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 MAY 20** **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 or diagrams wherever possible.
7. Answers must be given to an accuracy which is typical of practical conditions.

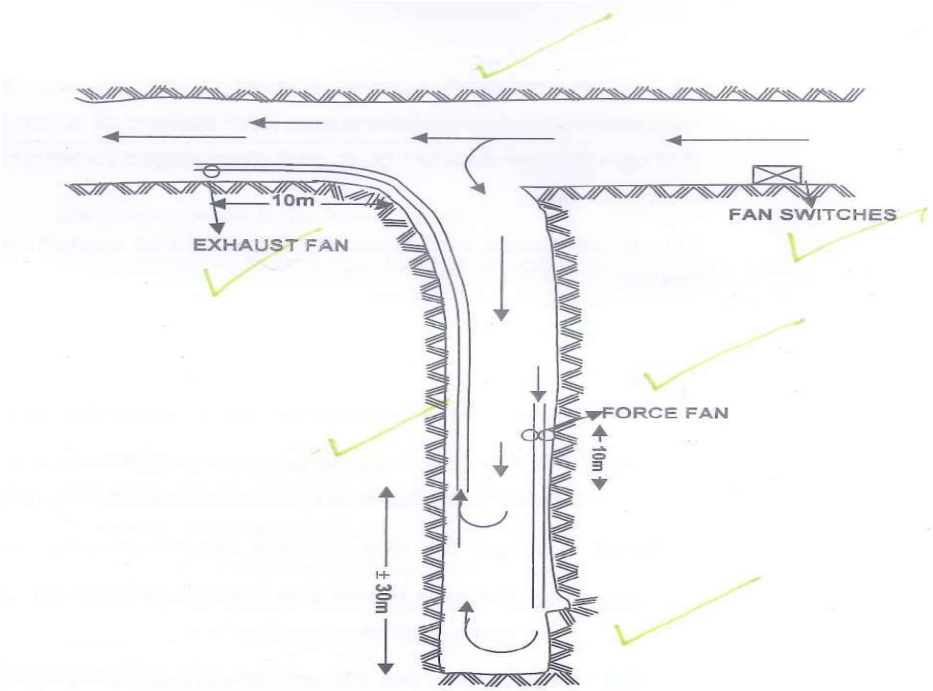
   NB Ensure that the correct unit of measure (SI unit) are recorded as marks will be deducted from answers if the incorrect unit is used. (Even if the calculated value is correct).

   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 With the aid of a sketch, draw an Exhaust overlap ventilation system for a development end. (6)

Sketch



1.2 List the requirements needed for the Exhaust overlap system. (6)

- **The exhaust fan to be located at least 10m in through ventilation**
- **The column to be extended to within 30m from the face**
- **A second smaller fan installed 10m from exhaust column intake**
- **The column to be extended to within 12m from the face**
- **The force fan must not handle more than 2/3 the exhaust fan intake volume**
- **The overlap section to be ventilated to prevent a possibility of any noxious and flammable gas accumulation**

1.3 List the advantages and disadvantages of the Exhaust overlap system? (8)

Advantages

- **Persons travelling and working in the development end do so in the fresh air as the return air is inside the exhaust column**
- **Short re-entry periods are possible when used in multi-blast or high speed development ends**

- **Return air is under control**

Disadvantages

- **Intake air moves slowly along the drive and picks up heat, dust and loco fumes along the way, hence the quality of air supplied to the face is inferior in quality to the air supplied by a force system**
- **Two columns and fans required**
- **Poor conditions can exist in the overlap.**
    - **Gas accumulation**
    - **Hence the overlap not to exceed 10m and air velocity to be above 0.30 m/s**
- **If the exhaust column is not kept under a negative pressure, contaminated air from the face will leak into the air flowing to the face. Undesirable in multi blast development ends.**

[20]

QUESTION 2

2.1 During the monitoring process of a fire how would you monitor the trend? (10)

- Gas samples, temperatures, air volumes and air pressure measurements are taken during a fire and plotted on a graph because this information is important in determining the trend of the fire
    - Carbon dioxide (CO_2) concentrations and temperatures will increase while the fire is burning. When they tend to level out or decrease the fire is being extinguished
    - The presence of carbon monoxide (CO) indicates that the fire is smouldering rather than burning, the seals around the fire should not be opened until the CO concentration is Zero
    - If the Temperature in the fire area remains greater than 90^{o}C, the fire area should not be opened, because the large amount of heat enclosed in the area may cause the fire to re-ignite if currents of air enter it
    - Air volume measurements will ensure the correct flow through the fire area is maintained
    - Each Mine has or should have a Fire Fighting Procedure Manual

2.2 Escape Routes are an integrated part of the Escape Strategy of a Mine. List the Strategy and essential Factors to effect a successful escape strategy. (10)

Strategy

- Displayed at the waiting places of all underground workings places, (Stopes, Development, Engineering Workshops, etc) as well as the surface structures (Offices, Plants, Workshops etc)
- Reviewed / Revised and updated on a regular basis, preferable after routine survey of the work place and following a ventilation change over
- Clearly demarcated with symbolic signs from the work place to the applicable Refuge Bay / Place of Safety

Essential Factors

- Training
- Regular fire drills
- Demarcation of route
- Accessibility of route
- Shortest route to the Refuge Bay / Place of Safety

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QUESTION 3

3.1 Describe the function of each of the main components of a Refrigeration Plant. (16)

- The Function of each component of Refrigeration Plant

Evaporator

- The refrigerant enters the evaporator as a cool liquid and absorbs the heat from the medium to be cooled (usually water) which flows inside the evaporator tubes. As the refrigerant liquid absorbs heat from the warmer water, it starts to evaporate into a refrigerant gas by absorbing latent heat at a constant temperature, the refrigerant leave the evaporator s a gas at a low temperature and pressure

Compressor

- The refrigerant gas at a low temperature and pressure is sucked into the compressor where it is compressed, adding sensible heat to the gas. The refrigerant gas now leaves the compressor at a high temperature and pressure

Condenser

- The hot refrigerant gas at a high pressure flows into the condenser and transfer the heat to a medium (water), which flows inside the condenser tubes. The water absorbs the sensible added by the compressor and the latent heat added by the evaporator. The refrigerant gas condenses to a liquid and leaves at a high temperature and pressure

Expansion Valve

- The refrigerant liquid then enters the expansion valve where the pressure is released, and the refrigerant liquids expands, cools

down and flows back to the evaporator, where the whole cycle is repeated continuously

3.2 Name the types of Refrigeration systems available. (4)

- Vapour Compression System
- Absorption System
- Steam-Jet System
- Ice-Making System
- Water Vapour System

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QUESTION 4

4.1 Calculate the Friction factor of a haulage, 450m long, which is 3.0m x 2.8m. The air density is 1.1 Kg/m^3 and the resistance of the hlge is 0, 1292 Ns^2/m^8. (5)

Give that: L= 450m C= 2(3.0 +2.8) = 11.6m
R= 0.1292Ns^2/m^8 A= (3.0 x 2.8) = 8.4m^2
W= 1.1 kg/m^3

$$R = \frac{KCL}{A^3} \times \frac{w}{1.2}$$

Re-arranging the formula

$$K = \frac{RA^3}{CL} \times \frac{1.2}{w}$$

$$= \frac{0.1292 \times (8.4)3 \times 1.2}{11.6 \times 450 \times 1.1}$$

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

Friction Factor = 0.016Ns^2/m^4

4.2 Air flows in a 1,5 Km haulage with a resistance of 0,444 Ns^2/m^8 and the air Power involved is 15 Kw. Calculate the quantity of the air flowing in the haulage. (5)

Give that: R= 0.444Ns^2/m^8 Wa= 15 kW
Q= ?

$$Wa = \frac{RQ^3}{1000}$$

Re-arranging the formula

$$Q = \frac{\sqrt[3]{1000\ Wa}}{R}$$

$$= \frac{\sqrt[3]{1000 \times 15Wa}}{0.444}$$

$$= 32.4\ m^3/s$$

Quantity Flowing = 32.4 m^3/s

4.3 List the factors that may cause a resistance to airflow? (10)

- **Friction**
  - "Skin" friction between the air surface and the inside of the duct
- **Size**
  - The larger the duct, the lower the resistance, and Visa Versa
- **Length**
  - The length of the duct also effects resistance and hence the amount of air flowing through at a fixed pressure, and Visa Versa
- **Shock Losses**
  - Sudden increase or decrease in a duct size result in a change in velocity of the air current flowing through the duct.
- **Obstructions**
  - Any obstruction affects the flow of air in a duct, causing a reduction in cross-sectional area and hence an increase in velocity that results in increased frictional resistance
- **Bends or change in air flow direction**
  - Air flowing around bend loses some of its momentum as a result of its inability to change its direction smoothly.

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QUESTION 5

5.1 The sketch below represents a network of airways with resistances given in Ns^2/m^8. Determine the total resistance of the whole network.

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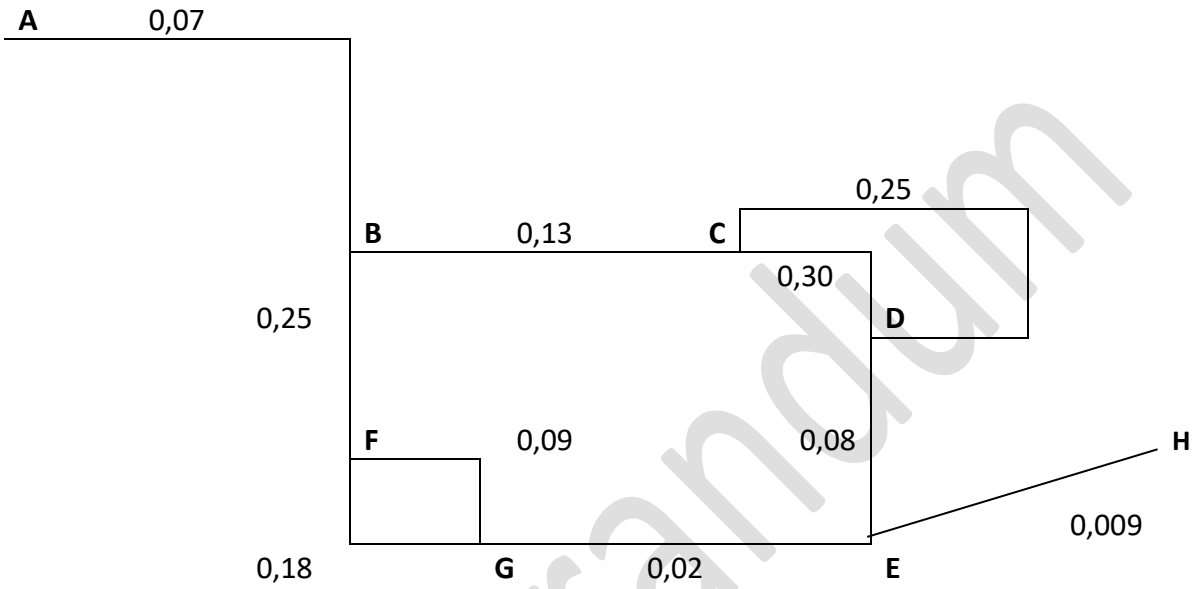
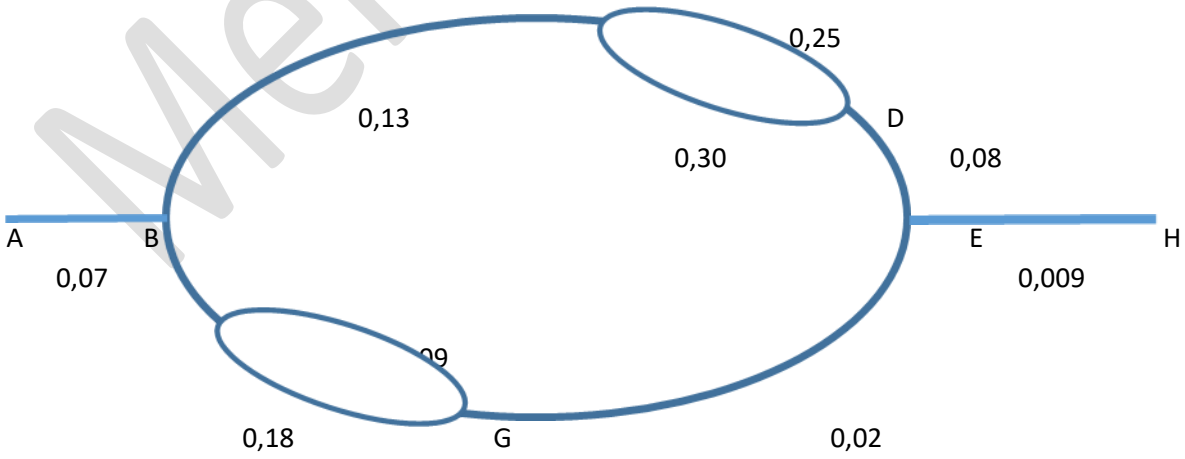


The above sketch can be re-drawn in a simple form



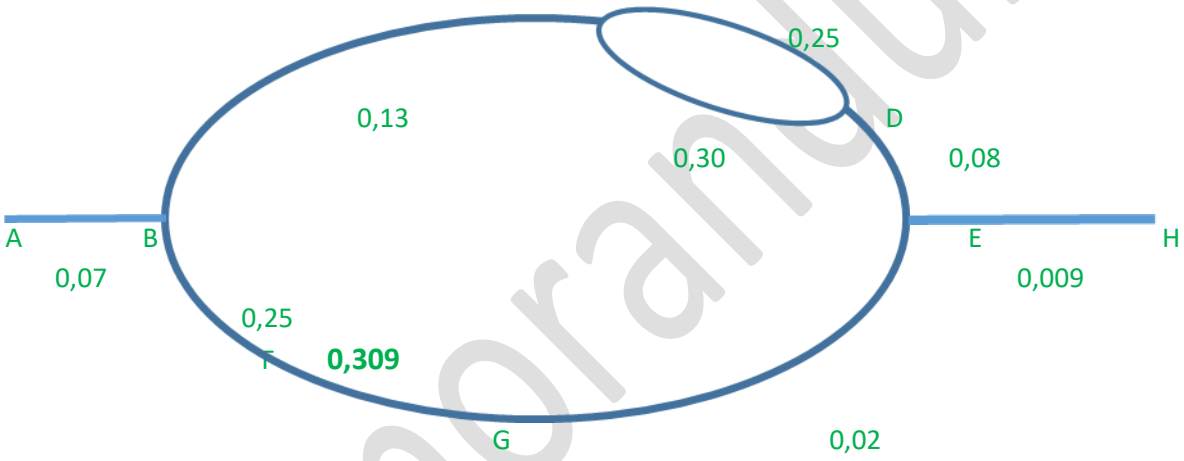
- Solve parallel system first, starting with the smaller parallel, within the bigger parallel system

$$FG: \quad \frac{1}{\sqrt{R_{FG}}} = \frac{1}{\sqrt{R_{FG\ Top}}} + \frac{1}{\sqrt{R_{FG\ Bot}}}$$

$$= \frac{1}{\sqrt{0.09}} + \frac{1}{\sqrt{0.18}}$$

$$R_{FG} = 0.0309\ Ns^2/m^8$$

The system can now be shown as:



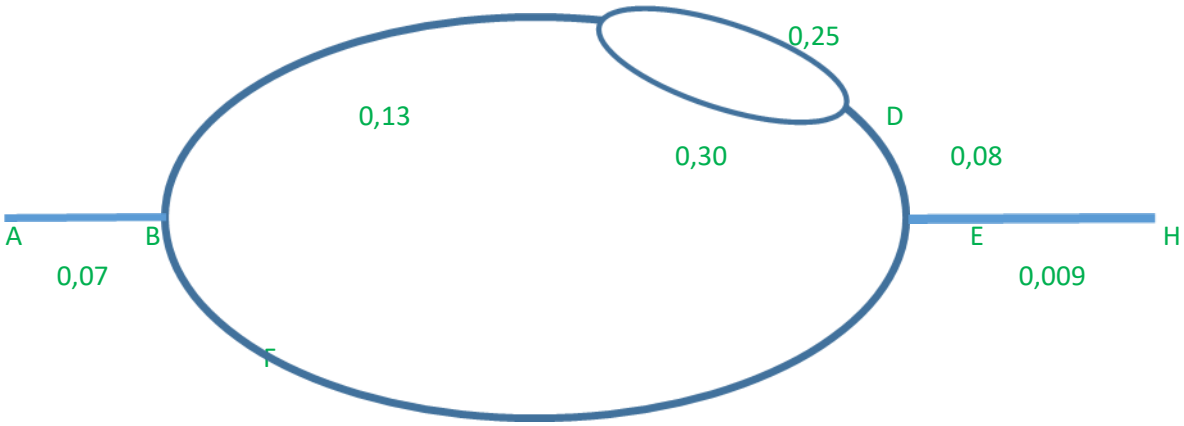
Know BF is in series with FG which is in series with GE

$$R_{BFGE} = R_{BF} + R_{FG} + R_{GE}$$

$$= 0.25 = 0.309 + 0.02$$

$$= 0.3009\ Ns^2/m^8$$

The system can now be shown as:



G

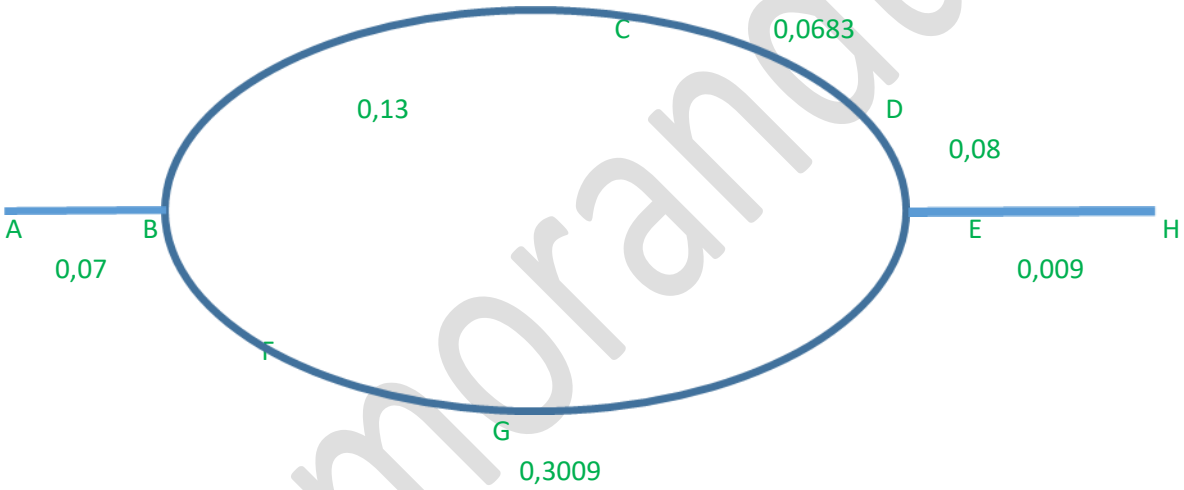
0,3009

$$CD: \quad \frac{1}{\sqrt{R_{CD}}} = \frac{1}{\sqrt{R_{CD\ Top}}} + \frac{1}{\sqrt{R_{CD\ Bot}}}$$

$$= \frac{1}{\sqrt{0.25}} + \frac{1}{\sqrt{0.30}}$$

$$R_{CD} = 0.0683\ Ns^2/m^8$$

The system can now be shown as:



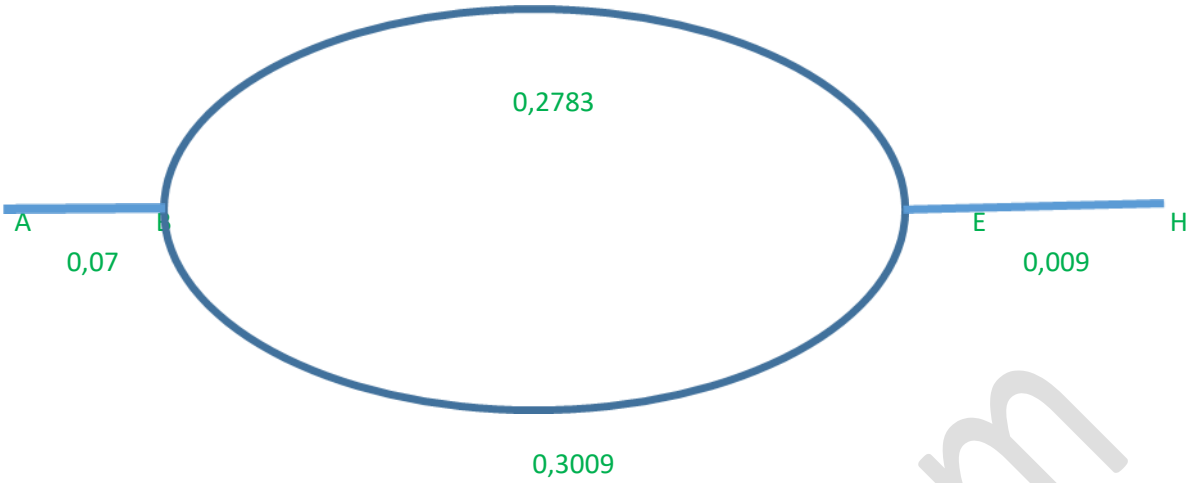
Know BC is in series with CD which is in series with DE

$$R_{BCDE} = R_{BC} + R_{CD} + R_{DE}$$

$$= 0.13 = 0.0683 + 0.08$$

$$= 0.2783\ Ns^2/m^8$$

The system can now be shown as:



$$\text{BE}: \quad \frac{1}{\sqrt{R_{BE}}} = \frac{1}{\sqrt{R_{BE\ Top}}} + \frac{1}{\sqrt{R_{BE\ Bot}}}$$

$$= \frac{1}{\sqrt{0.2783}} + \frac{1}{\sqrt{0.3009}}$$

$$R_{CD} = 0.0723\ Ns^2/m^8$$

The system can now be shown as:

Now AB is in series with BE, which is in series with EH

$$R_T = R_{AB} + R_{BE} + R_{EH}$$

$$= 0.07 + 0.0723 + 0.009$$

$$= 0.1513\ Ns^2/m^8$$

In other words the system has become:

TOTAL MARKS: 100