(*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?

Subject 4.—The haulage in shafts and in underground planes:—

(*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 $\frac{3}{4}$in. pins, the shearing resistance of which is 22 tons per square inch?

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

Subject 5.—On the ventilation of mines:—

(*a.*) What is natural ventilation? and state on what principle it is based; also state the weight of a cubic foot of air at 32° Fahr. and also at 80° Fahr.

(*b.*) State the composition of atmospheric air, also the composition of carbonic-acid gas and of carburetted-hydrogen gas.

(*c.*) State what means you would adopt to detect the presence of carbonic-acid gas, and also of carburetted-hydrogen gas, in mines.

(*d.*) What quantity of atmospheric air is required to mix with a cubic foot of carburetted-hydrogen gas to render it safe and harmless to the workmen employed?

(*e.*) If there were 4 per cent. of carbonic-acid gas in the air of a mine, what percentage of atmospheric air would be required to dilute the air and render it perfectly wholesome?

(*f.*) What is meant by the friction of air in air-courses, and how do you calculate it?

(*g.*) Suppose that 20,000 cubic feet of air was passing through an airway 6ft. by 5ft. and 1,000ft. long, and this air was divided into three divisions, and had to pass through three different air-courses with the same pressure as in the main air-course, the respective dimensions of each divisional air-course being as follow: 1st division, 5ft. × 4ft., 2,000ft. long; 2nd division, 5ft. × 3ft., 1,500ft. long; 3rd division, 5ft. × 2ft. 6in., 1,000ft. long—what quantity of air would pass through each air-course?

(*h.*) If natural ventilation proved insufficient, what means would you take to force atmospheric air into the mine? and explain the system you propose to adopt.

Subject 6.—Tapping water in mines, and mode of constructing dams in underground workings to keep the water back:—

(*a.*) If you meet with a stream of water coming through a certain stratum in the rock while sinking a shaft, what means would you adopt to dam the water back so as to prevent its going down to a lower level?

(*b.*) Show by sketch how you would construct a dam in an adit if the rock were solid, to keep the water back.

(*c.*) Describe the precautions you would take if you were approaching any place where there was a lodgment of water, and also state how you would tap the water.

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

Subject 7.—On blasting and the use of explosives:—

(*a.*) State the manner in which you would charge a hole with explosive, and the method of tamping; also state what tools and material you would use for tamping a shot.

(*b.*) If a shot missed fire, what steps would you take?

(*c.*) What are the relative strengths of blasting-powder, dynamite, and blasting-gelatine as per unit of weight, and which of these explosives produces the largest quantity of deleterious fumes when proper combustion is effected?

(*d.*) How do you calculate the quantity of explosive required to do the work? Suppose a hole $2\frac{1}{4}$in. in diameter were 5ft. deep, with the line of least resistance being 3ft., what quantity of dynamite would be required to be used?

(*e.*) If you had to use blasting-powder in wet ground, how would you charge the hole?

(*f.*) If dynamite was in a frozen condition, what would you do before using it, and what effect (if any) has cold on dynamite as regards its strength as an explosive?