1Minerals Council South Africa

MEMORANDUM

SUBJECT: CHAMBER OF MINES OF SOUTH AFRICA: INTERMEDIATE CERTIFICATE IN MINE ENVIRONMENTAL CONTROL PAPER 1 **SUBJECT CODE:** **COMIMEC1** **EXAMINATION DATE:** **10 MAY 2019** **TIME**: **14:30 – 17:30**	**Examiner:** Mervin van Rooyen **Moderator:** Inus Labuschagne **TOTAL MARKS:** [100] **PASS MARK:** [60%]

NUMBER OF PAGES: 9

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)

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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 List 3 types of detectors that can alarm in the case of a fire been detected in a Fire Detection System with sources. (11)

- Carbon Monoxide Monitors (5)
  - This monitor detect CO gas.
    - Passage of diesel vehicles
    - Blasting
    - Contamination of intake air
    - Back up for Smoke detectors
- Smoke Detectors (Beacons) (4)
  - This monitor detect smoke particles
    - Smoke particles in mine air
    - Diesel exhaust fumes
    - Immediate returns from working places
- Heat Sensors (2)
  - Normal operating temperatures

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

The role 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 take 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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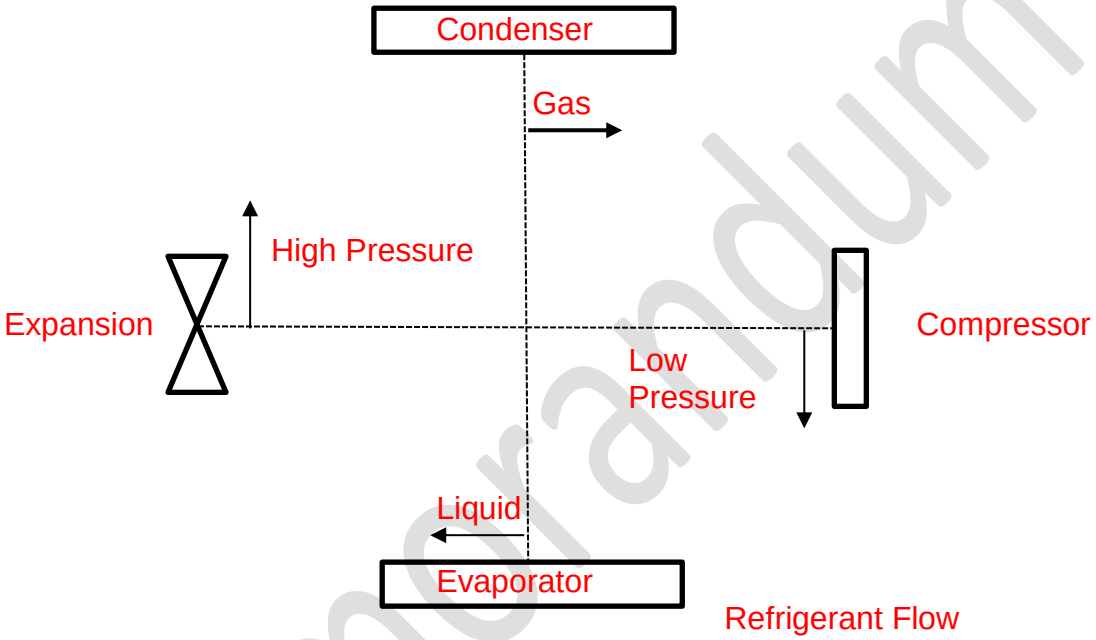
QUESTION 3

3.1 Explain the term "Refrigeration" (3)

- Refrigeration is a process of Cooling(1), whereby heat is removed from a substance (air), where it is not wanted (working place) (1), and put back where it does not affect workers (return airways) (1)

3.2 Draw and label a simple line sketch that illustrates the "Vapour Compressor Refrigeration Cycle". (8)



3.3 Complete the table below on the comparison between Condenser Cooling Towers and Cooling Coils. (9)

CONDENSOR COOLING TOWERS	COOLING COILS
Air side: 1. Air leaving the tower is at a higher temperature than air entering the tower 2. Air volume (m^3/s) leaving the tower is bigger than air volume entering the tower 4. Water evaporated into the air	**Air Side:** 1. Air leaving the Cooling Coil is at a lower temperature than air entering the Coil 3. Air volume (m^3/s) leaving the Cooling Coil is smaller than air volume entering the coil 3. Water condensed into the air
Water side: 1. Water entering the cooling tower is at a higher temperature than the water leaving the tower	**Water side:** 1. Water entering cooling coils is at a lower temperature than the water leaving the coil

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QUESTION 4

4.1 The air power is 52% efficient fan is 15.0 kW. What is the fan electrical input? (4)

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

Re-arrange the formula, then

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

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

= **28.8 kW** (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 x 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,

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

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

= 691.37 m

Length of haulage = 691.37m (1)

4.3 8.2m3/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
w = ?

Then:

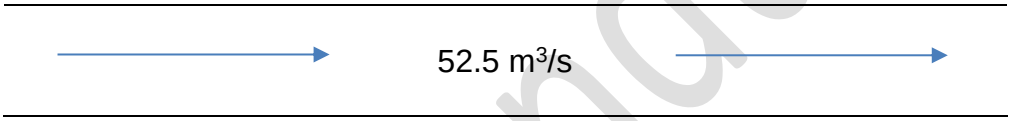
$$Wa = \frac{RQ^3}{1000} \quad (1)$$

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

$$= 6.78 \text{ kW}$$

Air Power = 6.8 kW (1)

4.4



- 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:

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

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

$$= 235 \text{ Pa} \quad (1)$$

- 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

$$= (720 - 235) \text{ Pa}$$

$$= 485 \text{ Pa} \quad (1)$$

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)

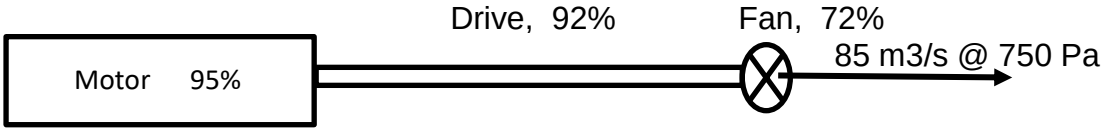
5.2 A fan handles 4.0 m3/s at 800 Pa. the electrical input power to the fan motor is 5.0 kW and the motor output power is 4.5 kW. The fan input power is 4.0kW. (14)

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)

= 3.2 / 5.0 x 100% (1)

= **64%** (1)

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TOTAL MARKS: 100