Minerals Council South Africa

EXAMINATION MEMORANDUM

SUBJECT: CHAMBER OF MINES OF SOUTH AFRICA – INTERMEDIATE CERTIFICATE IN MINE ENVIRONMENTAL CONTROL PAPER 2 **SUBJECT CODE: COMIMEC2** **EXAMINATION DATE: 15 OCTOBER 2018** **TIME**: 14:30 – 17:30	**EXAMINER:** M VAN DER BANK **MODERATOR:** N. KRUGER **TOTAL MARKS:** 100 **PASS MARK:** 60

NUMBER OF PAGES: 5

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

INSTRUCTIONS TO CANDIDATES:

1. Answer all questions **legibly** in English.

Write your **ID number** on the outside cover of each book used and on any graph paper or other loose sheets handed in. **Psychrometric charts at 82.0 kPa and 87.5 kPa, 105.0 kPa, 110.0 kPa and 110.5 kPa are provided for Question 4.2.**

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

2. Show all calculations **and check calculations on which the answers are based.**
3. Hand-held electronic calculators may be used for calculations.
4. Write **legibly** in ink on the **right hand page** only – **left hand pages will not be marked**.
5. Illustrate your answers by means of sketches or diagrams wherever possible.
6. 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).
7. 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 State the thermal capacity values of:

- Ice (2,094 kJ/kg^{o}C) (1)
- Coal (1,005 kJ/kg^{o}C) (1)
- Quartzite (0.837 kJ/kg^{o}C) (1)

1.2 Define the following:

- Power (2)
  Is the timed rate at which energy is released, expressed in watt (joules per second) or kilowatt (Kilo-joules per second)
- Latent Heat of Fusion (2)
  That which causes a change of state of a substance from a liquid to a solid e.g. water that changes to ice
- Latent Heat of Evaporation (2)
  That which causes a change of state of a substance from a liquid to a vapour e.g. water that changes into water vapour
- Heat Transfer Processes (2)
  The main "driving force" which causes heat to be transferred, is the difference in temperature between two substances or bodies. As mentioned earlier, heat always flows from a higher temperature (hot body) to a lower temperature (cold body).
- Wet-Bulb Temperature (2)
  Together with the dry-bulb temperature it is a measure of the evaporating capacity of the air in ℃.

1.3 Heat can effect a human in three different ways. Please explain all three ways and explain the different effects. (5)

Answer: Page 31-32

Heat can affect a worker in three different ways:

- Physiological effects
- Psychological effects
- Productivity effects (Work Performance)

Physiological effects

Is where the body tries to compensate by sweating more profusely when air temperatures and / or work rate increases. The evaporation of sweat produces cooling of the human body, but however, if thermal conditions deteriorate (temperature, humidity and velocity), the rate of sweat evaporation is greatly reduced, resulting in very little cooling. Working at a high rate in such conditions may result in the following heat disorders:

- Cramps
- Heat rash
- Dehydration
- Heat exhaustion

• Heat stroke

For the symptoms, signs, causes, treatment and prevention of the abovementioned heat disorders, refer to the "Heat Stress" notes, page 68.

Psychological Effects

Is where the mental and physical activities (human performance) are affected differently by heat. Some activities may improve as heat levels increase, but then deteriorates as the heat levels exceed a certain critical level.

A worker's ability to concentrate diminishes and become less aware of visual signals, resulting in making more errors and increased accident rates. It is also a well – known fact that tempers become worse under hot conditions.

Productivity Effects

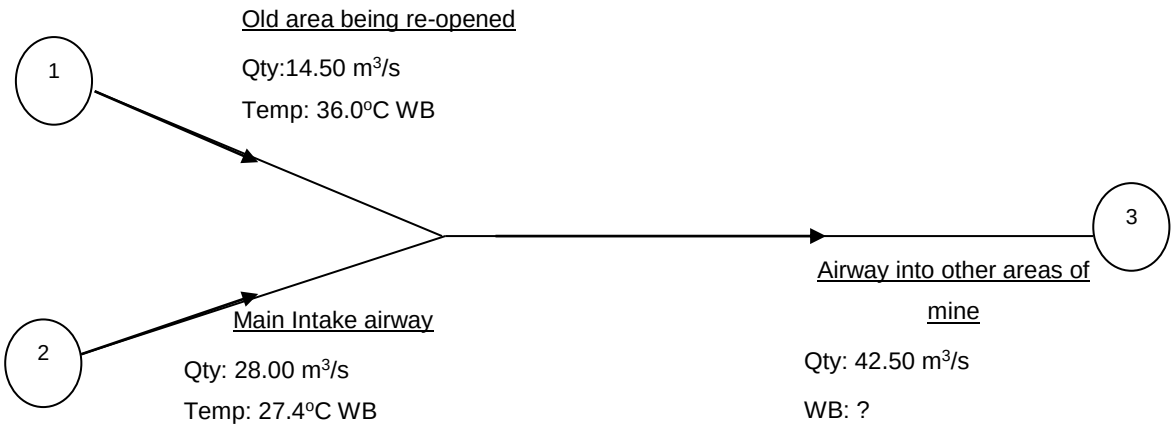
The performance of all tasks is adversely affected at temperatures above 27,0oC. Experiments done by the Chamber of Mines Research Organisation (COMRO) have shown that with wet-bulb temperatures of 27,0oC and lower, even with low air velocities, a person's work performance is unaffected.

1.4 What is the main methods of reducing the effects of heat? (5)

Answer: Page 33-35

- Reducing heat-flow from rock
- Removal of machinery
- Dilution by ventilation
- Acclimatisation
- Refrigeration

1.5 You are required to calculate the wet-bulb temperature of an area that will be opened for mining to be done in the near future. Calculate the wet-bulb temperature after mixing of the airstream and give comment if the condition will be conducive for mining to be done going into other areas of the mine at point 3. (5)



Answer: Page 61

Answer

Now $(Q_1 \times T_1) + (Q_2 \times T_2) = (Q_1+Q_2)\, T_3$

$$\therefore T_3 = \frac{(Q_1 \times T_1) + (Q_2 \times T_2)}{(Q_1 + Q_2)}$$

$$= \frac{(14.5 \times 36) + (28 \times 27.4)}{(14.5 + 28.0)}$$

$$= \frac{(522 + 767.2)}{42.5}$$

$$= \frac{1289.2}{42.5}$$

∴ **Wet bulb after mixing = 30.3ºC (The temperature is conducive and work may continue at the downstream end of this working place.)**

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QUESTION 2

2.1 Flammable gas is a known danger in mines. In some instances the most common system failures can lead to gas accumulations, fires or disastrous explosions. Indicate these system failures. (5)

Answer: IMEC Workbook 2, Pg 217

- Poor Supervision
- Lack of Awareness
- Irresponsibility
- Production Pressure
- Psychological Factors

2.2 What is the normal procedure to take when testing for flammable gas layering? (7)

Answer: IMEC Workbook 2, Pg 237

When testing for flammable gas layering, the normal procedure to test for flammable gas must be applied:

- Perform all the pre-use checks on the flammable gas measuring instrument.
- Test for flammable gas in the normal way (never use a probe - raise instrument to hanging wall).
- If a flammable gas source is detected, continue with testing upstream and downstream from the source of issue against the hanging wall, in order to detect and determine whether any roof layering has occurred.
- If any roof layering has occurred, take further tests / readings to explore the extent, thickness and concentration of the flammable gas roof layer.
- Determine the velocity of the ventilating air flowing over the source.

- Never attempt to disperse the roof layer during the shift, but make arrangements to do it during the off-shift period or under controlled conditions by competent people.
- Action the withdrawal procedure.

2.3 What are the effects or symptoms on people when they are exposed to oxygen at the following levels? (5)

1. At 17% Oxygen
2. At 14% Oxygen
3. At 13% Oxygen
4. At 10% Oxygen
5. At 9% Oxygen

IMEC Workbook 2, Pg 227

- At 17% oxygen by volume, the breathing rate increases.
- At 14% oxygen by volume, faster breathing and dizziness occur.
- At 13% oxygen by volume, high breathing rate, headaches, dizziness and buzzing of the ears occur.
- At 10% by volume, high breathing, rapid pulse and unconsciousness occur.
- At 9% and below by volume, rapid collapse, coma and sudden death will occur.

2.4 You are instructed to accompany a team into an old worked out area to investigate potential mineable ground. What instruments would you take to measure the environmental conditions? (5)

Old exam paper Oct 2007 Q3e

1. Instrument with an oxygen sensor
2. Flammable gas measuring instrument
3. Chemical detector tubes
4. Whirling hygrometer
5. Self- contained self- rescuer

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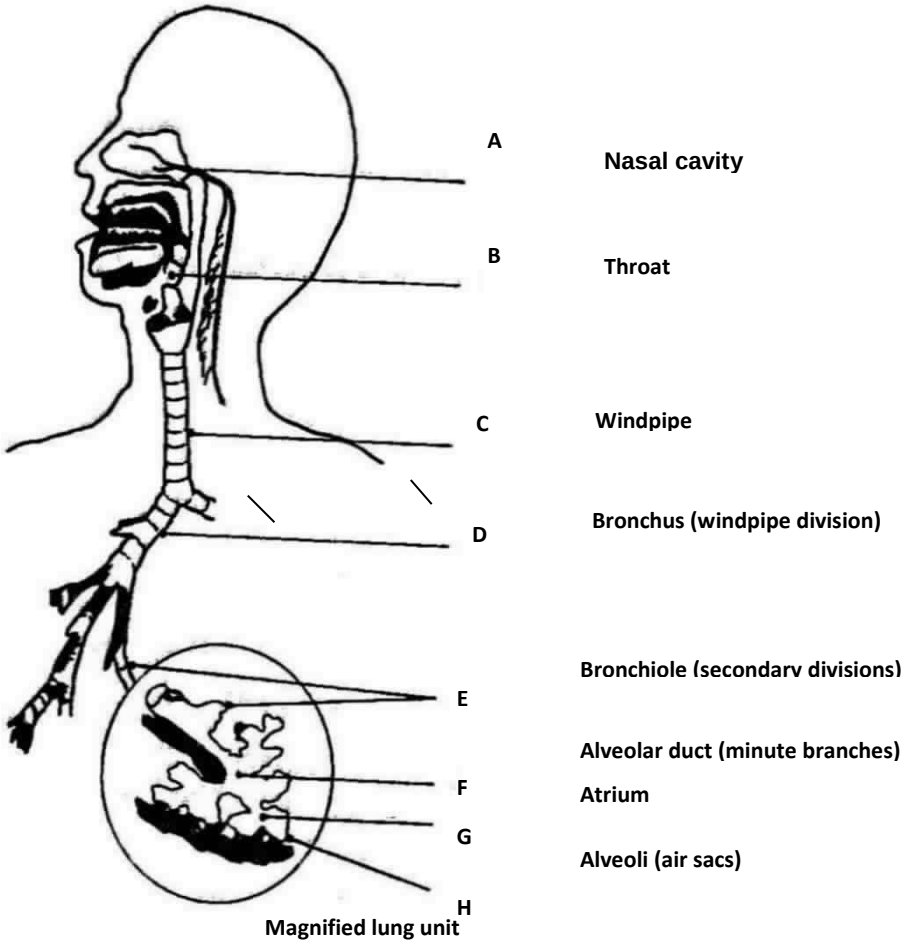
QUESTION 3

3.1 The diagrammatic sketch of the human respiratory system below indicates the air passages consist of the human, please indicate all the parts on the sketch below: (8)



Magnified lung unit

IMEC Workbook 2, Pg 212

3.2 Name five of the physical characteristics of airborne particulates of dust. (5)

IMEC Workbook 2, Pg 167

The following parameters can be used to describe airborne particulates and the extend to which they are found in air:

- The number of particles per unit volume.
- The size distribution of the particles.
- The mass of the particles per unit volume.
- The total surface area of particles per unit volume.
- The chemical composition of the particles.

3.3 Name the characteristics of a real-time ideal dust measuring instrument (Tyndalometer)? (6)

IMEC Workbook 2, Pg 174

The ideal instrument should meet the following requirements:

1) Measure accurately the dangerous dust in the air.
2) Be portable, robust and dependable.
3) Be easy to use and to evaluate the samples.
4) Take a sample over a long enough period so as to obtain a representative sample.
5) Not require external power supplies.

3.4 What is the five factors to be considered for industrial water supply? (5)
IMEC Workbook 2, Pg 194

The suitability of an industrial water supply depends mainly on five factors, namely:-

a) Its acidity. (pH)

b) The concentration of solids in solution and in suspension.(e.g. dust).

c) Its pressure.

d) Its temperature.

e) Its flow rate.

3.5 Explain the effects of good and poor illumination and give two examples of each. (4)
IMEC Workbook 2, Pg 320

Good Illumination
There is no doubt that good or improved illumination underground and/or on surface have the following beneficial effects:

- Decreases the risk of accidents and reduce errors.
- Increases productivity.
- Improve working conditions, morale and motivation.
- Preserves human energy.
- Reduce eye-strain and minor illnesses.
- Prevent the accumulation of waste and rubbish.
- Better utilisation of men and material.
- Improve the ability to move around and provide greater safety.

Poor Illumination
Poor illumination can be an important contributing factor to the following:

- Tiredness: people using their hands and eyes to perform work under poor illumination tires more quickly.
- Accidents: causes loss of money, life and incalculable suffering.
- Poor productivity: caused by low morale and motivation in the work force.
- Safety hazard: dangerous acts and working conditions cannot be easily noticed or detected.
- Causes eye-strain and minor eye illnesses.
- Hamper the ability to move around easily.
- Sharp increase in the number of errors by workers.
- Wastage of material and damage to equipment.
- Accumulation of waste, rubbish and old explosives that can pose a fire hazard and unhealthy environments.

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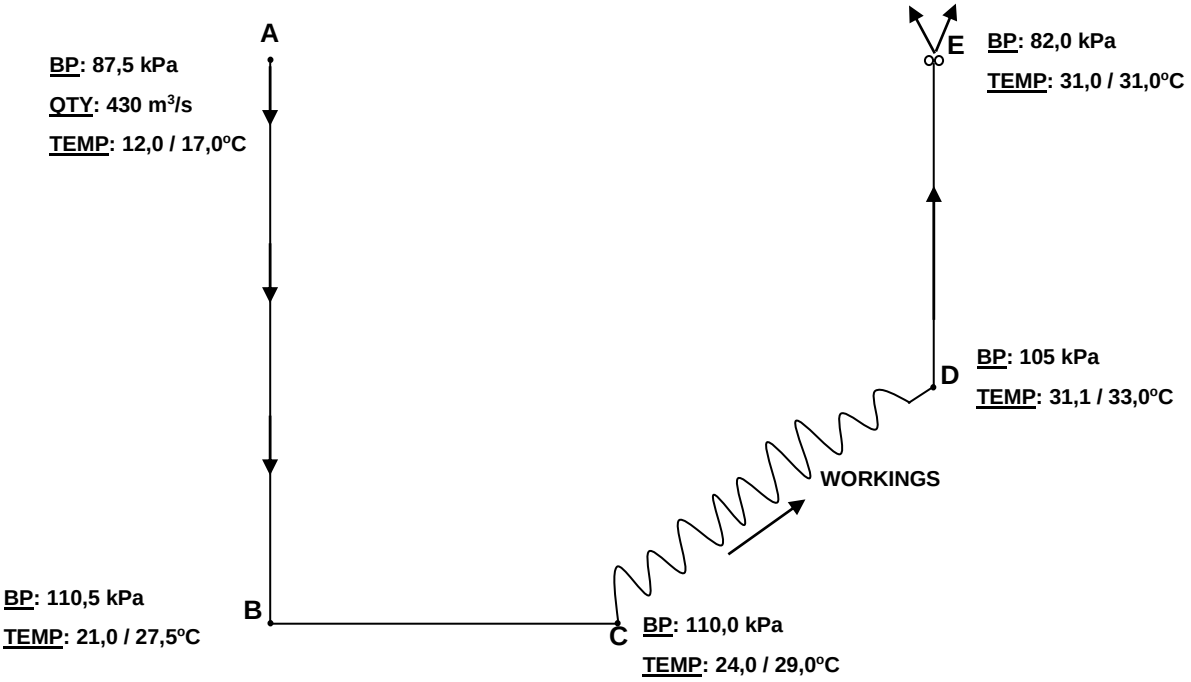
QUESTION 4

4.1 The attached sheet marked Annexure A indicates an example of a Psychrometric Chart. Name all the components of the chart as indicated in the sketch? (8)

IMEC Workbook 2, Pg 150

4.2 From the below sketch, calculate the quantities at B,C,D and E assuming there are no air leakages? (10)



IMEC Workbook 2, Pg 134-135

Answer

Mass-flow at A = $\frac{Q}{ASV}$ (where ASV = 0,965m³/kg from 87,5 kPa psychrometric chart)

= $\frac{430}{0,965}$

= 445,6 kg/s

But mass-flow remains constant throughout the system.

Therefore mass-flow A (M_A) = 445,6 kg/s = M_B = M_C = M_D = M_E

Now if M = $\frac{Q}{ASV}$

Then Q = M x ASV

∴ Q_B = M x ASV (where ASV = 0,799 m³/kg from 110,0 kPa Psychrometric chart)

= 445,6 x 0,799

= **356,0 m³/s**

Q_C = M x ASV (where ASV = 0,808 m^3/kg from 110,0 kPa chart)

= 445,6 x 0,808

= **360,0 m^3/s**

Q_D = M x ASV (where ASV = 0,873 m^3/kg from 105 kPa chart)

= 445,6 x 0,873

= **389,0 m^3/s**

Q_e = M x ASV (where ASV = 1,12 m^3/kg from 82,5 kPa chart)

= 445,6 x 1,12

= **499,0 m^3/s**

(Note that at B and E, the closest psychrometric to the given barometric pressures have been used).

4.3 Define the following:

- Charles' Law (2)

  This law states, that at constant pressure, the volume of a given mass of a gas is directly proportional to the absolute temperature.
  Now remember, from the Heat Notes, absolute temperature (Kelvin):
  K = 273 + oC (Dry-Bulb)
  Therefore (at constant pressure)
  Where V = Volume (m3, m3/s, m3/kg)
  T = Absolute temperature (K)
  Subscripts 1 and 2 have the same meaning as stated with Boyle's Law.

- Universal Gas Law (2)

  This law is a combination of Boyle's and Charles' Laws. It express the relationship between pressure, volume and absolute temperature.

  Therefore

  Where P = Absolute pressure (Pa, kPa)
  V = Volume (m3, m3/s, m3/kg)
  T = Absolute temperature (K)

IMEC Workbook 2, Pg 112-113

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TOTAL MARKS: [100]

Annexure A – Question 4.1 Answer Sheet IMEC Workbook 2, Pg 150