SUBJECT NO. 3.—GASES OF MINES, SPONTANEOUS COMBUSTION, AND VENTILATION.

1. What is the composition of the atmosphere? Give volume and weight of each constituent, and state under what conditions air increases or decreases in weight; also state whether the constituents of the atmosphere are chemically combined or otherwise. Give the chemical symbols and names of the gases most frequently met with in collieries.

2. What is spontaneous combustion, and what causes are assigned for spontaneous outbreaks of fire in collieries? State what measures you would adopt in dealing with such fires. Give reasons.

3. Assume a mine in which the air-current is 100,000 cubic feet per minute, travelling in three splits as follows:—

Split	A	is	6 ft.	by	10 ft., by	8,000 ft. long
"	B	"	6 ft.	"	12 ft., "	15,000 ft. "
"	C	"	5 ft.	"	10 ft., "	6,000 ft. "

find the natural division of the current.

4. The ventilation required in a colliery is—

Split	A,	6 ft.	by	9 ft.,	by	8,000 ft. long:	40,000 cubic feet
"	B,	5 ft.	"	8 ft.,	"	6,000 ft. "	40,000 "
"	C,	9 ft.	"	9 ft.,	"	8,000 ft. "	10,000 "
"	D,	6 ft.	"	8 ft.,	"	10,000 ft. "	30,000 "

In which of the splits should regulators be placed to accomplish the required division of the air; and what will be the mine-pressure? (Use Atkinson's formula.)

5. 50,000 cubic feet of air is passing per minute in a certain colliery in two equal splits, under a pressure of 2 in. of water-gauge, and it is required to reduce the quantity passing in one of the splits by a regulator placed at the end of the split so as to pass 15,000 cubic feet: find the area of the opening in the regulator, assuming that the ventilating-power is decreased to maintain the pressure constant at the mouth of the splits. The size of each split is 6 ft. by 10 ft., by 10,000 ft. long.

6. Ventilate the annexed plan, showing stoppings, air-crossings, air-splits, doors, &c., by conventional signs.

7. Give sketch of good form of self-acting door for main levels in collieries; also describe and sketch a good overcast capable of passing 25,000 cubic feet per minute at a velocity of 5 ft. per second. State kind of material you would use in constructing the crossing.

SUBJECT 4.—DEALING WITH OLD WORKINGS AND OTHER SOURCES OF DANGER.

1. Enumerate the dangers to be apprehended from extensive areas of old workings in collieries, and the precautions you would take in dealing with same for general safety.

2. In a colliery working both to the dip and rise, with seam giving off firedamp freely, explain fully the means you would adopt to secure the maximum degree of safety.

3. How would you overcome the dangers which are liable to arise from the presence of coal-dust in a mine that gives off firedamp freely? and what percentage of firedamp in the general atmosphere of the workings would you consider dangerous in such case?

4. Would you consider it necessary to increase the quantity of air in a mine if it were worked double-shift, and putting out double the quantity of coal, than if worked one shift?

5. Give a complete list of the apparatus and material which should be on hand at collieries in case of general accidents, fires, and explosions.

SUBJECT 5.—STEAM BOILERS AND ENGINES USED ABOUT MINES.

1. Explain the principle of the injector, and state how it is that water at atmospheric pressure and steam at, say, 80 lb. pressure may be forced into a boiler carrying the same pressure without interposing mechanical movement.

2. Describe the type of steam-boiler you consider the best for colliery-work. Give reasons for preference; state the causes leading up to boiler-explosions, and remedies for same. Enumerate the various fittings, and calculate bursting-pressure and safe working-load for a boiler 30 ft. by 7 ft. 6 in. made of ½ in. steel plate.

3. A beam of uniform size is 18 ft. long between supports, and weighs 250 lb.; there is a load of 2,800 lb. at 7 ft. from one end: find the pressure on each support.

SUBJECT 6.—ON MINE-DRAINAGE, HAULAGE, AND APPLIANCES FOR SAME.

1. Find the horse-power required for an endless-rope system of haulage 2,000 yards long, output 1,000 tons per shift of 7½ hours, in a flat seam, the mine-tubs having a capacity of 12 cwt., and weighing each 550 lb.

2. Having a winding-drum 12 ft. diameter, the stroke of engine 5 ft. 6 in., the steam-pressure 100 lb. per square inch, the steam cut off at three-fourths stroke, and load 5 tons, what diameter of double cylinders will be required?

3. A column of pipes 225 yards vertical, filled with water, what is the total pressure upon a ram at the bottom, 8 in. diameter? and what size cylinder would be required with air-pressure of 100 lb. per square inch to keep the said column of water in motion at a speed of 180 ft. per minute, and how many gallons would be pumped per hour?

4. What must the thickness of metal in the walls of a cast-iron pipe 11 in. diameter be to withstand a head of 500 ft.?

5. Supposing you were unwatering a fiery mine from a shaft on the dip of the workings, what would you expect to occur, and what precautions would you take?

6. Give sketches and description of suitable arrangement of colliery sidings, showing position of two shafts with winding-engine and boiler, fan-engine, head-gear, screens, and picking-belts suitable for an output of 1,000 tons daily.

7. What is meant by the term "direct haulage"? Also, what is the difference between the main and tail rope and the endless-rope systems?