

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: 11 MAY 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, Responsibilities and Stress factors)**(Total Marks: 20)**

Define the following:

- a) Occupational hygiene (as per MHSA, Act. 29 of 1996) (4 marks)
- The Mine Health and Safety Act (MH&SA), Act 29 of 1996 defines occupational hygiene as follows: "means the anticipation, recognition, evaluation and control of conditions (at the mine or workplace) that may cause illness or adverse health effects to persons".
- 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) Particulates not otherwise classified (2 Marks)
- Substances for which there are no evidence of specific toxic effects
- d) Agent (4 Marks)
- Harmful or potentially harmful substance which may enter the body through indigestion, inhalation or skin 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) List the factors affecting the quantity of a substance entering the body via inhalation (4 Marks)
- Concentration in the air
 - Duration of exposure
 - Pulmonary ventilation volume
 - Constituent form
- g) What is the body's main defence against ingestion? (1 Mark)
- The liver

QUESTION 2 (Anatomy, Physiology and Pathology)

(Total Marks: 15)

- a) Define respiration (3 Marks)
- The enzyme oxidation processes that uses oxygen and produces CO₂
- b) List the four components into which respiration is subdivided (4 Marks)
- Breathing
 - External respiration
 - Internal respiration
 - Intercellular respiration
- c) Name the three auditory ossicles and explain their function (7 Marks)
- Incus
 - Malleus
 - Stapes
 - The smallest bones in the human body that are connected to each other like hinges. They act as mechanical levers to carry and push vibrations toward the flexible membrane of the oval window
- d) Name the carrier medium in the circulatory system (1 Mark)
- Hemoglobin

QUESTION 3 (Ergonomics: Fatigue)

(Total Marks: 10)

- e) Define Circadian Rhythm (1 Marks)
- Wakened/ sleeping cycle on a daily average basis
- f) Explain the difference between the ergotropic and trophotropic phase (2 Marks)
- Ergotropic – daylight hours when organs are ready to operate
 - Trophotropic – night time i.e. organs need to rest/ recuperate
- g) List the 7 types of fatigue (7 Marks)

- Visual
- Bodily
- Mental
- Nervous
- Chronic
- Circadian
- Fatigue by monotonous activity

QUESTION 4 (Ventilation)

(Total Marks: 15)

- a) An 18.1 m² tip is served by a 72 bag filter unit. The bags need to be replaced and the supplier can now only supply 20cm diameter bags. The velocity down the tip is constant at 0.5 m/s, whilst the velocity through each bag is constant at 0.1 m/s. Calculate what the length of these bags must be. (10 Marks)

- Calculate quantity down the tip
 - $18.1 \times 0.5 = 9.05 \text{ m}^3/\text{s}$
- Calculate the quantity through one bag
 - $9.05/72 = 0.1257 \text{ m}^3/\text{s}$
- Calculate the surface area of one bag
 - $0.1257/0.1 = 1.257 \text{ m}^2$
- Calculate the length of each bag
 - $1.257 = (\pi D \times L) + (\pi D^2/4)$
 - $1.257 = 0.659 \times L$
 - $L = 1.257/0.659$
 - $L = 1.9\text{m}$

- b) An airstream contains 0.95 mg/m³ of dust. It mixes with another airstream that carries 3.2 mg/m³ of dust at a volumetric flow rate of 11.5 m³/s. What quantity of air must airstream 1 carry in order to reduce the overall concentration to 2.0 mg/m³ (5 Marks)

- X = quantity of air required
- $(11.5 \times 3.2) + (X \times 0.95) = (11.5 + X)2.0$

- $36.8 + 0.95X = 23 + 2.0X$
- $36.8 - 23 = 2.0X - 0.95X$
- $13.8 = 1.05X$
- $X = 13.8/1.05$
- $X = 13.14 \text{ m}^3/\text{s}$

QUESTION 5 (Airborne Pollutants and Noise)

(Total Marks 25)

Define the following:

- a) Inhalable dust (2 marks)
- Dust of particle size capable of entering the nose and mouth during breathing. Generally regarded as dust up to 100 micrometres aerodynamic diameter.
- b) Thoracic dust (2 Marks)
- Dust of a particle size capable of entering the lung airways (50% cut point of 10 micrometres)
- c) Respirable dust (2 Marks)
- Dust of a particle size small enough to enter the gas exchange region of the lungs. Up to 10 micrometers aerodynamic diameter
- h) The atmosphere in a workplace contains gases with similar toxicological effects. The results from the personal sampling are depicted below. Calculate the combined AQI and comment on the result. (5 Marks)

Gas	Measured Concentration	OEL
A	15 ppm	CO
B	130 ppm	100
C	30 mg/m ³	30
D	3000 ppm	CO ₂

Gas	Measured Concentration	OEL
A	15 ppm	30
B	130 ppm	100
C	30 mg/m ³	30
D	3000 ppm	5000

$$AQI = (C_A/OEL_A) + (C_B/OEL_B) + (C_C/OEL_C) + (C_D/OEL_D)$$

$$AQI = (15/30) + (130/100) + (30/30) + (3000/5000)$$

$$AQI = 0.5 + 1.3 + 1 + 0.6$$

$$AQI = 3.4$$

The AQI is higher than 1, resulting in an over exposure

e) List the major headings of a hearing conservation program. (5 marks)

- Risk assessment and control
- Personal exposure monitoring
- Hierarchy of controls
- Medical surveillance
- Reporting and reviewing

f) Two noise sources are radiating noise. One source has a sound power level of 123 dB, whilst the other source has a sound power level of 117 dB. Calculate the combined power level of the two sources (5 marks)

- $10 \log_{10} (10^{12.3} + 10^{11.7}) / N$
- $10 \log(10^{12.3} + 10^{11.7})$
- $10 \log 12.40$
- 124dB

g) When measuring noise in accordance with SANS, what must the microphone position be for each of the following: (4 marks)

- For standing persons
 - For seated persons
 - For fixed work stations
 - For specific noise sources
-
- 1.5m above the floor, ground or platform for standing persons
 - 0.9m above the seat, for seated persons
 - Position of the employee's most exposed ear for fixed work stations
 - 1m from the source when measuring specific noise sources

QUESTION 6 (Cold stress)

(Total Marks: 10)

A temperature of $1/5^{\circ}\text{C}$ is measured at shaft bottom. A massflow of 48kg/s flows in the roadway with dimensions, $2.5\text{m} \times 7\text{m}$, at a density of 1.2 kg/m^3 . Determine the following:

a) The wind chill temperature employees are exposed to (5 marks)

- 3.4°C

b) Given the wind chill temperature, is this a category A, B or C risk? (1 Marks)

- B

c) Does this WCET warrant the implementation of a cold stress management Program? (1 Mark)

- Yes

d) List, in the correct order, the hierarchy of controls to manage and control exposure to stressors. (3 Marks)

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

Question 7 (Vision and Illumination)

(Total marks 5)

a) Define Vision (2 marks)

- The transformation of light energy into biological energy which is decipherable by the brain

c) A light source of 600 lumen is placed 4 meters away from a working surface

Calculate the illuminance on the surface at 90° to the light source (3 marks)

- $E = I/d^2$
- $E = 600/4^2$
- $E = 37.5 \text{ lux}$