

Minerals Council South Africa



EXAMINATION PAPER

SUBJECT: OCCUPATIONAL HYGIENE CHAMBER OF MINES OF SOUTH AFRICA – CERTIFICATE IN MINE ENVIRONMENTAL CONTROL PAPER 5 - OCCUPATIONAL HYGIENE SUBJECT CODE: COMMEC 5 EXAMINATION DATE: OCTOBER 2021 TIME: 3 Hours	EXAMINER: S Bergh MODERATOR: S Wheeler TOTAL MARKS: 100 PASS MARK: 60%
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NUMBER OF PAGES: 9

SPECIAL REQUIREMENTS:

THIS IS NOT AN **OPEN BOOK EXAMINATION**. FORMULA HANDOUT IS AVAILABLE

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).

8. In answering the questions, full advantage should be taken of your practical experience as well as data given.
9. Please note that you are not allowed to contact your examiner or moderator regarding this examination.
10. Cell phones are **NOT** allowed in the examination room.

QUESTION 1 (Definitions and Acronyms)

(Total Marks: 25)

Define the following:

- a) Airborne Pollutant (4 marks)
 - means any **substance in the air** that is **harmful to health**, including **dust, fumes, aerosols, gases, fibres, vapours or mists** (any 2 of the examples)
- b) Time weighted average (TWA) (3 Marks)
 - The TWA concentration for a **normal 8-hour workday** or **40 hour work week** to which nearly all workers may be repeatedly exposed to, **without suffering adverse health effects**
- c) Dose (2 Marks)
 - The **amount of a pollutant** to which a person is **exposed**
- d) Exposure (4 Marks)
 - means the **subjection of a person** to a **pollutant** in the **course of employment** through **any route of entry** (e.g. inhalation, ingestion, skin contact, or absorption);
- e) Homogenous exposure group (2 Marks)
 - **Means a group of employees who experience pollutant exposures similar enough that monitoring exposures of any representative sub group of employees in the group**, provides data useful for predicting exposures of the remaining employees.
- f) Sampling Areas (4 Marks)
 - means an **area derived** from **the breakdown of a mine** into a **ventilation district** or combination of ventilation districts with a common intake and return of which the **return is not used as an intake to another vent area**;
- g) Ventilation District (3 Marks)
 - means such **part of a mine** as has an **independent intake** commencing from a main intake air-course and an **independent return airway** terminating at a main air-course;

h) 90th Percentile

(3 Marks)

- means the **value** which must be used to **determine when HEG's** need to be **re-classified**.

QUESTION 2 (Statutory Sampling and Reporting)

(Total Marks: 25)

- a) Chapter 9 of the Mine Health and Safety Act (MHSA, Act. 29 of 1996) states the employer must establish and maintain a system of Occupational Hygiene Measurements where the following hazard limits prevail: (7 Marks)

Hazard / stressor	Limits
Particulates	≥1/10 of the OEL
Gases and vapours	≥½ of the OEL
Thermal stress : Heat	>25 °C Wet Bulb >32 °C Dry Bulb >32 °C Mean Radiant Temperature
Thermal Stress :Cold	<10 °C equivalent chill temperature
Noise	≥82 dB Laeq, 8h

- b) Please state the steps to be taken to calculate a 90th percentile (4 Marks)

- Place all sample results in order from the lowest concentration to the highest concentration (i.e., concentration of specific contaminants).
- Next, assign each sample result a number, starting with the number 1 for the lowest concentration result up to the highest concentration being given the number equal to the total number of samples collected in that HEG.
- Multiply the total number of samples collected by 0.9.
- The sample result with the number corresponding to this calculated value is the 90th percentile.

c) Please complete the following Classification Band Tables

(11 Marks)

Pollutants (Excluding Toxic Gases and Vapours)

	CLASSIFICATION BANDS
CATEGORY	PERSONAL EXPOSURE LEVEL
A	Exposures $\geq$ the OEL or mixtures of exposures ≥ 1
B	Exposures $\geq 50\%$ of the OEL and $< \text{OEL}$ or mixtures of exposures $\geq 0,5$ and < 1
C	Exposures $\geq 10\%$ of the OEL and $< 50\%$ of the OEL or mixtures of exposures $\geq 0,1$ and $< 0,5$

Toxic Gases and Vapours

	CLASSIFICATION BANDS
CATEGORY	PERSONAL EXPOSURE LEVEL
A	Exposures $\geq$ the OEL or mixtures of exposures ≥ 1
B	Exposures $\geq 50\%$ of the OEL or mixtures of exposures $\geq 0,5$ and 1

- d) Complete the table below indicating the Mandatory Frequency of Sampling for Pollutants (excluding toxic gases and vapours) (3 Marks)

CATEGORY	Minimum FREQUENCY
A	Sample 5% of employees within a HEG on a 3 monthly basis with a minimum of 5 samples per HEG, whichever is the greater.
B	Sample 5 % of employees within a HEG on a 6 Monthly basis with a minimum of 5 samples per HEG, whichever is the greater
C	Sample 5 % of employees within a HEG on an annual basis with a minimum of 5 samples per HEG, whichever is the greater

QUESTION 3 (Anatomy, Physiology and Pathology)

(Total Marks: 15)

- a) Name the three layers of the skin (3 Marks)

- Epidermis
- Dermis
- Subcutaneous layer

- b) List and give a brief explanation of the three (3) types of cells in the epidermis (6 Marks)

- Keratinocytes
 - Make up the bulk of the epidermis, form from below and move upwards to make dead/ horny cells
- Melanocytes
 - Pigment forming cells
- Langerhans cells
 - Small % of cells. Plays an important role in the immune processes.

- c) Name the two (2) types of glands that can be found in the skin (2 Marks)

- Sweat Glands
- Oil Glands

d) Give a brief description of each of the following: (3 Marks)

- Tidal volume
 - Volume of air inspired or expired during each breathing cycle
- Inspiratory reserve volume
 - Maximal volume that can be forcibly inspired following a normal breathing in cycle
- Residual volume
 - Amount of air remaining in the lungs following a maximum expiratory effort

e) There are different lung capacities. A spirometer is used to measure which one?

(1 Mark)

- Vital Lung Capacity

QUESTION 4 (Ergonomics and Fatigue)

(Total Marks: 10)

a) Briefly discuss two (2) advantages and two (2) disadvantages of incorporating seating at workstations (4 Marks)

- Advantages
 - Weight is taken off legs
 - Energy consumption is reduced
 - Lower demands on the blood circulation system
 - Avoids unnatural body postures
- Disadvantages
 - Slackening of abdominal muscles
 - Curvature of spine leads to poor digestions and impacts on breathing efficiency
 - Increased pressure on the intervertebral disks

b) Briefly discuss the effects of shift work on employees (4 Marks)

- Eating habits – poor eating habits and loss of appetite
- Digestive system disorders – generally have more digestive system and nervous system disorders
- Substance abuse – tend to misuse drugs
- Chronic fatigue – night shift workers suffer mostly
- Occupational sickness – often exhibit symptoms of weariness, mental depression, loss of vitality and disinclination to work
- Circadian rhythm – waking / sleeping cycle is disturbed
(any of the 4 above, 1 point each)

c) List four (4) major ergonomic risk factors

(2 Marks)

- Awkward body postures
 - Exertion of forces
 - Work procedures
 - Repetitions
 - Contact stress
 - Environment
 - Shift work
- (any four, half mark each)

QUESTION 5 (Airborne Pollutants)

(Total Marks 15)

- a) A personal pump sampled for 6 hours and 40 minute at a rate of 5.0 ml/min. The analysts reported the sample contained the following
- Butanol = 0.156 mg
 - Xylene = 0.298 mg
 - Toluene = 0.187 mg

Calculate the airborne concentration of each contaminant

(7 marks)

- Time = 400min
 - Flow rate = 5.0 ml/min = 0.005 l/min
 - Volume (m^3) = flow rate x sample time = $0.005 \times 400 = 2\text{l}$ of air
 - Sample volume = $2/1000 = 0.002 \text{ m}^3$
 - Butanol = $0.156/0.002 = 78\text{mg}/\text{m}^3$
 - Xylene = $0.298 / 0.002 = 149\text{mg}/\text{m}^3$
 - Toluene = $0.187 / 0.002 = 93.5 \text{ mg}/\text{m}^3$
- b) Assuming the exposure was zero for the remainder of the 8 hour shift, what was the 8 hour TWA for each contaminant

(3 Marks)

- Butanol = $78 \times 400/480 = 65 \text{ mg}/\text{m}^3$
 - Xylene = $149 \times 400/480 = 124\text{mg}/\text{m}^3$
 - Toluene = $93.5 \times 400/480 = 78 \text{ mg}/\text{m}^3$
- c) List the components of a gravimetric sampling train used for the membrane filter method of sampling fibres

(5 Marks)

- An approved battery operated gravimetric sampling pump, charger and pump calibration kit
- Membrane filters

- Filter support pads
- Open-faced filter holders fitted with protected cowls
- Flexible tubing of sufficient length and clips

QUESTION 6 (Cold stress)

(Total Marks: 10)

a) A wind chill equivalent temperature of 4°C is measured in a surface workshop.

Please complete the table below:

(4 Marks)

Category	Temperature range	General action
A 'Abnormally cold'	$\leq -30^{\circ}\text{C}$	Stop work and evacuate
B 'Severe cold'	$\leq 5^{\circ}\text{C}$ but not $\leq -30^{\circ}\text{C}$	Implement formal CSM
C 'Cold'	$>5^{\circ}\text{C}$	No special precautions; monitor equivalent chill temperature

b) List, in the correct order, the hierarchy of controls to manage and control exposure to stressors.

(6 Marks)

- Elimination
- Substitution
- Isolation
- Engineering
- Administrative
- PPE