Minerals Council South Africa

EXAMINATION PAPER

SUBJECT: **CHAMBER OF MINES OF SOUTH AFRICA – CERTIFICATE IN MINE ENVIRONMENTAL CONTROL**	EXAMINER**: Margaret Jepi**
PAPER 2 – MEC Intermediate	MODERATOR: **Navarre Kruger**
SUBJECT CODE: **COMMEC2**	TOTAL MARKS: **[100]**
EXAMINATION DATE: 16 May 2022	
TIME: 14:30 – 17:30	PASS MARK: **(60%)**

NUMBER OF PAGES: 11 (including Psychrometric charts)

SPECIAL REQUIREMENTS:

THIS IS **NOT** AN **OPEN BOOK EXAMINATION**.

FORMULA HANDOUTS ARE AVAILABLE TO CANDIDATES:

1. Answer all 4 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 your 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 measurement (SI unit) is recorded, as marks will be deducted from answers if the incorrect unit is used (even if the calculated value is correct).

8. Please note that you are not allowed to contact the examiner or moderator regarding this examination.
9. Cell phones and any other electronic devices are **NOT** allowed in the examination room.
10. **The following Psychrometric charts are included: 105 kPa and 120 kPa.**

QUESTION 1

1.1 The table below indicates classification and appropriate action for various level of emission. Name occupational hygiene SAMOHP and stipulate the use of Categories and emission classification factor (ECF) method and appropriate action for various level of emission (12)

1.2 Briefly describe the following terms:

LAeq,T,LReq,T Or TWA 8h dB(A)	Emission classification according to:		
	Occupational Hygiene SAMOHP	Emission classification factor (ECF), level of significance and required action	
<82	- (½)	0(½)	Insignificant risk of NIHL(1)
82-85	C(½)	1(½)	Potential risk NIHL. Monitor emission and exposure levels for upward trends.(1)
86-90	B(½)	2(½)	Moderate risk of NIHL. Intervene, Re-e-assess and monitor(1)
91-95	B(½)	3(½)	Significant risk. Priority intervention. Re-assess and monitor(1)
96-105	B(½)	4(½)	Unacceptable risk. Immediate intervention. Re-assess and monitor.(1)
≥106	A(½)	5(½)	Extreme risk. Urgent intervention. Re-assess and monitor(1)

a) Equivalent continuous A weighted sound pressure level (2)

-LAeq is that constant A- weighted sound pressure level which is equivalent to the varying A- weighted sound pressure level (LpA) over a given time interval.

b) Decibels (dB) and how it is expressed mathematically *(*2)

-Is ten times the logarithm to the base of ten of the ratio between two quantities of power

c) Intruding noise (2)

Is noise in a space that is generated by sources other than those resulting from the intended activities of the space

d) Sound power and name SI units (2)

-Is the nett amount of power emitted by a source to the surrounding medium in the form of sound waves expressed in (W/m^2)

1.3 Give two reasons why noise dosimeter instrument was developed (2)

-Sometimes workers move around a lot to several locations in their working environment and are therefore subjected to different noise levels. This makes it difficult to accurately determine the workers exposure to noise with the aid of sound level meter. For this reason, the personal noise dosimeter was developed which gives a more accurate reflection of the individual's exposure to noise-most commonly the daily noise dose.

1.4 Describe the process for retrieving noise dosimeters after sampling (3)

-Remove the dosimeter and while the worker is still present, examine the instrument for damage while accessing the controls and display. If the dosimeter was not set to stop at a pre-determined time, manually pause it to halt further logging and record the stop time. Display the relevant parameters (variously indicated as Leq,TWA 8h or % Dose) and inform the worker of the result. Do not clear the instrument's memory at this time.

(25)

QUESTION 2

2.1 Define and give the formulae with units for Boyle's Law. (3)

This law states, that at a constant temperature (½), the volume of a given mass of a gas (½) is inversely proportional (½) to the absolute pressure exerted on it (½).

$P_1V_1 = P_2V_2$ (at constant temperature) (½)

P = Absolute pressure (kPa) V = Volume (m_3, m_3/s, m_3/kg) (½)

2.2 Define and give the formulae with units for Charles' Law. (3)

This law states, that at a constant pressure (½), the volume of a given mass of gas (½) is directly proportional (½) to the absolute temperature (½). Note absolute temperature = Kelvin.

$V_1 = V_2$ (at constant pressure) (½)

T_1 T_2

V = Volume (m, m/s, m/kg) T = Absolute Temperature (K) (½)

2.3 A certain mass of air has a volume of 450m^3/s on surface where the barometric pressure is 87.5 kPa. What would the pressure be at the bottom of the shaft where volume is 350m^3/s assuming the temperature remain constant. Assume density of 1.2 kg/m^3

The temperature remains constant, therefore Boyle's Law must be used

$P_1V_1=P_2V_2$

Where $V_1=450m^3/s$

$V_2=350m^3/s$

$P_1=87.5$ kPa

$P_2=?$

Re arranging the formula

$$P_2=\frac{P_1V_1}{V_2}$$

$$=\frac{87.5X450}{350}$$

$$=112.5kPa$$

(3)

2.4 Calculate the amount of heat required in the following cases: (5)

2.4.1 To heat 1kg of water at 0°C to water at 100°C = 418.7 kJ (1)

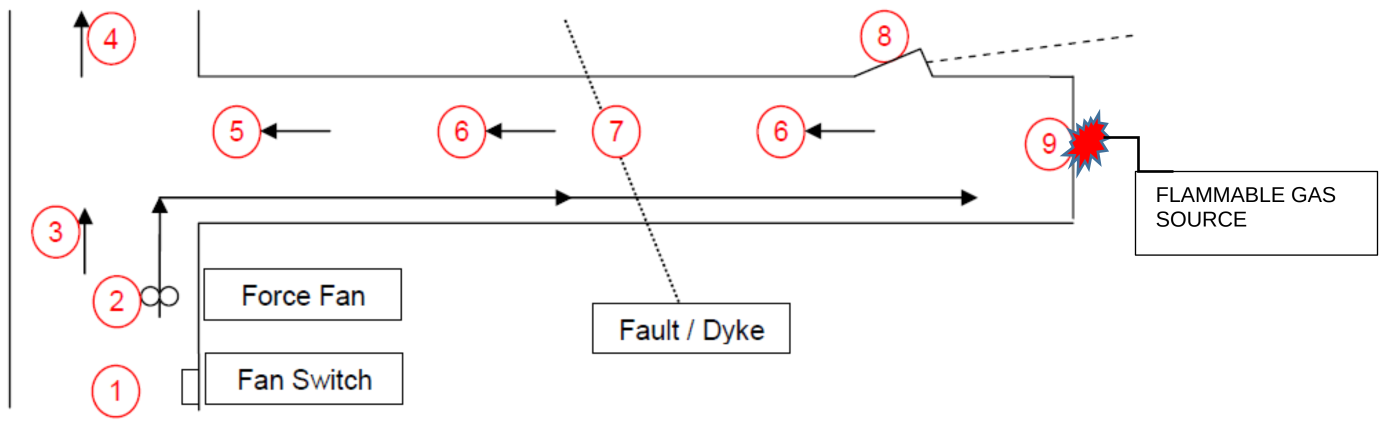
2.4.2 To heat 2kg of dry air at 30°C to dry air at 64°C = 68.34 kJ (1)

2.4.3 To heat 4kg of ice at 0°C to water at 0°C = 1 340 kJ (1)

2.4.4 To heat 4kg of water at 20°C to water vapour at 150°C = 11 476 kJ (2)

(5)

2.5During the underground survey flammable gas was detected in a development end. Describe how and indicate ten points where you will test for flammable gas. Redraw the sketch to indicate all testing points. (**10**)



1) In through ventilation, upstream from the fan switch (1)
2) At the fan switch (1)
3) Around the fan (1)
4) Five metres downstream from the dev end breakaway in through vent (1)
5) Five metres into the dev end in general air and against the hanging (1)
6) Test at regular intervals against hanging wall and all cavities (1)
7) Test at the fault, doing a complete traverse (foot-wall to hang-wall) (1)
8) Test at the diamond drill cubby, collar, 0.5m away and highest point (1)
9) When reaching the face, start at the bottom pilot hole and continue with a horizontal traverse (1), testing all drill hole sockets or along 0.5m intervals along the face until the top pilot hole is reached (1).

2.6 Whilst drilling the face a flammable gas blower emitting 100% at source with a velocity of 33.8m/s (i.e. 0.066 m^3/s), was intersected. The force outlet volume was 3.0 m^3/s with a flammable gas concentration of 0.1% in the intake air. What will be the concentration of the flammable gas in the return air from the face?

(Now (Q1 x G1) + (Q2 x G2) = Q3 x G3
Then G3 = (Q1 x G1) + (Q2 x G2) / (Q1 + Q2)
= (0.066 x 100) + (3 x 0.1) / (0.066 + 3) (3)
= (6.6 + 0.3) / 3.066
= 6.9 / 3.066
= 2.25 % (2)

(5)

(25)

QUESTION 3

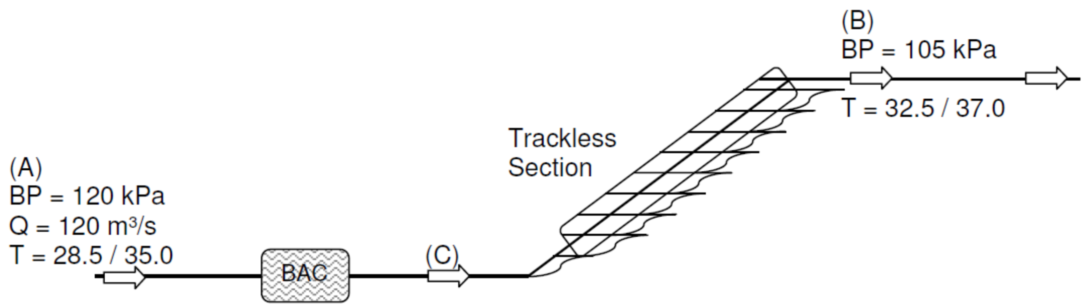
3.1 A trackless section in a deep underground mine experienced high reject temperatures and installed a buck air cooler (BAC) on the intake side of the section. By using psychrometric charts calculate the following parameters **(12)**

3.1.1 Calculate the total heat load in the trackless section with the readings at points A & B before the BAC was installed. (Ignore the effects of auto-compression):(2)

3.1.2 The BAC installed is rated at 5 000 kW, but can only operate at 50% of the designed duty due to insufficient water supply. Determine what will be the expected wet and dry bulb temp's at point C (BAC return). Assume the air / water heat transfer was 100%. (4)

3.1.3 Determine the wet and dry bulb temperatures at point B (trackless return) with the BAC operating. The return humidity is 70%. (3)

3.1.4 An additional trackless fleet has been allocated to increase production and will generate at least 1 200 kW more heat into the section. Determine new reject temperature at point B. (3)



3.1.1 Sigma Heat of intake air at A = 79.3 kJ/kg (120 kPa chart at 28.5 / 35.0)
Sigma Heat of return air at B = 106.2 kJ/kg (105 kPa chart at 32.5 / 37.0)

Sigma Heat from workings = ∑H return air – ∑H intake air
= 106.2 – 79.3
= 26.9 kJ/kg (1)

Thus Heat from workings = Massflow x ∑H eat Massflow = (120 / 0.76)
= 157.9 x 26.9 = 157.9 kg/s
= 4 247.5 kW (1)

3.1.2 BAC operating duty = Design duty x (rating % / 100)
= 5000 x (50 / 100)
= 2 500 kW (1)

BAC Δ ∑Heat = BAC duty / Massflow
= 2500 / 157.9
= 15.8 kJ/kg (1)

BAC Return ∑ H = Intake ∑H - Δ∑H
= 79.3 - 15.8
= 63.5 kJ/kg (1)

BAC return wet bulb temp = 24.2°C (from 120 kPa chart at 63.5 kJ/kg)
Assume that dry bulb temp is the same as air is saturated. (1)
BAC

3.1.3 ∑H at Trackless return = ∑ BAC outlet + ∑workings
= 63.5 + 26.9
= 90.4 kJ/kg (1).

Trackless return wet bulb temp = 29.3°C (from 105 kPa chart at 90.4 kJ/kg) (1)
Return dry bulb temp = 34.0°C (from 105 kPa chart at 70% humidity) (1)

3.1.4 New fleet Δ∑heat = heat / massflow
= 1200 / 157.9
= 7.6 kJ/kg (1)

∑ H at Trackless return = ∑BAC outlet + ∑ workings + ∑new fleet
= 63.5 + 26.9 + 7.6
= 98.0 kJ/kg (1).

New return wet bulb temp = 30.9°C (from 105 kPa chart at 98.0 kJ/kg) (1)

3.2 A Bulk Air Cooler (BAC) was installed in the main intake to an underground section. The water intake temperature was 10°C, water outlet temperature only 18°C with a flowrate of 80 l/s. An air volume of 100 m3/s enters the BAC at 29.0 / 32.0°C with a barometric pressure of 120 kPa. **(13)**

3.2.1 Calculate the water heat transfer duty of the BAC and the air massflow through the BAC (2)

3.2.2 The wet bulb air outlet temperature of the BAC if it was operating at 100% and 50% efficiencies. (7)

3.2.3 What is the minimum BAC efficiency to be maintained to ensure an outlet wet bulb temperature of not less than 25°C (3)

3.2.4 What will be the main reason for a BAC to start losing efficiency if the water flow remains constant? (1)

3.2.1 Water heat transfer duty

W = M x Cp x Δ T — M = 80 l/s
= 80 x 4.187 x (18 – 10) — Cp = 4.187
= 2 679.7 kW (1)

M = Q / ASV — ASV of BAC intake = 0.754 m^3/kg
= 100 / 0.754 — (120 kPa chart at 29.0 / 32.0)
= 132.6 kg/s (1)

3.2.2 The heat transfer to the air is less due to the water /air inefficiencies.

100% air duty = Water duty — efficiency = 100%
= 2679.7 kW (1)
Δ∑heat at 100% = BAC duty / Massflow
= 2679.7 / 132.6
= 20.2 kJ/kg (1)
∑ heat BAC out = ∑ heat in - Δ∑
= 81.4 – 20.2 — ∑Heat of BAC intake = 81.4 kJ/kg
= 61.2 kJ/kg (1) — (120 kPa chart at 29.0 / 32.0)

Thus wet bulb temp BAC outlet = 23.4°C (1) — (air saturated at BAC outlet)
50% air duty = Water duty x (50/100) — efficiency = 50%

= 2679.7 x 0.5
= 1339.9 kW (1)
Δ∑heat at 50% = BAC duty / Massflow
= 1339.9 / 132.6
= 10.1 kJ/kg (1)

∑ heat BAC out = ∑ heat in - Δ∑
= 81.4 – 10.1
= 71.3 kJ/kg (1)
Thus wet bulb temp BAC outlet = 26.5 $_0$C (1)

∑Heat of BAC intake = 81.4 kJ/kg
(120 kPa chart at 29.0 / 32.0)
(air saturated at BAC outlet)

3.2.3 Δ∑ heat required = _ heat in - ∑ heat out
= 81.4 - 66.3 _ Heat of BAC outlet = 66.3 kJ/kg
= 15.1 kJ/kg (1) (120 kPa chart at 25.0 / 25.0)

Air duty required = Δ∑ x Massflow
kol= 15.1 x 132.6
= 2002.3 kW (1)
Efficiency required = Air duty / water duty x 100
= 2002.3 / 2679.7 x 100
= 74.7 %
BAC heat transfer duty may not be less than 75% (1)

3.2.4 Heat transfer efficiency loss is mainly due to incorrect spray patterns when the supply water flow remains unchanged. Spray nozzle openings have increased and must be replaced to ensure an effective spray pattern. (1)

(25)

QUESTION 4

4.1 Name maximun daily exposure limits for cold conditions on below table

Wind chill equivalent temperature	Maximum daily exposure
0 to 18 ºC	4.1.1 No limit
-18 ºC to -34 ºC	4.1.2 Alternate 1 hour out of the low temperature area
-34 ºC to -57 ºC	4.1.3 Two periods of 30 min each ,at least 4 hours apart
<-57 ºC	4.1.4 Maximum permissible working times 5 min during any 8 hour period.

(4)

4.2 Define the following terms

4.2.1 Pneumoconiosis (with meaning of Greek words derived from) (2)
The word pneumoconiosis is derived from these Greek words:
Pneumon – meaning lung (½)
Konis – meaning dust (½)
Osis – meaning condition (½)
The term includes several lung conditions caused by dust (½)

4.2.2 Pleural thickening (2)
The lungs are surrounded by a thick, smooth membrane and a similar membrane lines the inside of the chest. This makes it easy for the lungs to move against the rib cage during normal respiration. These membranes are known as Pleura and the space between these two membranes as the Pleural cavity. Sometimes, microscopic asbestos fibres from the lung are carried to the pleural surface. During normal respiration the pleura are irritated and this result in thickening of the membranes. Such thickening does not affect the function of the lungs, unless it extends over a large area, where it might restrict respiratory movement.

4.2.3 Chronic bronchitis (2)
Are an inflammatory state of the larger upper airway which causes swelling and the discharge of protecting mucus. The excess mucus causes obstruction to the free flow of respiratory air with severe and exhausting bouts of coughing. If this condition reoccurs repeatedly over extended periods by the irritation of dust of gases ,the bronchitis become chronic. Smoking tobacco aggravates this disease.

4.2.4 Emphysema (2)
Is the rupture of the interalveolar cell membrane as a result of excessive pressure build up, which may be due to a restriction of the respiratory air passage. Such ruptures occur during coughing that merge and form large cyst-like cavities which prevents the natural exchange of gases (O_2 and CO_2) in the lungs.

4.2.5 Presbyopia (2)
Is an age associated progressive loss of the focusing power of the lens caused by loss of elasticity of the eye lens, occurring especially in middle and old age people, the process of adjusting to near vision becomes extremely difficult.

(10)

4.3 The suitability of a industrial water supply depends on five factors, list these five factors. (5)

1. Its acidity (pH) (1)
2. The concentration of solids in solution in suspension.(e.g. dust) (1)
3. Its pressure (1)
4. Its temperature (1)
5. Its flow rate (1)

(5)

4.4 Name six typical sections of an Occupational Hygiene Report

1. Overview /Executive summary (1)
2. Introduction/Objective (1)
3. Methods (1)
4. Results (1)
5. Discussion (1)
6. Recommendations (1)

(6)

(25)