

- (b.) Show by sketch how you would arrange the lifts in an 18in. pumping-plant consisting of five lifting sets and one forcing set, the shaft being 1,000ft. deep and the water to be pumped to the surface.
- (c.) What is a balance-bob or -beam? In what position is it fitted, and for what purpose?
- (d.) What is a V-bob? In what position is it fitted, and for what purpose?
- (e.) What is a snifter-valve or wind-bore, where fitted, and for what purpose?
- (f.) In the case of a plunger-pump, what do you consider the best relative height (as regards such pump) for the cistern from which it receives its supply?
- (g.) What are the advantages of a combined plunger- and bucket-pump? Explain its action.
- (h.) Required the thickness in cast-iron of a 16in. pipe for a head of water 150ft. high.
- (i.) What weight of cast-iron pipes would be required for a pumping-plant, the engine and pumps being placed near the bottom of the shaft, the water being forced through a vertical column of 1,000ft., pipes 8in. diameter and 9ft. long?
- (j.) Show by sketch how two complete sets of pumps are worked off one beam, side by side, the motion of the spears being in opposite directions.
- (k.) How many gallons of water will be raised per hour by a combined bucket- and plunger-pump, the plunger being 10in. diameter and the working-barrel 14in., with a stroke of 6ft., giving six strokes per minute?
- (l.) What is the velocity of discharge from a pump having a stroke of 10ft. and making six strokes per minute?
- (m.) Describe the different methods of making joints in connection with ordinary pumps and pumps working under high pressures.
- (n.) In gearing buckets and clack-valves, which side of the leather is used as the working-face?
- (o.) What description of buckets and clack-valves are used in modern pumps where the pressure is high?
- (p.) In splicing pump-rods and main spears should round- or square-bodied bolts be used in fixing the fish-plates, and why?

(2 p.m. to 5 p.m.)

Subject 7.—The haulage on planes and in shafts, also the different systems of underground haulage, with horse-power required to do the work:—

- (a.) Where cages are used in which the tubs are carried one above the other, what arrangements are made at the bottom of the shaft by which the tubs in each flat of the cage may be changed at the same time?
- (b.) Describe a drop-cage and its action.
- (c.) What type of winding-engine requires a counterbalance weight? How is such balance-weight fitted?
- (d.) What would be a safe load on a flat three- and four-linked chain having $\frac{5}{16}$ in. pins, the shearing resistance of which is 22 tons per square inch?

Subject 8.—The theoretical and effective power of steam-engines and boilers; also on the strength of haulage ropes and chains:—

- (a.) What are the principal causes of the falling-off in the evaporative efficiency of boilers? What are the remedies?
- (b.) Show by sketch how you would construct the flues of Cornish, Lancashire, egg-ended, or multitubular boilers.

Subject 9.—The incrustations in steam-boilers, and the cause of same, and remedy therefor:—

- (a.) What parts of Cornish and Lancashire boilers are first affected by shortness of water? What parts are most injuriously affected by an accumulation of scale?
- (b.) In what part of Cornish and Lancashire boilers are fusible plugs fitted, and for what purpose?

Subject 10.—Tapping water in mines, and the mode of constructing dams in underground workings to keep water back:—

- (a.) What precautions are necessary while driving a heading in a locality where a waste full of water is known to exist?
- (b.) With what varieties of underground dams are you acquainted? Describe the best kind of dam for withstanding a heavy pressure of water, showing by sketches its mode of construction.

Subject 11.—Blasting, and the use of explosives:—

- (a.) What is a blown-out shot? What may cause it?
- (b.) What danger may be anticipated from a blown-out shot?
- (c.) What do you consider the safest explosive in a fiery mine?
- (d.) What kind of cartridges have been invented to guard against the possibility of flame from a shot?
- (e.) What precautions are necessary in a fiery mine before shot-firing?
- (f.) What sort of a tamping-tool ought to be used?
- (g.) Is coal-dust a proper material for tamping, and, if not, why?

THIRD DAY (9 a.m. to 12 noon).

Subject 14.—A knowledge of underground surveying, and of making plans showing system of working, inclination of seam, faults, and system of ventilation:—

- (a.) The candidate must produce a plan showing the surface boundaries of a mining claim of at least twenty acres in extent, and also show (in different-coloured ink) the underground workings, with all traverse-lines, &c., to illustrate the method of survey adopted. Such plan and survey to be the actual work of the candidate.