

5. If a plough-steel-wire rope (of diameter $D = 1$ in.) is made of material having a breaking-stress of 120 tons per square inch, what maximum load would you put on it (a) for winding, (b) for hauling? (Note: Assume the wire section in the rope equal to one-half of $\frac{\pi}{4} D^2$; allow 20 per cent. for tension set up in twisting the wires.)
6. What are the various causes of priming in boilers? State any possible remedies for each.
7. What are the advantages and disadvantages of using compressed air for underground work, and how does it compare with electricity? What do you consider the most economical air-pressure at the compressor?
8. What is the use of a friction-clutch? Sketch and describe any form with which you are acquainted.

SUBJECT III.—*Ventilation.*

1. In a sample of mine-air the following percentages of gases were found by analysis: O, 16.06; CO₂, 3.84; N, 77.88; CO, 0.02; CH₄, 2.20: state (a) the percentage of normal air and black-damp in the mixture, (b) the percentage composition of the black-damp, (c) the effect of such atmosphere upon the burning of lights and upon human life.
2. A horizontal 20 in. air-pipe 3,400 ft. long, delivers 3,500 cubic feet per minute; an aneroid barometer observed inside the pipe at both ends indicated a difference in pressure equivalent to 0.52 in. of mercury: calculate the co-efficient of friction in terms of water-gauge.
3. The speed of a fan is to be doubled: if the airways of the mine remain unchanged, what will be the effect of the increased speed—(a) on the water-gauge at fan drift; (b) on the quantity of air passed by the fan; (c) on the power required to drive the fan?
Supposing that the water-gauge of a mine is increased (say, through falls), but that the speed of the fan is kept constant, will the horse-power required to drive the fan increase or decrease?
4. A mine-fan delivered 21,500 cubic feet of air per minute against a water-gauge of 0.68 in.; it is driven by Pelton water-wheel supplied with 31 cubic feet of water per minute, having an effective head of 138 ft.: assuming the efficiency of the water-wheel to be 80 per cent., what is the efficiency or useful effect of the fan?
5. The quantity of air passing through the downcast shaft of a mine is 100,000 cubic feet per minute at a temperature of 40° Fahr. The quantity in the upcast is 106,000 cubic feet per minute at a temperature of 65° Fahr. Find the amount of gas being given off in the mine.

SUBJECT IV.—*Arithmetic and Law.*

1. A pound avoirdupois contains 7,000 grains. A piece of gold weighs 13 lb. 5 oz. troy: find its weight in pounds ounces and grains avoirdupois.
2. A chain is 22 yards long and contains 100 links: how many square links are there in an acre?
3. Find the value of 2 tons 17 cwt. 3 qr. 14 lb. at £5 9s. 6d. per hundredweight.
4. An engine working steadily day and night consumes a hundredweight of coal in $7\frac{1}{2}$ hours: how many tons will be used in 100 days?
5. Make up a pay-sheet in proper form for a fortnight's wages in connection with a mine, a day being reckoned as eight hours: 9 men at 1s. 0½d. per hour, 46 men at 11¼d. per hour, 27 men at 10½d. per hour, 15 boys at 7½d. per hour.
6. What are the conditions under which powder and other explosive or inflammable substances can be used in a mine?
7. State the uniform code of signals to be adopted at each mine.
8. State generally the requirements in connection with the employment of engine-drivers in a mine.
9. Name the bones of the lower extremities.
10. Describe the procedure with a man on a live wire in an unconscious condition.
11. Give a diagram of the blood-circulation, and name the principal and tourniquet points.
12. What are the symptoms of and treatment for a case of cyanide poisoning?
13. Describe some system of artificial respiration with which you are familiar.

SUBJECT V.—*Surveying.*

1. A drive terminates at A: how far must it be continued to reach the boundary at B?

