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:** **10 MAY 21** **TIME**: **14:30 17:30**	**Examiner:** Mervin van Rooyen **Moderator:** Inus Labuschagne **TOTAL MARKS:** [100] **PASS MARK:** [60%]

NUMBER OF PAGES: 3

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, diagrams and tables 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 Discuss the guidelines in distributing Routine Environmental Engineering Reports. (10)

- Make a copy of all reports that leave the Department, and file them in a "Original" file. After signature of the section head with recommendations.
- Enter the report number and date of the report, to whom the report is going to in the record register book.
- The person who is receiving the report (HOD) signs for the report in the record book, acknowledging receipt thereof.
- The HOD will write their comments and send the report down the line of management. (Shift boss, Foreman) They will then scrutinize the report giving a schedule with dates for the required tasks to be implemented. A copy of the report is given to the miner, artisan to expedite the required tasks.
- The report is then taken to the Manager by the HOD for discussion, if needed.
- The Manager scrutinizes the report, signing and returns to the Environmental Control Department.
- The Production /Section Manager, Environmental Engineering Manager must be informed of important matters needing their attention.
- The report is returned to the Environmental Control Department for filing and follow-up inspections for loop closure.
- The report register book is updated with the return of the report.
- A copy of the report is forwarded to the HOD for the records and display in the workplace.

[10]

QUESTION 2

2.1 List five main sources of underground fires. (5)

- Electrical sources
- Friction sources (scraper ropes, conveyor belts)
- Flame cutting and Welding activities (Hot work)
- Spontaneous combustion
- Smoking / Contraband
- Diesel engines and fuel
- Flammable liquids
- Methane or other gas explosions
- PVC or other similar material
- Impact generating sparks
- Discharges of accumulations of static electricity
- Arson

2.2 List five main sources of fires on surface. (5)

- Electrical sources
- Frictional sources
- Cutting and welding sources
- Smoking and contraband
- Spontaneous combustion (oily waste, coal stockpiles)
- Veld fires
- Arson

2.3 When a new Refuge Bay is planned, what parameters should be taken into account? (10)

- Location, Normal route to work place, Distance from work place, Area free of combustible material
- Access Route, Demarcated, Accessible from work place, Shortest possible route
- Design and Construction, Construction must as far as possible be fire resistant, the size to accommodate the number of people in the area, 0.6m2 per person, Seating, Accommodate stretchers
- Air Supply and Ventilation, Compressed air to be piped into the refuge bay and distributed evenly
- Air Whistle and Flash Light, install a compressed air whistle outside, flashing light installed outside for identification
- Entrance, (Front wall) Large enough to accommodate a stretcher, maintain a positive pressure, drainage pipe, illuminated, white washed, demarcated with number / location
- Portable Water, sufficient supply
- Toilet facilities, basic toilet facilities provided
- Equipment, First aid, Communication, standard procedures
- Inspections / Maintenance, weekly inspection by Shift Boss, Monthly Quarterly inspections by environmental department
- Training, regular training in all aspects of the escape strategy

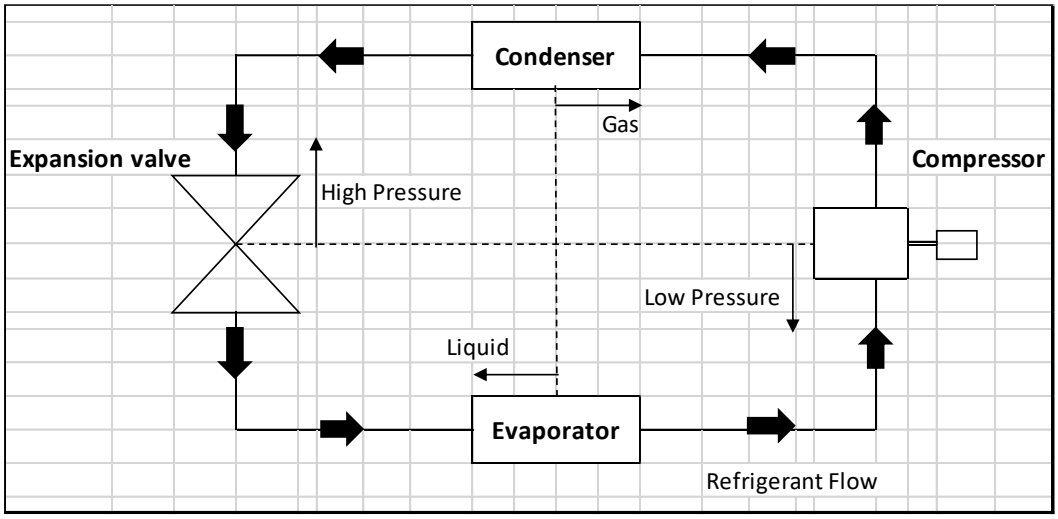
[20]

QUESTION 3

3.1 Name the main components of a Refrigeration Plant. (4)

- The Evaporator
- The Compressor
- The Condenser
- The Expansion Valve

3.2 Sketch a Vapour Compression Refrigeration Cycle. (4)



3.3 When cooling a mine either from surface or underground, what factors should be taken into account in the method of cooling? (12)

- **Surface Cooling**
  - **To bulk cool the air before entering the downcast shaft**
  - **Cool the mine service water before sending it underground**

  It is the **cheapest and easiest** application of refrigeration, because **maintenance and supervision are easy** and **the heat is removed from the air or water can be rejected to the atmosphere**. However, surface cooling is **inefficient due to its position**, because it is situated so far from the place where cooling is required underground. This is called "**Positional Efficiency**" of the plant. (6)

- **Underground cooling**
  - **Bulk cool 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 the preferred method in very hot mines**
  - **Chill the service water that is used for drilling, cleaning and allaying dust**

  Underground cooling has a much better **"Positional Efficiency"**, because it is situated closer to the place where cooling is required. However, **heat rejection is much more difficult and expensive**, because the **heat absorbed from the air and / or water has to be transferred to a limited flow if up-cast air**, which is **already hot and humid.**

  (6)

[20]

QUESTION 4

4.1 Calculate the hoist motor input and output power. The hoist motor gives off 320kW as heat and the motor is 87% efficient. (6)

Percentage given off as heat = 100 - 87 = 13% (1)

But this 3% equals to 310kW (het given off is inefficiency of the motor)

Therefore 100% = $\frac{100}{13}$ x $\frac{310}{1}$

= 2384.6 kW (1)

Hoist motor output = 2384.6 x 0.87

= 2074.6 kW (1)

Check: - motor input = Output + Heat given off (1)

= 2074.6 + 310 (1)

= 2384.6 kW (1)

4.2 Determine the pressure required to overcome friction when 60m^3/s of air flow along a 4.0m * 3.0m rock tunnel. 1500m long at a density of 1.35kg/m^3. (7)

Given that: K = 0.011Ns^2/m^4 (assumed as it has not been given)

C = 2(4+3) = 14m (1)

L = 1500m

Q = 60 m^3/s

A = (4 x 3) = 12m^2 (1)

w = 1.35 kg/m^3

Now $P = \frac{KCLQ^2}{A^3} \times \frac{w}{1.2}$ (1)

$= \frac{0.011 \times 14 \times 1500 \times (60)^2}{(12)^3} \times \frac{1.35}{1.2}$ (3)

= **541 Pa** (1)

4.3 5.0m^3/s of air flows in a 570mm galvanized duct, 210m in length Calculate the air power involved (7)

Given that: Q = 5.0 m3/s

L = 210 m

D = 570 mm

Wa = ?

Then, C = πD
= 3.14 x 0.570 (remember D is always in meters)
= 1.789 m (1)

And A = $\frac{\pi D^2}{4}$
= 0.255 m^2 (1)

Now Wa = $\frac{RQ^3}{1000}$ where R = $\frac{KCL}{A^3}$
= $\frac{0.0037 \times 1.789 \times 210}{(0.255)^3}$ (1)
= 83.83 Ns^2/m^8 (1)

Hence Wa = $\frac{RQ^3}{1000}$ (1)
= $\frac{83.83 \times (5.0)^3}{1000}$ (1)
= 10.47 kW

Air Power involved = 10.5 kW (1)

[20]

QUESTION 5

5.1 The following figures were obtained from a fan test conducted on a direct driven axial flow fan,
Fan speed: 13.5 r/s
Air density: 1.012 kg/s

Quantity (m3/s)	Pressure (Pa)	Input Power (kW)
0	930	3.6
2	840	4.6
4	870	5.9
6	910	7.8
8	860	10.0
10	730	12.4
12	490	14.7
13	310	15.0
14	0	14.6

From these figures draw a complete fan performance curve, including power and efficiency curves.

Determine the fan operating point, (FOP) input power and efficiency of this fan if installed in a 760mm galvanised duct, 54m long, having a frictional factor of 0.0035 Ns^2/m^8 at a prevailing density of 1.012 kg/m^3.

From the information given in the table above, without any additional calculations, draw the following curves after selected a suitable scale to be used on the graph paper,

a. Fan characteristic curve or performance curve. Plotting quantity on horizontal or x-axis, against pressure on vertical or y-axis. (3)
b. Input power curve by plotting quantity (X-axis) against in-put power (y-axis) (3)

See Graph

Plot Fan Efficiency curve

Fan Efficiency = $\frac{\text{Airpower}}{\text{Fan input Power}}$ x 100 (1)

Air Power (Wa) = $\frac{PQ}{1000}$ (1)

Using the table above, add in two additional columns to the table with the headings “Air-Power” and “Efficiency

Quantity (m3/s)	**Pressure (Pa)**	**Input Power (kW)**	**Air-Power (kW)** $Wa = \frac{PQ}{1000}$	**Efficiency (%)**
0	930	3.6	0	$\frac{0}{3.6} \times 100 = 0$
2	840	4.6	1.7	37.0
4	870	5.9	3.5	59.0
6	910	7.8	5.5	70.0
8	860	10.0	6.9	69.0
10	730	12.4	7.3	59.0
12	490	14.7	5.9	40.0
13	310	15.0	4.0	27.0
14	0	14.6	0	0
			(4.5)	(4.5)

From the above table plot the Efficiency curve by plotting the quantity (x-axis) against the efficiency (y-axis) (2)

Before the fan operating point, fan input power and fan efficiency can be determined, the system resistance must be calculated and then plotted.

Given that: the fan is to be installed in a 760mm galvanised duct, 54 m long with a frictional factor of 0.0035 Ns2/m4, the resistance can be calculated,

R = $\frac{KCL}{A^3}$ (note $\frac{w}{1.2}$ was not included as both fan and system are at a

density of 1.012 kg/m^3)

$$= \frac{0.0035 \times 2.386 \times 54}{(0.453)^3} \quad (1)$$

$$= 4.85\ Ns^2/m^8 \quad (1)$$

Calculate the points to be plotted on the graph for the system resistance curve, use P = RQ2

Assume quantities ad calculate their corresponding pressure using the resistance calculated in the above system

Quantity	Resistance	$Quantity^2$	Pressure
0	4.85	0	0
2	4.85	4	19
4	4.85	16	78
6	4.85	36	175
8	4.85	64	310
10	4.85	10	485
12	4.85	144	698
14	4.85	196	951

(4)

Plot the above pressure (y-axis) against quantities on (x-axis) (2)

Read the graph as follows: -

- Where the system resistance curve intersects the fan characteristic curve, is the Fan Operating Point (FOP)
- From the FOP, go horizontally on a constant pressure line to the left and read off the pressure – 610 Pa. This is the pressure the fan must operate to overcome the resistance of the system.
- Again from the FOP point, go vertically down on a constant quantity line and read off the quantity – 11.2 m^3/s. this is the quantity the fan will handle at a pressure of 610 Pa.
- Where the vertical quantity line intersects the efficiency curve, go horizontal to the right, read off the efficiency of the fan on the efficiency scale – 49%.
- Read off the input power of the fan. Start at the FOP, go vertically up to intersect the power input curve, then go right and read off the input power of the fan on the input power scale – 13.8 Kw.

Thus	FOP	=	11.2 m3/s @ 610 Pa	(1)
	Fan input Power	=	13.8 kW	(1)
	Fan Efficiency	=	49%	(1)

[30]

TOTAL MARKS: 100