Minerals Council South Africa

EXAMINATION PAPER

SUBJECT: CHAMBER OF MINES OF SOUTH AFRICA: INTERMEDIATE CERTIFICATE IN MINE ENVIRONMENTAL CONTROL PAPER 1 **SUBJECT CODE:** **COMIMEC1** **EXAMINATION DATE:** **XX OCT 2022** **TIME**: **14:30 – 17:30**	**Examiner:** Ronald Motlhamme **Moderator:** Inus Labuschagne **TOTAL MARKS:** [100] **PASS MARK:** [60%]
NUMBER OF PAGES: 12	

SPECIAL REQUIREMENTS:

THIS IS **NOT** AN OPEN BOOK EXAMINATION. **THERE IS NO FORMULA HANDOUT**

INSTRUCTIONS TO CANDIDATES:

1. Answer all questions **legibly** in English.
2. Write your **ID number** on the outside cover of each book used and on any graph paper or other loose sheets handed in.

NB: Your name **must not** appear on any answer book or loose sheets.

3. Show all calculations **and check calculations on which the answers are based.**
4. Hand-held electronic calculators may be used for calculations.
5. Write **legibly** in ink on the **right hand page** only – **left hand pages will not be marked**.
6. Illustrate your answers by means of sketches or diagrams wherever possible.
7. Answers must be given to an accuracy which is typical of practical conditions.

   NB Ensure that the correct unit of measure (SI unit) are recorded as marks will be deducted from answers if the incorrect unit is used. (Even if the calculated value is correct).

   In answering the questions, full advantage should be taken of your practical experience as well as data given.
8. Please note that you are not allowed to contact your examiner or moderator regarding this examination.
9. Cell phones are **NOT** allowed in the examination room.

QUESTION 1

1.1 In Table form list the Advantages and Disadvantages of a Development "Forcing System". (8)

FORCE SYSTEM	
ADVANTAGES	**DISADVANTAGES**
• Air flows to the face inside the pipe at a high velocity, thus good quality is delivered at the face. (1) • The fresh air is discharged right at the face, where the workers derive the maximum benefit from it. (1) • A single fan and column are required. (1) • The fan and motor are always in fresh air, causing less wear and tear on the fan. (1) • Leakage in the column is outward and hence easily detectable. (1)	• Persons travelling or working in the return do so in contaminated return air from the face. (1) • A long re-entry period is required, hence it is unsuitable for multi-blast development ends. (1) • The return air usually flows back into the general air stream and cause contamination. (1)

1.2 Sketch and describe the "Four Gate System" used in ventilating a Sinking Shaft. (12)

When gates 2 and 4 are opened (***1***) and gates 1 and 3 are closed (***1***), the system forces air down the shaft.(***1***) To reverse the airflow, gates 1 and 3 are opened (***1***) and gates 2 and 4 are closed (***1***), it changes to an Exhaust system (***1***). The change over for the system from force to exhaust and vice versa, can be done manually or hydraulically in a few minutes. (6)

Force System

Gate 1 Closed

Gate 4 Open Fan

Gate 3 Closed Gate 2 Open

(3)

Exhaust System

Gate 1 Open

Gate 4 Closed Fan

Gate 3 Open Gate 2 Closed (3)

(6)

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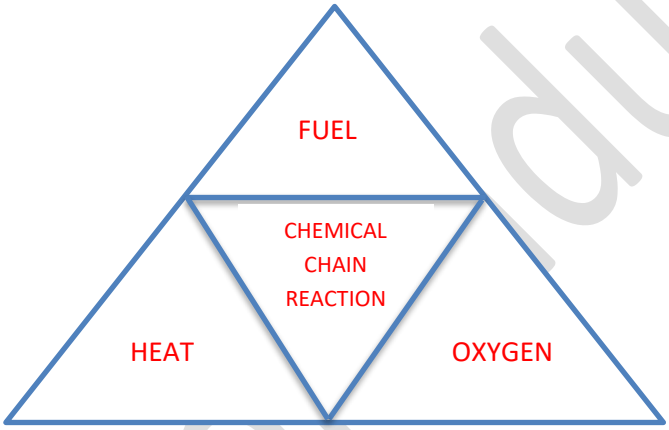
QUESTION 2

2.1 List the basic principles for a Fire Detection System. (4)

- Concentrated detection where hazards are great
- Ensure detection operates continuously and fails to condition of safety
- Detection system must raise appropriate levels of alarm
- A combination of detection systems are used to improve discrimination and to maximise sensitivity.

2.2 Draw the Fire Triangle and briefly describe the role of each component contributing to an active fire? (11)



- Fuels – Solids, Liquids and gases. Combustion occurs when a fuel is subjected to sufficient heat
- Heat and Ignition – Ignited by an external heat source
- Oxygen – Combustion cannot take place without oxygen
- Chemical Chain Reaction – By arresting the chemical chain reaction in the flame zone, combustion is rapidly terminated

Intermediate work book, page 100, 101

2.3 What is the purpose of an "Early Warning Device" and what does the device indicate? (5)

The purpose of an early warning device, is to sense the first signs of a fire or explosion and(***1***), communicate an alarm so that evacuation of the mine or part of the mine can be done safely(***1***), through reasonable uncontaminated escape routes(***1***) and control measures can be taken at the earliest time(***1***).

Carbon Monoxide (***1***)

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QUESTION 3

3.1 Describe the principle of operation for the Cold Water Circuit used in underground refrigeration.
You can draw a sketch to assist with your answer. (8)

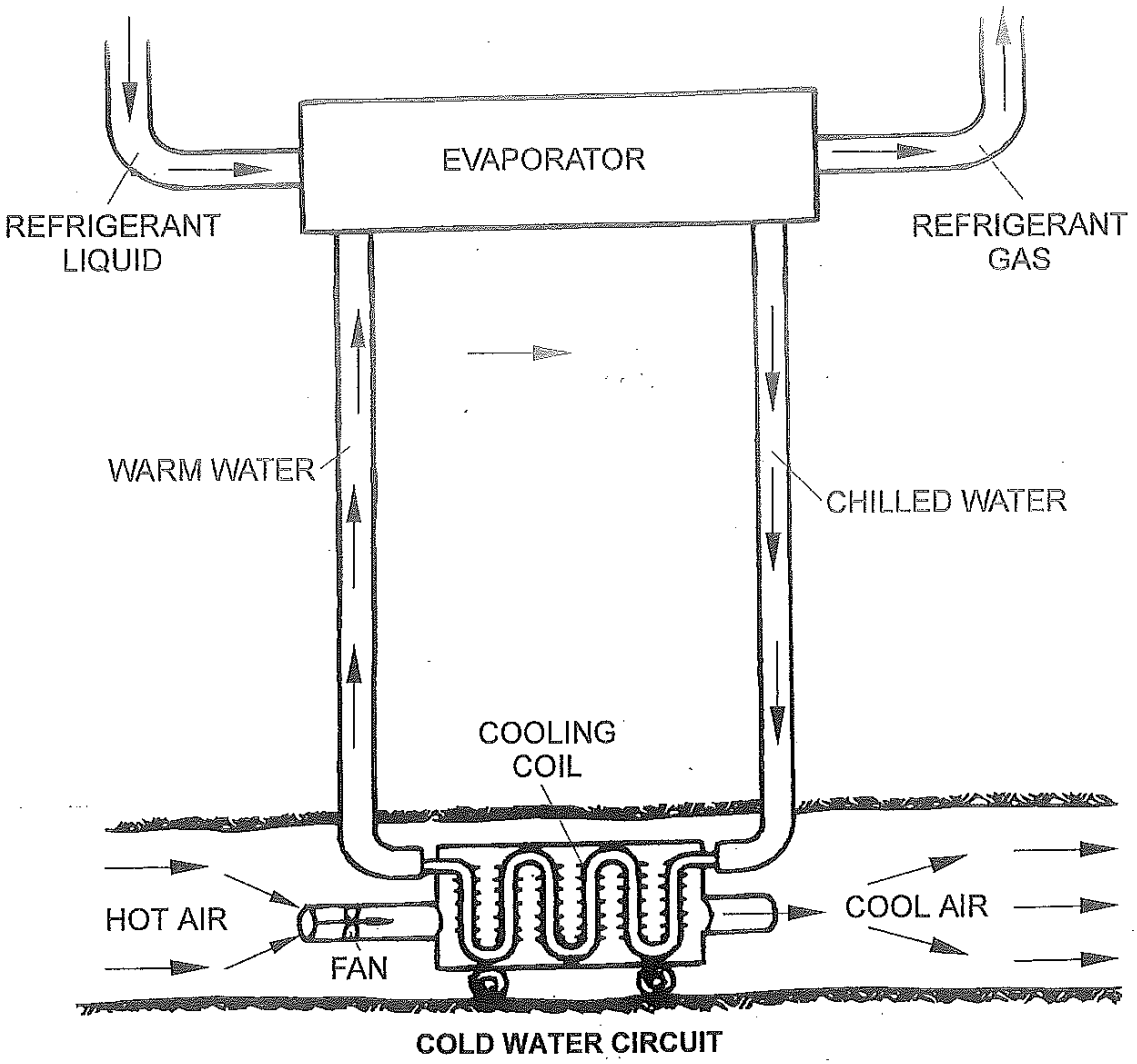
At the Cooling Coils:

- Hot air passes through the cooling coils by means of a fan.
- As the air flows over the coils, the heat is transferred from the hot air to the chilled water that flows inside the coil tubes.
- The absorbing heat from the air, the water leaves the coil at a higher temperature than the water entering the coil and flows back to the evaporator.
- The cool air leaves the coil and enters the working place at a lower temperature.

At the Evaporator

- The heat added to the water by the hot air is transferred to the cool refrigerant liquid in the evaporator.
- The water is cooled and flows back to the cooling coils where the whole cycle is repeated, continuously.

Intermediate work book, page 154 & 155


EVAPORATOR
REFRIGERANT LIQUID
REFRIGERANT GAS
WARM WATER
CHILLED WATER
COOLING COIL
HOT AIR
FAN
COOL AIR
COLD WATER CIRCUIT

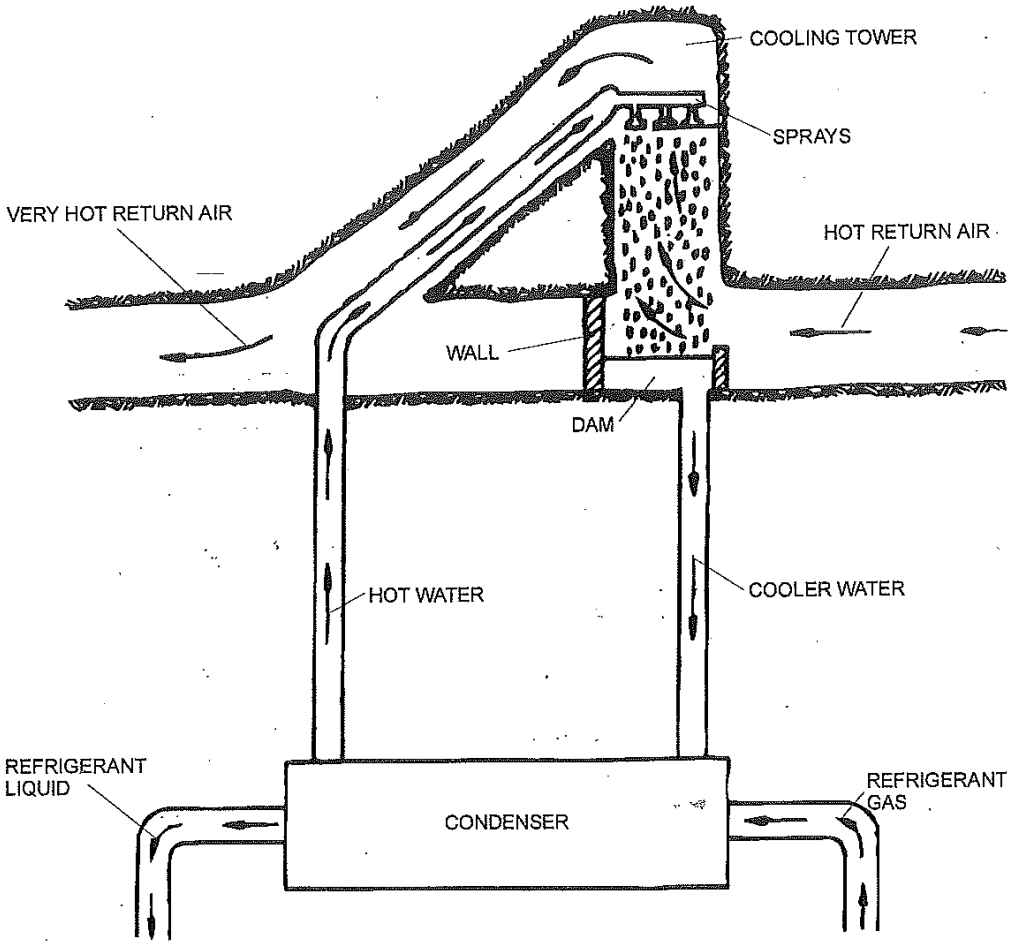
3.2 Describe the principle of operation for the Hot Water Circuit used in underground refrigeration.
You can draw a sketch to assist with your answer. (8)

At the Hot Water Circuit:

- Hot air leaving the Condenser is passed through the condenser cooling towers by means of pumps and sprays.
- As the hot water is sprayed into the hot return air, the heat is transferred from the hot water to the hot air, which is at a lower temperature than the hot water.
- After absorbing the heat from the hot water, very hot air leaves the condenser cooling towers via the up-cast shaft to surface.
- The cooler water collected in a dam, leaves the condenser cooling tower and flows back to the condenser.

At the Condenser

- The heat added to the refrigerant gas by the evaporator and compressor, is transferred to the cool water in the condenser.
- The water is heated and flows back to the condenser cooling towers, where the heat is rejected into the hot return air. The whole cycle is repeated, continuously.



HOT WATER CIRCUIT

Intermediate work book, page 155 & 156

3.3 Why would you consider underground cooling over surface cooling? (4)

- Bulk cooling large volumes of air at one or more convenient places, before entering the mining area, or section.
- Work place cooling that cools the air entering a working place, which is preferred method in very hot mines.
- Chilled service water that is used for drilling, cleaning and dust allaying.
- Underground cooling has a much better positional efficiency.

Intermediate work book, page 161

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QUESTION 4

4.1 The air power of a 15.0kW fan is 52% efficient. Calculate the fan electrical input power (4)

$$\text{Efficiency} = \frac{\text{Output power}}{\text{Input power}} \times \frac{100}{1} \quad (1)$$

Re-arrange the formula, then

$$= \text{Output power} \times \frac{100}{\text{Efficiency}} \quad (1)$$

$$= 15 \times \frac{100}{52} \quad (1)$$

$$= \mathbf{28.8\ kW} \quad (1)$$

4.2 $60m^3/s$ of air at a density of $1.0kg/m^3$ flows in a haulage with a resistance of $0.1292Ns^2/m^8$. The haulage is 3.2m x 3.0m, with a friction factor of $0.016Ns^2/m^8$. Calculate the length of the haulage. (6)

Given that :

$R = 0.1292\ Ns^2/m^8$

$K = 0.016\ Ns^2/m^4$

$C = 2(3.2 + 3.0) = 12.4m$

$A = 3.2 \times 3.0 = 9.6m^2$

$W = 1.0\ kg/m3$

Now $R - \frac{KCL}{A^3} \times \frac{1.2}{w}$ (1)

Re-arranging the formula by manipulation,

$$L = \frac{RA^3}{CK} \times \frac{1.2}{w} \quad (1)$$

$$= \frac{0.1292 \times (9.6)^3}{12.4 \times 0.016} \times \frac{1.2}{1.0} \quad (1.5)\ (1.5)$$

= 691.37 m

Length of haulage = 691.37m (1)

4.3 $8.2m^3/s$ of air flows in a ventilation pipe with a resistance of $12.31Ns^2/m^8$. Calculate the air power (4)

Given that : Q = $8.2\ m^3/s$
R = $12.31\ Ns^2/m^8$
Wa = To be calculated

Then:

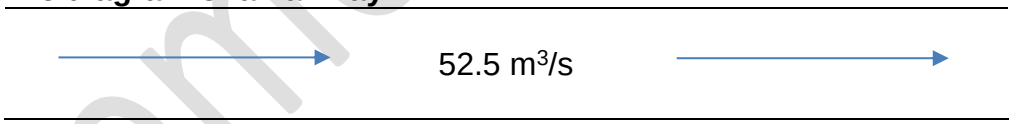
$$Wa = \frac{RQ^3}{1000} \quad (1)$$

$$= \frac{12.31 \times (8.2)^3}{1000} \quad (2)$$

$$= 6.78\ kW$$

Air Power = 6.8 kW (1)

4.4 **Line diagram of an airway**



- The pressure loss in the above airway is 720 Pa and the air density is $1.058\ kg/m^3$.

What size regulator would be required to reduce the air quantity to $30m^3/s$? (6)

Answer:

- To pass $52.5\ m^3/s$ of air requires a pressure of 720 Pa.

Therefore to pass $30\ m^3/s$ of air requires a pressure of:

$$p_2 = p_1 \times \frac{Q_2^2}{Q_1^2} \quad (1)$$

$$= 720 \times \frac{30^2}{52.5^2} \quad (1)$$

$$= 235\ Pa \quad (1)$$

- This will now be the pressure required for 30m^3/s in the actual airway, and the regulator must use up (destroy) the rest

Therefore pressure to be used up (destroyed) by regulator

= (720 – 235) Pa
= 485 Pa (1)

Area of regulator,

$$Ar = 1.2 \times Q \times \sqrt{\frac{w}{p}} \quad (1)$$

$$= 1.2 \times 30 \times \sqrt{\frac{1.058}{485}}$$

$$= \mathbf{1.68\ m^2} \quad (1)$$

Remember: This area calculated (1.68 m2) above, is the open area of the regulator through which the required air flow will flow

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QUESTION 5

5.1 List the type of fans used in the mining environment and give a brief description on each. (6)

Axial Flow Fans (1)
The direction of flow, entering and leaving the fan is parallel to the axis or shaft of the fan (2)

Centrifugal or Radial – Flow Fans (1)
The direction of flow entering the fan, is parallel to the axis or shaft of the fan. The discharge of the fan is at right angles to the fan axis or shaft. (2)

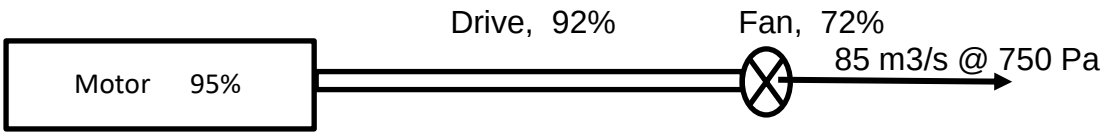
5.2 A fan handles 4.0 m3/s at 800 Pa. the electrical input power to the fan motor is 5.0 kW and the motor output power is 4.5 kW. The fan input power is 4.0kW. (14)

Calculate :

i. The Motor efficiency
ii. The drive efficiency
iii. The fan efficiency
iv. The overall efficiency

Answer:

Draw a simple sketch



i. The Motor efficiency = Motor output power / Motor input x 100% (1)

= 4.5 / 5.0 x 100% (1)

= **90%** (1)

ii. The drive efficiency = Drive output / Drive input x 100% (1)

(Remember motor output is drive input and fan input is drive output)

= 4.0 / 4.5 x 100% (1)

= **89%** (1)

iii. The fan efficiency = Fan output / Fan input x 100% (1)

(Remember fan output = Air-Power = P Q / 1000)

Therefore fan output (air-power) = P Q / 1000 (1)

= 800 x 4 / 1000

= **3.2 kW** (1)

Therefore fan efficiency = Airpower / Fan input x 100% (1)

= 3.2 / 4.0 x 100%

= **80%** (1)

iv. The overall efficiency = Airpower / Motor input x 100 (1)

= $\frac{3.2}{5.0}$ x 100% (1)

= **64%** (1)

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TOTAL MARKS: 100