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:** **11 OCTOBER 19** **TIME**: **14:30 – 17:30**	**Examiner:** Mervin van Rooyen **Moderator:** Inus Labuschagne **TOTAL MARKS:** [100] **PASS MARK:** [60%]

NUMBER OF PAGES: xx

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 order, to control and maintain satisfactory ventilation and thermal conditions underground, what is essentially required? (6)

- Adequate shaft systems (up-cast and down-cast shafts)
- Large intake and return airways to ensure minimum air velocity of not less than 3.0 m/s and 5.0 m/s respectively.
- Adequate fan power
- Proper splitting or distribution of available air to all ventilation districts
- Effective control of available air. (reduce leakage of air and air wastage)
- Refrigeration (applicable to deep level mining)

Intermediate work book, page 25

1.2 Under what conditions must all work be stopped in a working place? (4)

- The wet bulb temperature exceeds 32.5°C and the dry bulb exceeds 37.0°C
- The wet kata is below 6.0 and the SCP below 125 w/m^2
- If flammable gas tests indicate the presence of such gas in the general atmosphere, no matter how low the concentration
- If any scraper rope friction against timer is present, or any other fire hazard

Intermediate work book, page 50

1.3 With the increase in the degree of Mechanised Mining it creates additional Ventilation, Health and Safety concerns. What would they be? (8)

- Increase in face advance rates
- Increases the amount of dust produced into the air
- Increases the heat content of the air
- Increases the possibility that more flammable gas can be released into the air
- Increases the amount of gases, fumes and other contaminates in the air, where diesel driven equipment is used
- Increases the risk of flammable gas ignition and coal dust explosions where diesel driven and / or electrical driven machines are found
- Increases the risk of underground fires
- Increase the risk of exceeding the recommended equivalent noise exposure limit
- Make the installation, extension and maintenance of ventilation equipment difficult

Intermediate work book, page 55

1.4 What are the objectives in Reporting on Environmental Conditions? (2)

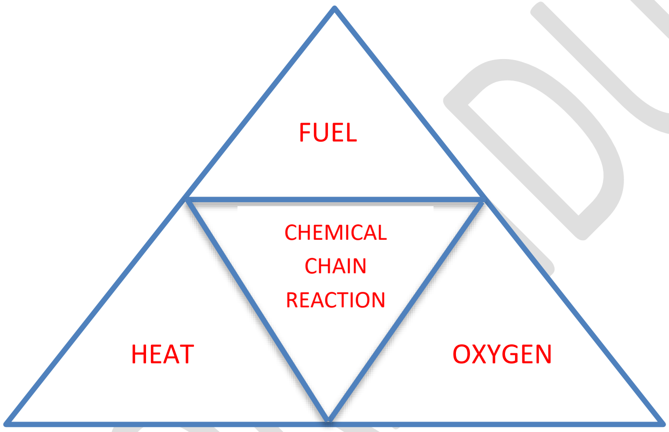
- To answer questions
- To make recommendations
- To convey ideas

Intermediate work book, page 50

[20]

QUESTION 2

2.1 Draw the Fire Triangle and briefly describe the role of each component contributing to an active fire? (10)



- 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

2.2 List the requirements that need to be indicated on Mine Rescue Plans in terms of Reg.10.18, 24.13.1 and 24.13.2. (10)

- Ventilation Districts and Fire Zones
- The direction of flow (different colour for intake and return)
- The quantity and temperature of air circulating
- The position of each permanent fan installation, ventilation and fire doors, regulators, crossing, stoppings, barricades (all ventilation appliances)
- The position of each permanent telephone, first aid station, refuge bays, fire detection heads (CO and Beacons) main water valves, fire hydrants, fire patrol points and fir fighting equipment

- The position of every permanent workshop, battery bay, major and mini-substations, dam, pump chambers, store, truck repair bays, etc.
- Major falls of ground (restrictions) in main intake and return airways
- The position of all refrigeration plants and cooling installations (cooling coils / cars, bulk air coolers, etc.
- The position of intake fire hazards (eg timber support, HDPE pipes, etc.)
- Escape routes to adjoining shafts
- All flammable gas intersections

Intermediate work book, page 100, 101

[20]

QUESTION 3

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

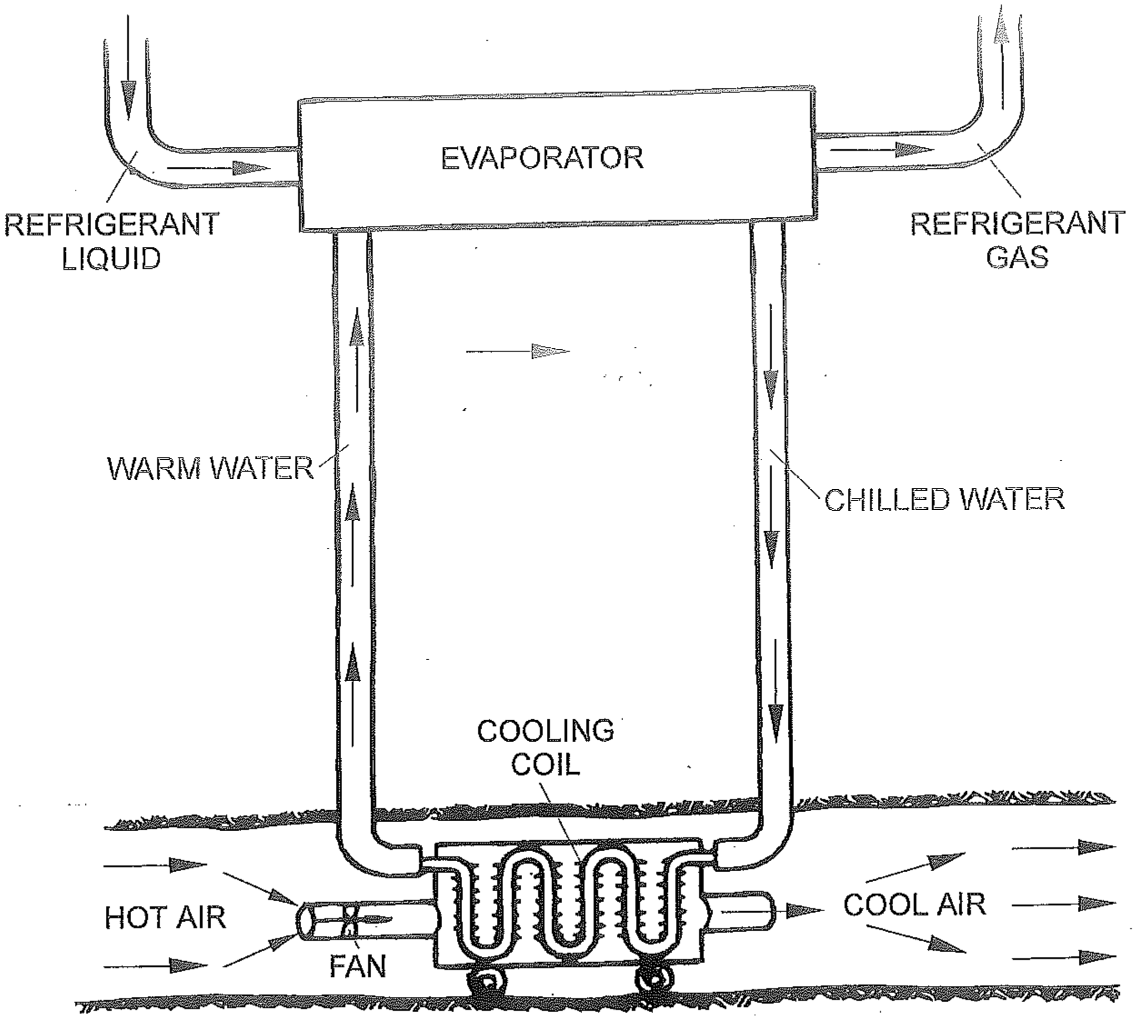
At the Cooling Coils:

- 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



COLD WATER CIRCUIT

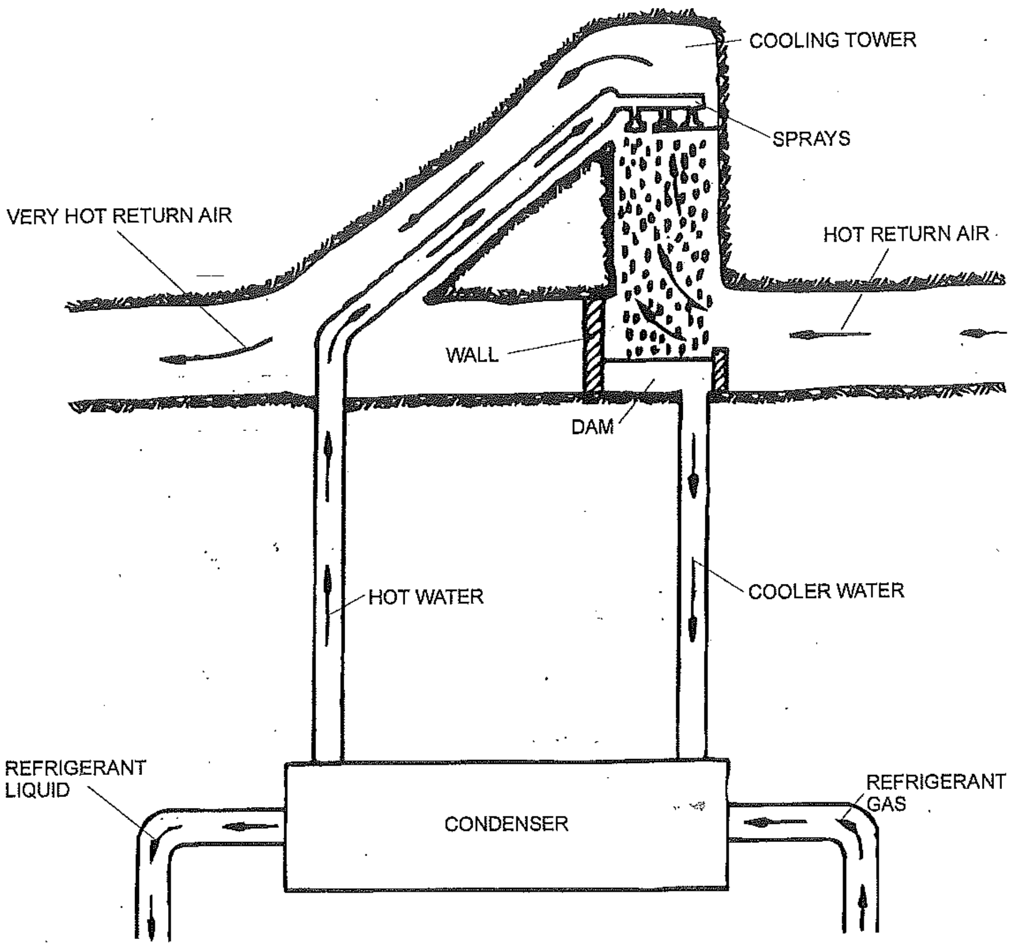
3.2 Describe the principle of operation for the Hot Water Circuit used in underground refrigeration.
You can draw a sketch to assist with your answer. (8)

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 delaying.
- Underground cooling has a much better positional efficiency.

Intermediate work book, page 161

[20]

QUESTION 4

4.1 Calculate the resistance of a heavy lined timber haulage, 200m long, which is 3.1m high and 2.9m wide. (5)

The K-Factor has not been given, therefor it must be assumed. Thus for a heavily supported haulage the K-Factor = $0.0018 Ns^2/m^4$ is used.

Given that: - L = 200m
C + 2(3.1 + 2.9) = 12.0m
A = (3.1 * 2.9) = $8.99m^2$

Now R = $\frac{KCL}{A3}$ ($\frac{w}{1.2}$ is ignored because no density is given)

= $\frac{0.018 \times 12.0 \times 200}{(8.99)^3}$

= 0.0595Ns2/m8

Say = $0.06 Ns^2/m^8$

The resistance = $0.06 Ns^2/m^8$

Intermediate work book, page 194

4.2 $68 m^3/s$ of air flows in a rock-lined haulage, (3.5m by 3.2m) at a specific volume of $0.893 m^3/kg$. The haulage is 257m long. Calculate:
4.2.1 The velocity pressure (7)

Given that: VP = $\frac{V^2 w}{2}$

Where V = $\frac{Q}{A}$

= $\frac{68}{3.5 \times 3.2}$

= 6.07m/s

And w = $\frac{1}{\text{Specific volume}}$

= $\frac{1}{0.893}$

= $1.12 kg/m^3$

Now VP = $\frac{(6.07)^2 \times 1.12}{}$

$$= \quad 21 \text{ Pa}^{2}$$

Velocity pressure = 21 Pa

Intermediate work book, page 207

4.2.2 The total pressure (6)

Knowing TP = SP + VP, we can calculate SP using Atkinson's formula.

$$P = \frac{KCLQ^2}{A^3} \times \frac{w}{1.2}$$

Where

	P	=	?
	K	=	0.011 Ns^2/m^4 (Assume rock lined haulage)
	C	=	2(3.5 +3.2) = 13.4m
	L	=	257m
	Q	=	68.0 m3/s
	A	=	3.5 x 3.2 = 11.2m2
	W	=	1.12kg/m3 (Calculated from specific volume)

Now P

$$= \frac{KCLQ^2}{A^3} \times \frac{w}{1.2}$$

$$= \frac{0.011 \times 13.4 \times 257 \times (68)^2}{(11.2)^3} \times \frac{1.12}{1.12}$$

$$= 116 \text{ Pa}$$

Static Pressure = 116 and TP = SP + VP

= 116 + 21

= 137 Pa

Total Pressure = 137 Pa

Intermediate work book, page 207 & 208

[18]

QUESTION 5

5.1 The following data was recorded during a fan test on surface:

Motor:	Volts	-	6600
	Pf	-	0.94
	Efficiency	-	94%
	Phases	-	3
Gearbox:	Efficiency	-	90%
Drive:	Efficiency	-	91%
Fan:	Efficiency	-	85%
	Quantity	-	241m3/s @ 3.1 kPa

Calculate:

5.1.1Fan input power (4)

$$\text{Fan Input Power} = \text{Air Power} \times \frac{100}{85}$$

$$= \frac{P\,Q}{1000} \times \frac{100}{85}$$

$$= \frac{3100 \times 241}{1000} \times \frac{100}{85}$$

$$= \mathbf{879\ kW}$$

5.1.2 Motor input power (3)

$$\text{Motor input power} = \text{Fan Input} \times \frac{100}{\text{Drive Eff}} \times \frac{100}{\text{Gearbox Eff}} \times \frac{100}{\text{Motor Eff}}$$

$$= 879 \times \frac{100}{91} \times \frac{100}{90} \times \frac{100}{94}$$

$$= \mathbf{1142\ kW}$$

5.1.3 Amps consumed by motor (3)

Now, if $W = E I pf \sqrt{n}$ (Input Power)

Then $I = \frac{W}{E pf \sqrt{n}}$ (Amps)

$$= \frac{1142}{6.6 \times 0.94 \times \sqrt{3}}$$ (Remember E = kilovolts = $\frac{6600}{1000}$ = 6.6)

$$= \mathbf{106\ Amps}$$

Intermediate work book, page 267 & 268

5.2 You are working on a deep level gold mine. Your line manager is concerned about the excessive costs of running the 3 main surface fans, these fans run in parallel to each other, they handle a volume of 400m^3/s at a pressure of 2.4 kPa and have a efficiency of 80%. You are further aware from your quantity surveys that 40% of all ventilation is lost in the ventilation circuit due to leakage. Assume that the electrical cost is 78c per kW/hour.

Calculate:

5.2.1 The input power to each fan (4)

$$\text{Fan Air Power} = \frac{P\,Q}{1000}$$

$$= \frac{2.4 \times 4000}{1000}$$

$$= 960\ \text{kW}$$

$$\text{Fan Input Power} = \text{Fan Air Power}$$

Efficiency

$= \frac{960}{0.80}$

= **1200 kW**

5.2.2 The total running cost of these fans, per annum (3)

Running cost per year = FIP x 24hrs x 365 days x electrical costs
= 1200 x 24 x 365 x 0.78
= **R 8 199 360 per fan**

For 3 fans = R 24 598 080 per annum

5.2.3 The cost of your ventilation circuit's losses per year (2)

Cost of leakage = annual running cost x % Leakage
= R24 598 080 x 0.40
= **R 9 839 232 per annum**

5.2.4 You draw up a leakage reduction strategy which will cost R6 735 266 and take 120 days to complete. Determine the payback period in number of days. (3)

Payback period $= \frac{(R6\ 735\ 266 \times 365)}{R9\ 839\ 232}$

= 250 days

Exam question October 2016.

[22]

TOTAL MARKS: 100