.	TOTAL.		Mathematics.	Civil Engineering.	Surveying and Levelling.	TOTAL.
1.	272	330	189	791	11	208	260	140	608
2.	339	320	127	786	12	315	300	93	708
3.	308	330	141	779	13	227	235	123	585
4.	311	320	139	770	14	165	265	96	526
5.	320	285	142	747	15	129	290	102	521
6.	285	295	163	743	16	130	265	62	457
7.	258	335	132	725	17	78	230	52	360
8.	228	320	148	696	18	91	190	73	354
9.	253	300	100	653	19	57	195	7	259
10.	210	325	115	650					

PUBLIC WORKS DEPARTMENT—INDIA.

CIVIL ENGINEER ESTABLISHMENT.

EXAMINATION PAPERS for June 1864.

June 1864.

EUCLID.—Rev. *J. Cape.*

1. Define an *angle*, a *right angle*, an *acute angled triangle*, a *sector of a circle*, and a *circumscribed figure about a circle*.

2. To draw a straight line perpendicular to a given straight line of an unlimited length, from a given point without it.

If two circles cut each other, the line joining their point of intersection is bisected at right angles by the line joining their centres.

3. The perpendicular is the shortest line that can be drawn from a given point to a given straight line; and of any two oblique lines, that which is nearer to the perpendicular is less than the one which is more remote.

4. To describe a parallelogram that shall be equal to a given triangle, and have one of its angles equal to a given rectilineal angle.

5. All the exterior angles of any rectilineal figure are equal to four right angles.

6. If all the alternate sides of a polygon meet when produced outwards, the angles formed by these lines, together with eight right angles, are equal to twice as many right angles as the figure has sides.

7. If a straight line be divided into any two parts, the squares of the whole line, and of one of the parts, are equal to twice the rectangle contained by the whole and that part, together with the square of the other part.

Hence show that the squares of any two unequal straight lines are together greater than twice the rectangle contained by those lines.

8. If a straight line touch a circle, and from the point of contact a straight line be drawn, cutting the circle, the angles which this line makes with the line touching the circle shall be equal to the angles which are in the alternate segments of the circle.

9. The angle formed within a circle by the intersection of two chords, *AB*, *CD*, is measured by half the sum of the intercepted arcs *AC*, *BD*.

10. To inscribe a circle in a given equilateral and equiangular pentagon, *ABCDE*. Prove also, if the diagonals be drawn, that the angles *ABE*, *BCA*, *CDB*, *DEC*, *EAD* are together equal to two right angles.

11. The rectangle contained by the diagonals of a quadrilateral figure inscribed in a circle, is equal to both the rectangles contained by its opposite sides.

12. If two straight lines be cut by parallel planes, they will be cut in the same ratio.

4 PAPERS RELATING TO EXAMINATION OF CANDIDATES FOR

June 1864.

ARITHMETIC, TRIGONOMETRY, and MENSURATION.—Rev. J. Cape.

1. Divide the sum of $3\frac{1}{3}$ and $9\frac{1}{8}$ by their difference; and multiply the quotient by $\frac{2}{7}$ of $4\frac{1}{3}$.

2. Divide 167·5 by ·00536; and also ·04181 by 46·25.

3. Find the value of

$$\frac{6\frac{3}{4}}{1\frac{6}{10}} \text{ of a ton} + (2 \text{ cwt. } 3 \text{ qrs.}) + (5 \text{ cwt. } 2 \text{ qrs. } 14 \text{ lbs.}) \div 1\frac{2}{3}.$$

4. A person bought sugar at 3 guineas per cwt., and sold it again at $10\frac{1}{2}$ d. per lb.; how much did he gain per cent., supposing the loss to be 4 lbs. per cwt.?

5. If 27 men can do a piece of work in 14 days, working 10 hours a day, how many hours a day must 24 boys work, in order to complete the same in 45 days,—the work of a boy being half that of a man?

6. Required the compound interest on 342 l. 10 s. for 3 years, at $3\frac{1}{2}$ per cent. per annum.

7. Define *complement* and *supplement* of an arc; *cosine*, *tangent*, and *secant* of an arc.

8. The natural sine of an arc being ·6, it is required to find the natural cosine, versed sine, tangent, and secant of that arc.

9. Find from the tables the following quantities:—

(α). Logarithm of ·0345678.

(β). Number corresponding to logarithm 2·765432 to six places of significant figures.

(γ). Log. cosine of $66^\circ 40' 40''$.

(δ). Arc to log. cotangent 9·123456 to the nearest second.

10. Prove the proposition by which the angles at the base of a triangle can be found, when the two sides and the included angle are given.

11. Having given the side $AB = 168$, the side $AC = 96$, and the angle $A = 128^\circ 4'$; to find the other angles and the base.

12. From the top of a hill I observed two milestones in the same direction on level ground; the depression below the horizontal line of the nearest was $14^\circ 3'$, and that of the other $3^\circ 56'$; required the height of the hill.

13. How many acres, roods, and perches are contained in a parallelogram whose two adjacent sides are 625 yards, and 750 yards, and the included angle = 30° ?

14. If the equatorial diameter of the earth be 7924·9 miles, what is the length of a degree of the equator?

15. Required the content and the convex surface of a right cone, the radius of the base being 40 feet, and the perpendicular height 30 feet.

16. Required

16. Required the number of cubic yards which were cut out of a canal, the areas of five transverse sections being

586·2; 624·4; 710; 720·2; 651·4 square feet respectively; and the common distance between two transverse sections being 50 feet.

17. A cask is composed of two equal conic frustrums joined together at their bases; how many imperial gallons will it hold, supposing that the bung diameter is 28 inches, the head diameter 20 inches, and length 40 inches?

[Note.—The imperial gallon = 277·3 cubic inches, nearly.]

18. It is required to raise a bowling-green, which is 300 feet long, and 200 feet broad, one foot higher, by means of the earth to be dug out of a ditch that goes round it; to what depth must the ditch be dug, supposing its breadth to be everywhere 8 feet?

June 1864.

ALGEBRA.—Rev. J. Cape.

1. Multiply $x^3 + x + x^{-3} + x^{-1}$ by $x^3 - x + x^{-3} - x^{-1}$; and divide $-2x^5y^{-3} + 17x^6y^{-4} - 5x^7 - 24x^8y^4$ by $-x^2y^{-5} + 7x^3y^{-1} + 8x^4y^3$.

2. Solve the equations:

$$(a) \quad \frac{x-7}{x+7} = \frac{2x-15}{2x-6} - \frac{1}{2(x+7)}$$

$$(b) \quad \sqrt{x} + \sqrt{[a - \sqrt{ax + x^2}]} = \sqrt{a}$$

3. A messenger starts on an errand at the rate of 4 miles an hour; another is sent $1\frac{1}{2}$ hours after to overtake him, walking at the rate of $4\frac{3}{4}$ miles an hour; at what distance will he overtake him?

4. Solve the simultaneous equations:

$$(a) \quad x - \frac{y-2}{7} = 5, \text{ and } 4y - \frac{x+10}{3} = 3.$$

$$(b) \quad \begin{cases} 5v - 2x = 34, & 2v - x + 8z = 20. \\ 3y - 72 = 11, & 3v + 4x - 5y + 6z = 38. \end{cases}$$

5. A number consists of 3 figures or digits. The second digit is an arithmetic mean between the first and third; and 5 times the second digit exceeds 3 times the third digit by 7. Also, if 198 be added to the number, the digits will be inverted.

6. Solve the equations:

$$(a) \quad x^2 - 4x = 6\sqrt{x^2 - 4x + 13} - 18.$$

$$(b) \quad x^2 + 2xy - 3y^2 = 17; \quad 4x^2 - 5y^2 = 20.$$

7. A person bought a number of sheep which cost him £. 40, out of which he reserved 5, and sold the remainder for £. 45, gaining 4s. a head by them. How many sheep did he buy, and what was the price of each?

8. Reduce to their simplest form:

$$\sqrt{\frac{8}{27}} - \sqrt{\frac{1}{6}}; \text{ and } \sqrt[3]{\frac{2}{3}} - \sqrt[3]{\frac{9}{32}};$$

$$x\sqrt{12a^2x} + 2a\sqrt{27x^3} + 3\sqrt{48a^2x^3} - 20ax\sqrt{3x}.$$

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9. Find the cube of $2\sqrt{a} + 3\sqrt[3]{x}$, and the cube root of $\frac{1}{8}\sqrt{2xy^3}$.

10. Prove the proposition for finding the sum of a series of quantities in arithmetical progression.

Find the sum of the series 1, 3, 5, 7, &c. to n terms.

11. Find two geometric means between $\frac{1}{2}$ and 32; and find the sum of the series $\frac{1}{2} + \frac{1}{2} + \frac{1}{2} + \&c.$ continued to 8 terms, and also in *infinitum*.

12. Expand $x - \frac{1}{x}$ to the ninth power by the binomial theorem.

June 1864.

MECHANICS AND HYDROSTATICS.—Rev. J. Cape.

1. Prove the proposition for finding the resultant of two parallel forces acting in the same direction upon a rigid straight line.

Ex. Two parallel forces, 3 and 5, act on a rigid line at a distance of 12 inches; required the magnitude and position of a third force which will keep them at rest.

2. A weight of 100 lbs. suspended freely from a fixed point A , is drawn aside from the vertical, through an angle of 30° by a force P acting horizontally; determine this force P , and the pressure on A .

3. If a body be placed upon a horizontal plane it will be sustained or not, according as the perpendicular to the horizon drawn through its centre of gravity falls within or without the base.

The higher the centre of gravity is, *cæteris paribus*, the more easily it is overturned.

4. Seven equal bodies, considered as points, are placed at seven of the angles of a regular octagon; required the distance of centre of gravity from the remaining angle.

5. In any compound lever, the power and weight are in equilibrium, when they are to each other as the continual product of the alternate arms commencing from the weight, to the continual product of the alternate arms commencing from the power; the arms being supposed to act perpendicularly upon each other.

Explain what is meant by the *principle of virtual velocities*, and prove that it is true in the compound lever.

6. When a loaded beam AC is supported by a strut BD , to determine the strains at the points of support A and B .

7. Find the pressure exerted to overturn the pier of an arch.

8. Show how the value of the co-efficient of friction may be determined by experiment.

9. When two bodies impinge upon each other directly with given velocities, and the force of compression is to the force of restitution in a given ratio, it is required to determine their velocity after impact.

10. The

10. The weights of *A* and *B* are 6 and 10 lbs., and their velocities before impact are 7 and 9 feet per second in opposite directions; required their velocities after impact: 1st. When the bodies are inelastic; 2d. When they are perfectly elastic; 3d. When the force of elasticity is $\frac{1}{2}$ of the force of compression.

11. To find the accelerating force when a heavy body hanging freely draws another up an inclined plane.

Ex. A weight of 10 lbs. hanging freely draws another of 12 lbs. up a plane inclined to the horizon at an angle of 30° ; how far will the latter body ascend in 12 seconds?

12. Find the number of vibrations which a given pendulum will lose in a day when the force of gravity is diminished.

Ex. A pendulum which vibrates seconds is carried to the top of a mountain 2 miles high: how many seconds will it lose in 24 hours, supposing the radius of the earth to be 4,000 miles?

13. An equestrian standing upon a horse gallops in a ring 30 feet in diameter at the rate of 10 miles an hour; required the angle at which the horse and rider must be inclined to the horizon.

14. Explain the uses and advantages of the *Fly-wheel*; and find the position of the crank corresponding to its maximum and minimum velocity, the force acting in one direction only.

15. 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.

Ex. Compare the pressure against the upright surface of a cylinder filled with fluid with the pressure on the base.

16. When a body is weighed in water, the weight lost is equal to the weight of an equal bulk of fluid.

17. Explain the method of finding the specific gravity of a solid which is lighter than its bulk of water.

Ex. A piece of elm weighs 15 lbs. in air, and when a piece of copper which weighs 16 lbs. in water is affixed to it, the compound body weighs 6 lbs. in water; required the specific gravity of the elm.

18. If a body float in a fluid, to determine when the equilibrium is *stable*, *unstable*, or *indifferent*.

Explain the meaning of these terms.

19. Show how the heights of mountains may be found by the barometer.

20. Explain the principle of the diving bell; and supposing that it is a cylinder and let down into the sea to the depth of 100 feet, how high would the water rise within it?

[*Note.* Specific gravity of sea water = 1.026; and the height of the barometer = 30 inches.]

8 PAPERS RELATING TO EXAMINATION OF CANDIDATES FOR

EXAMINATION PAPERS for Competitive Examination of Candidates for Appointments in the Engineer Establishment of the Department of Public Works in India, held at the India Office, London, in June 1864.

George Preston White, C.E., Examiner.

[*Note.*—You are particularly 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 in which free-hand sketches or diagrams are used to illustrate the subject, it is requested that they may be carefully executed, in order to show the Candidate's proficiency 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 *visá 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.

RAILWAY ESTIMATES.

1. Calculate the quantity of earthwork in the accompanying Table; explain the different modes of calculating earthwork, how the Tab. Numb. is obtained; and give the names of Standard Books of Tables used to facilitate the calculation of earthwork.

Cuttings.

Base 30 feet. Slope $1\frac{1}{2}$ to 1.

Number on Section.	Depths.		Lengths in Links.	Tab. Numb.	Cont. C. Yds.	Total in C. Yds.	Price.	£. s. d.
1	0	3	5.00	1.83				
"	3	12	10.00	11.83				
"	12	12	25.00	21.33				
"	12	13	20.00	22.57				
"	13	8	25.00	17.91				
"	8	0	10.00	5.63				

Embankments.

Base 30 feet. Slope $1\frac{1}{2}$ to 1.

Number on Section.	Depths.		Lengths in Links.	Tab. Numb.	Cont. C. Yds.	Total in C. Yds.	Price.	£. s. d.
1	0	7	10.00	4.80				
"	7	6	10.00	9.57				
"	6	17	10.00	20.69				
"	17	0	17.50	14.80				
2	0	8	17.50	5.63				
"	8	5	14.00	9.61				
"	5	0	8.00	3.24				

RAILWAY ESTIMATES.

2. Fill up the prices and amount in the accompanying Table for a Railway Estimate, and state when and at what distances usually it becomes desirable to throw stuff to spoil, and use side cutting.

Base, 30 feet. Slopes, 1½ to 1.

Number on Section.	Contents in Cube Yards.	Material.	Where taken to.	Average Lead in Chains.	Price per Cube Yard.	Amount.
1	46·668	Blue clay -	{No. 1 Bank and sub- sidence - -}	60 chains		£. s. d.
"	20·000	- - -	{No. 2 Bank and sub- sidence - -}	50 "		
"	36·000	- - -	{Stuff for burning into ballast for 3 miles}	80 "		
"	4·000	Blue clay -	{To widen Nos. 1 and 2 banks, or to spoil}	40 "		
					£.	

3. Make sketches of the undermentioned bridges, culverts and cottage, in sufficient detail to enable you to take out the quantities; fill up the prices, adopting your own data; and carry out the amounts in the accompanying columns, for a Railway Estimate.

No.	Description.	Road.	Span.	Quantity.	Price.	Amount.	Total Amount.
1	Public road bridge, askew } < 70°, at 4 miles 5 fur. in 20 ft. embankment - }	30	20			£. s. d.	£. s. d.
	Brickwork in bridge -						
	Stonework in ditto -						
	Backing up bridge, tem- porary road, culverts under roadway, &c., and metalling under bridge }						
2	4 feet culvert at 4 miles } 6½ fur. in 31 feet em- bankment - - - }						
3	Parish road bridge in 31 } feet embankment, at 4 miles 7 fur. - - }	30	15				
	Brickwork in bridge -						
	Backing up bridge cul- verts, metalling under roadway, &c. &c. - }						
4	Parish road level crossing } in 4½ feet cutting, at 5 miles 1 fur., including gates, culverts and cot- tage - - - }						
	Excavated approach -						
	Metalling, &c. - -						
	Single fencing - -						
						£.	

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RAILWAY ESTIMATES.

4. Fill up the quantities and make an estimate, giving your own prices, for one mile of double railway.

	£.	s.	d.	£.	s.	d.
Tons of rails, 75 lbs. to the yard - - - - at						
Tons of chairs - - - - - "						
Sleepers - - - - - "						
Cube yards of ballast - - - - - "						
Lineal yards double road laying, including pins and keys "						
Lineal yards double 4-rail fencing, including quick mound and ditch - - - - - "						
Field gates and making good fences, say - - - -						
Trespass and compensation for damage by carting - - -						
	£.					

Roofs.

5. Explain the objects of the following parts of a roof, viz., king post, queen post, tie beam, straining beam, rafters, purlins, braces, ridge piece, struts, &c.

6. Give the names of some remarkable examples of roofs in wood and iron, stating the span.

Irrigation.

7. In carrying out works of irrigation in tropical countries, state what are the chief circumstances requiring attention.

8. State what has been the average cost per acre to irrigate land in Piedmont, Lombardy, and India; and what is the average return on money thus invested, and the increase of produce due to irrigation.

9. Describe the different modes employed to irrigate land. Name the crops most requiring irrigation, specifying which require complete and which partial irrigation, and the length of time and seasons of the year when water is most required.

10. What is the maximum and minimum gradient per mile you would recommend for the main canals in works of irrigation?

Miscellaneous Subjects.

11. Describe the different methods in practice for making foundations under water. State the comparative advantages of the different systems, and make free-hand sketches to illustrate the subject.

12. State which are the best and which are the most difficult soils to form foundations on, and under what circumstances sand becomes a good foundation.

13. Make a free-hand design for a centre, of simple construction, for a brick semicircular arch of 25 feet span.

14. Explain the objects of the following parts of a steam-engine, viz.: the throttle valve; the governor; the fly wheel; the parallel motion; the sun and planet motion; and the four-way cock; and illustrate the subject with free-hand sketches.

15. In what strata is coal, iron, lead, copper, tin, fire-clay most commonly found? What are the surface indications of the existence of minerals?

16. How is pig-iron, wrought-iron, and steel manufactured; and what is the object of employing the hot blast? Give the letters or marks used in the trade and in specifications to denote the different qualities of iron.

17. Describe the materials employed in the manufacture of bricks; the mode of manufacturing and burning bricks; the names of the different qualities; and what constitutes good bricks.

18. Give

18. Give the names of standard professional works of reference on the following subjects :—

Architecture.	Lighthouses.
Bridges of brick, stone, timber, cast and wrought-iron, and wire.	Limes, mortars, and cements.
Building materials.	Masonry and stone-cutting.
Carpentry.	Mining.
Canals of navigation and irrigation.	Machinery.
Drainage.	Preserving timber from dry-rot and decay.
Engineering biography.	Road-making.
Engineering reports.	Railways.
Embanking land from the sea and from rivers.	Surveying.
Foundations.	Specifications.
Harbours.	Strength of materials.
Iron (manufacture of).	Steam engine, locomotive and stationary.
India, reports on public works, and works of topography.	Tunnelling.
Law of contracts.	Tables for earthwork, quantities, and to facilitate calculations, &c.
	Water supply to towns.

19. Explain the meaning of the following terms, and illustrate the subject by free-hand sketches :—Abutment, adit level, ashlar, backing, batter, bay, bond, bressummer, buttress, caisson, camber, cantalever, collar beam conduits, coping, cornice, counterforts, discharging arch, extrados, intrados, fascines, façade, flying buttress, footings, gable, groin, groined arches, grillage, grout, hammer-beam, headers, hip roof, invert, joggle joint, lewis, neutral axis, pediment, pilaster, pontoon, puddling, purlins, puzzolana, quoins, rafters, retaining walls, ruling gradient, scantling, scarfing, soffit, spandrel, strut, templet, tensile strain, tie-beam, torsion, truss, under-pinning, wire gauge, water shed, spigot, and faucet joint.

SURVEYING.

EXAMINER—Major General *A. G. Goodwyn.*

1. Plot a fragment of survey in accordance with the following field book, on any scale not less than 400 feet, or greater than 350 feet to 1 inch. On the former scale, the plan will measure in its greatest dimensions about 12 inches by 10; on the latter scale, it may still appear conveniently on a sheet of foolscap. The meridian line may advantageously be arranged so that the first bearing be parallel to the long side of the opened sheet. On the former scale, the starting-point will best be at the lower left-hand corner of the paper, three inches from the bottom, and the same distance from the side. In the field book, the angles are mostly taken with a theodolite.

The Plan is to be headed as follows :

SURVEY OF GROUND

in the vicinity of

AYLESFORD.

It should be completed with a meridian line and with a scale, and should be inked in.

Spare time may advantageously be employed in giving finish to the plan, as from this work judgment will chiefly be formed of ability to draw similar plans; but it is not *essential* that the drawing should be complete at the expiration of the sitting, although the work on it must then altogether terminate.

N.B.—In all the work handed in, in this department, candidates should bear in mind, that whilst time will be wasted in working with *microscopic* accuracy, practical accuracy, especially in essentials, will earn higher credit than rapidity of work, valuable though that is.

2. Draw a field bounded by straight lines, in the shape of an irregular star of not less than five points, and with a parallel ruler reduce the figure geometrically,

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trically, either to a quadrilateral or triangle, facilitating the calculation of its area. Number any new lines you draw, in order, 1, 2, 3, 4, &c.

Also state how you would make a correct plan of such a field with a chain only, or with a chain and any simple implement for laying off right angles.

3. Accompanying is a sketch of ground of which it is supposed that a trigonometrical survey has to be constructed. The cultivable land may be taken as that level, or nearly so; for its survey accuracy is requisite, as also for the courses of roads and rivers as far as they lie in the plains; for the hills, it will suffice to fix trigonometrically the prominent points; the details here need less accuracy.

The lithographed plan may be lettered and drawn over as necessary.

(a) Draw in red ink a base line and scheme of triangulation; but such lines only as represent observations most to be relied on should appear.

(b) Calculate the surface drained by the Ranipoor River, as far as and no further than that surface is included within the *straight* lines bounding the sketch.

(c) State generally what system you would pursue in sketching these or other hills, supposing them to be uncleared or waste land.

(d) Detail the lines you would traverse with theodolite and chain.

(e) Sketch freely, as a specimen of how you *can* sketch hilly ground, the whole or any portion of the small range on the south side of the diagram; either the vertical or horizontal style may be adopted. The copy should be either of the same size as, or in proportion to, the original. Proportional accuracy will here suffice.

4. In a country in the northern hemisphere, on a long clear night, and having a theodolite, state how the variation of the compass may be ascertained.

LEVELLING, SURVEYING, and GEOMETRICAL DRAWING.

EXAMINER—Major General A. G. Goodwyn.

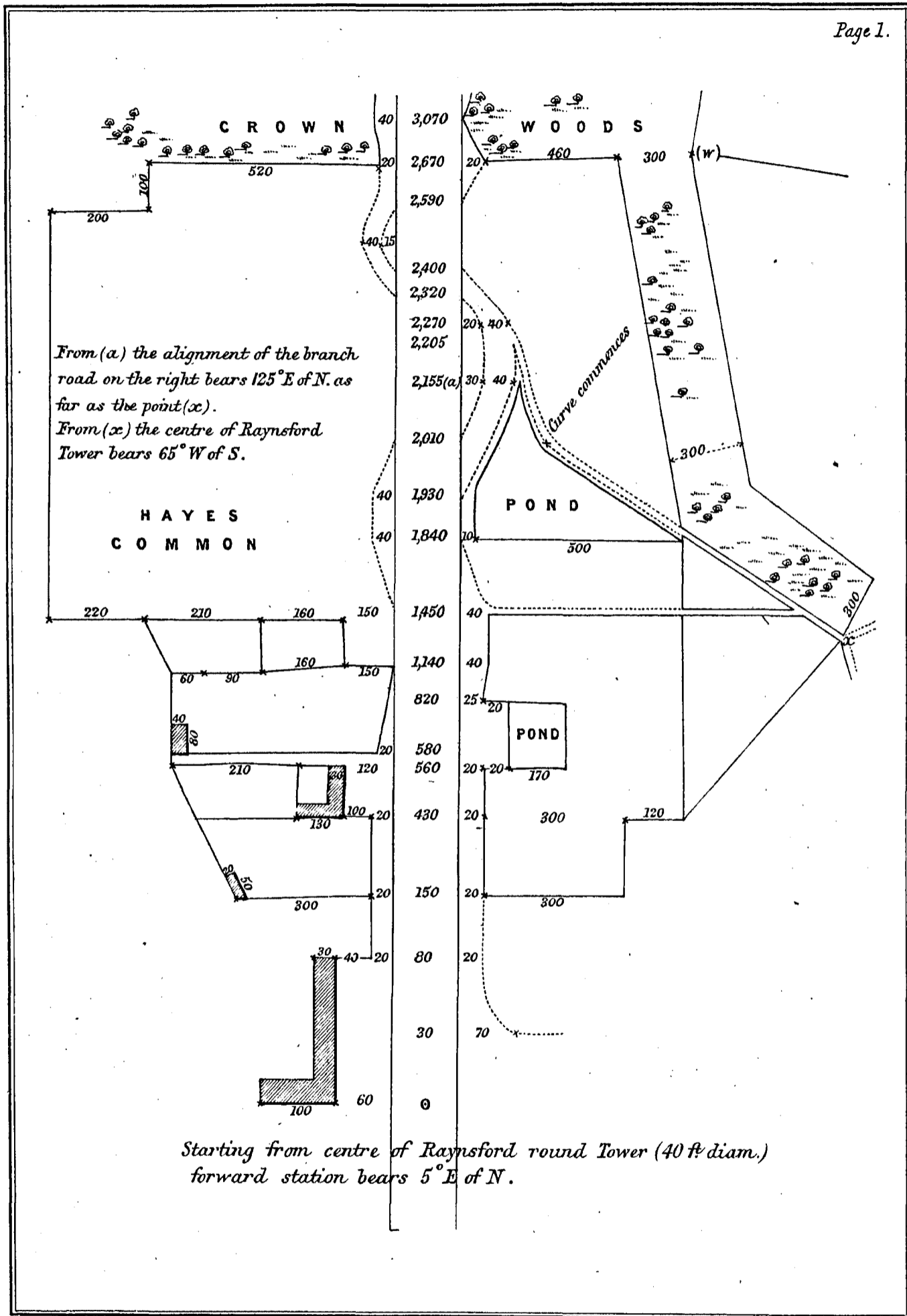
5. Having to make a straight and uniformly sloping drainage cut between two points (1) and (19), which are 1,800 feet asunder, I drive pins, 100 feet apart, flush with the surface of the ground, on the given alignment, and number them (1), (2), (3), &c., up to (19). I then set up my level over pins (4), (10), and (16), and record the following observations:—

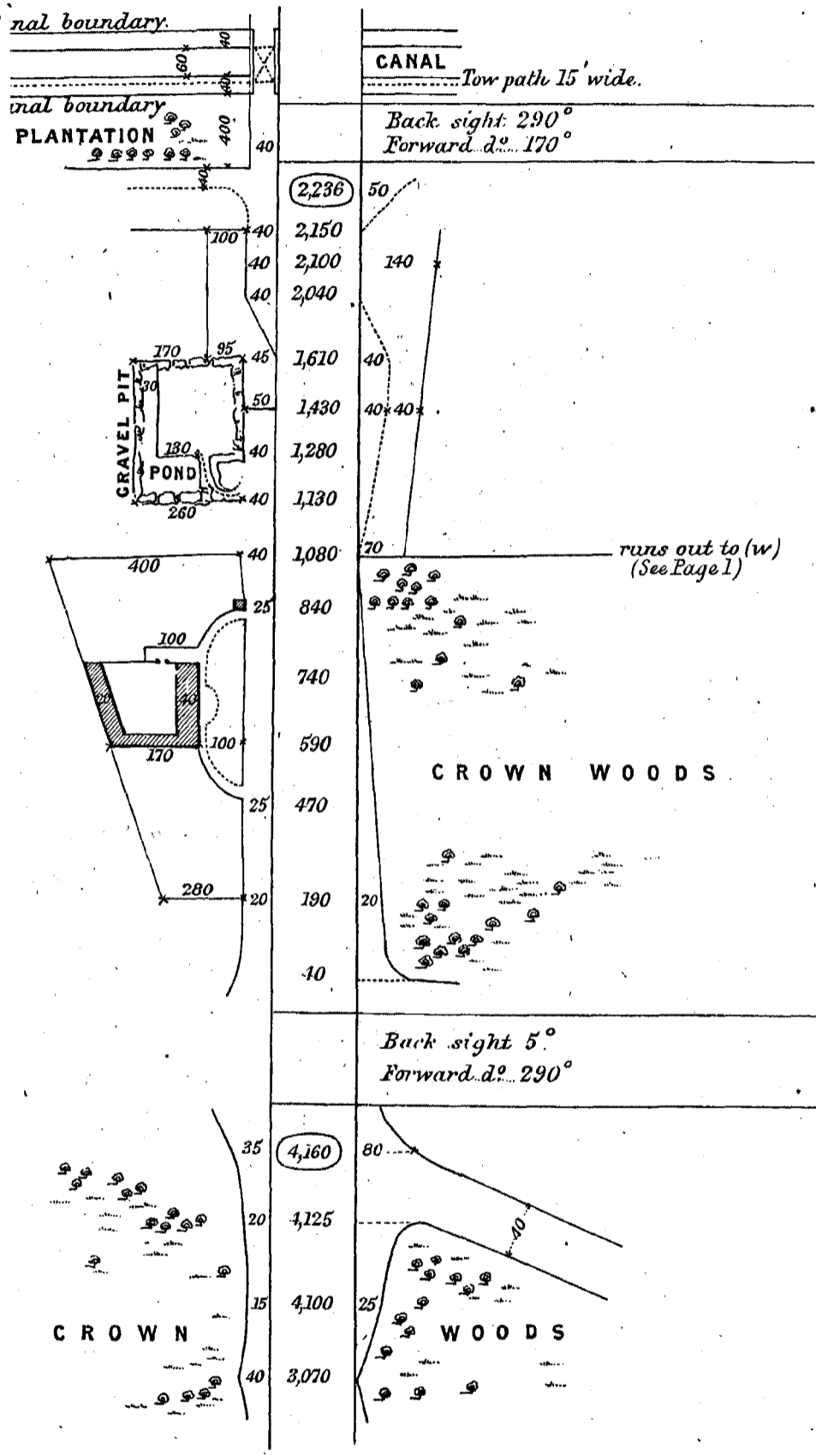
FIELD BOOK OF LEVELS.

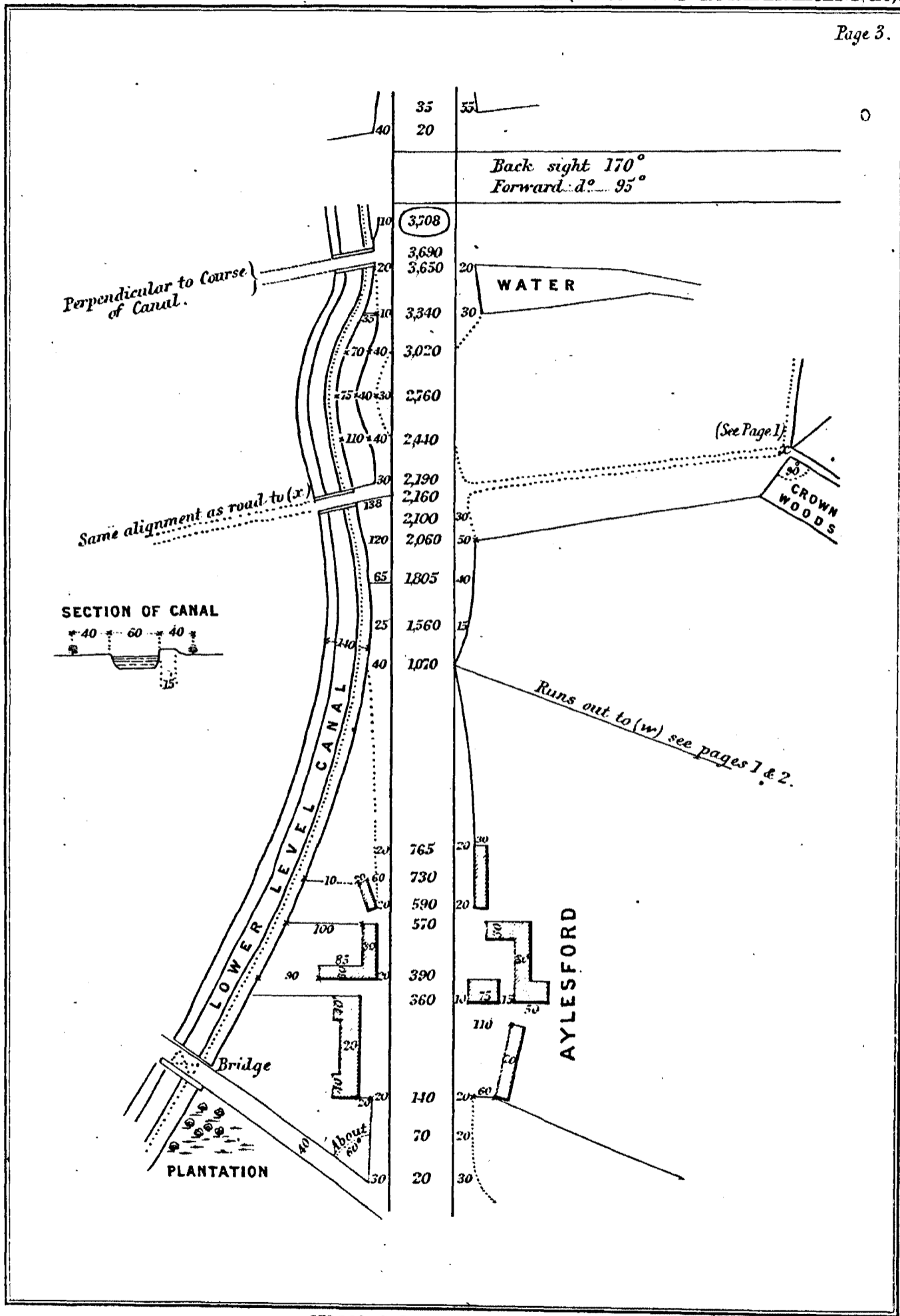
No. of Station.	BACK SIGHTS.				Height of Instrument.	FORE SIGHTS.				REMARKS.
	Bearing.	Number of Pins, and their Staff Readings.				Number of Pins, and their Staff Readings.			Bearing.	
		<i>Ft.</i>	<i>Ft.</i>	<i>Ft.</i>	<i>Ft.</i>	<i>Ft.</i>	<i>Ft.</i>	<i>Ft.</i>		
(4)	W. of S. 135°	(1) 8.81	(2) 7.64	(3) 6.04	5.10	(5) 6.09	(6) 7.14	(7) 7.01	E. of N. 135°	
(10)	Ditto -	(7) 4.24	(8) 6.68	(9) 4.51	4.92	(11) 5.21	(12) 5.88	(13) 6.64	- ditto.	
(16)	Ditto -	(13) 4.17	(14) 2.34	(15) 3.81	5.21	(17) 6.08	(18) 6.63	(19) 7.05	- ditto -	From (16) the staff reading of the floor of the bridge D was 9.08.

It is required to plot a section of the drainage cut, which is to be 2 feet deep at (1), and is to terminate at (19), at the depth of the floor of the bridge D, referred to in the Field Book, which floor is itself 20 feet above the datum line.

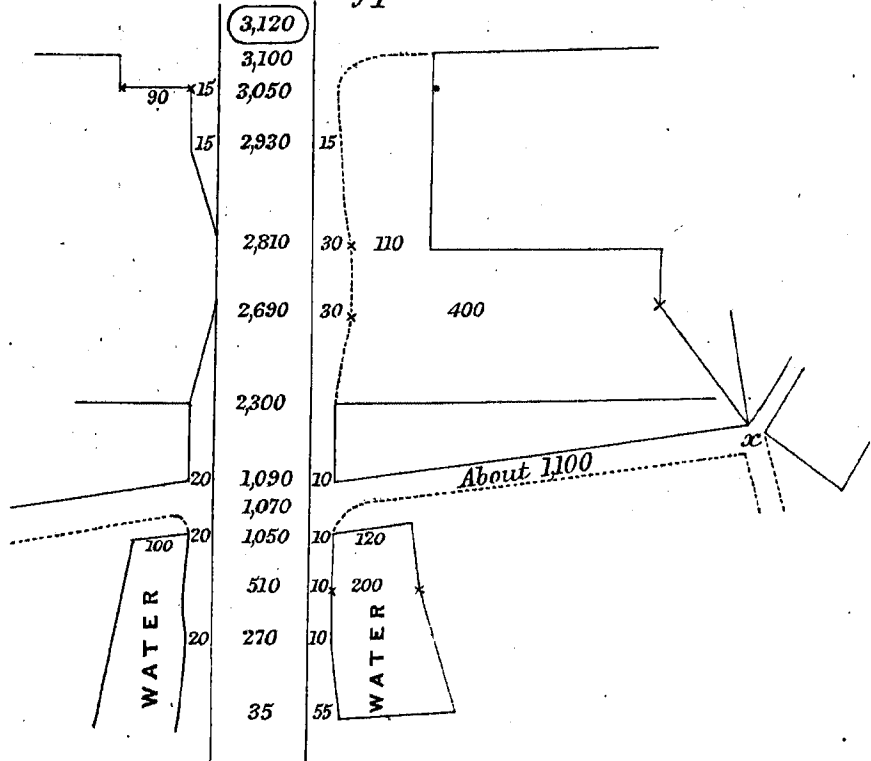
The







Closes on starting point.



The section may be on any convenient horizontal scale, one-tenth of the vertical scale. Scale and datum line to be drawn in.

The heights of the several pins above the datum line are to be figured in section, as well as the depths of digging necessary at each of the pins.

The work, to save time, need not be inked in. Neat pencilling will suffice.

6. There are two sorts of levelling staves. The first have sliding vanes; the second (known as Gravatt's) are so boldly graduated as to permit the observer at once to book his readings on making them.

(a) What are the advantages and disadvantages of each sort?

(b) Many staves are fitted with plumb-bobs. Where these are absent, or where staff men are not to be relied on, how do you satisfy yourself that you book perpendicular readings of your staves?

7. From a given point, A, there is a broad plane, sloping 1 in 25, or thereabouts, down to B, a distance of 2,000 feet. Your instrument is slightly out of adjustment, and will read your Gravatt's staves, which command a height of say 18 feet, on 300-foot sights only.

Show by a diagram, in plan, the best practical way of working down the plane so as to determine the *exact* difference of level between A and B, and state in how many observations this may be done. What is, in this case, the main point to be attended to in securing a correct result?

8. A court-yard, 200 feet by 150, is surrounded by a low flat-roofed range of sheds 20 feet wide and 12 feet high, except on one side, in the centre of which there is an opening 20 feet wide. At the angle nearest the observer, a flat-roofed tower, 30 feet square, with its outer sides flush with the outer walls of the sheds, rises to a height of 60 feet. Represent such a plain building in isometrical perspective. Attach or refer to a scale. In this and in the following case, neat pencilling will suffice.

9. Construct geometrically a scale of 17 feet to 2 inches.

10. Explain the principle of a diagonal scale.

EAST INDIA
(ENGINEERS' ESTABLISHMENT, &c.)

c

RETURNS of the Names of EXAMINERS appointed to examine the CANDIDATES who presented themselves, since the last Return, for Admission to the ENGINEERS' ESTABLISHMENT and PUBLIC WORKS DEPARTMENT in *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. 473, of Session 1863).

(*Mr. Adam.*)

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