

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: MAY 2022 TIME: 3 Hours	EXAMINER: S Swanepoel MODERATOR: S Wheeler TOTAL MARKS: 100 PASS MARK: 60%
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NUMBER OF PAGES: 6

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: Hazardous Chemical substances / Airborne Pollutants (20 Marks)

1.1 Definition: explain and define the following toxicological effect classifications:

1.1.1 Carcinogenic

Malignant effects on cellular reproduction mechanisms resulting in cellular transformations leading to structural deformities.

(2)

1.1.2 Mutagenic

Substances that change genetic material of the body, resulting in hereditary malformation or dysfunction.

(2)

1.1.3 Teratogenic

These cause abnormalities in the unborn fetus. The abnormalities are not transferable to subsequent generations.

(1)

1.2 Calculate the air quality index for silica

(10)

Information:

Pump flow rate	2.2 l/min
Total sampling time	8 hours and 20 minutes
Filter weight pre	20.66 mg
Filter weight post	20.78 mg
Filter Correction factor	0.07 mg (heavier picked up moisture)
Silica analyses result	5%

Calculation answer:

Flow rate and sampling time (1)

Flow rate 2.2 l/min

Sampling time in minutes: $8 \times 60 + 20 = 500$ minutes (1)

Sample volume (2)

Volume = Flow Rate (l/min) x time (minutes)

= $2.2 \text{ l/min} \times 500 \text{ min}$

= 1100 litres of air (1)

$1100 \div 1000$

= 1.1 m³ drawn through pump (1)

Corrected sample mass (2)

$$20.78 \text{ mg} - 20.66 \text{ mg} = 0.12 \text{ mg (1)}$$

$$0.12 \text{ mg} - 0.07 \text{ mg} = 0.05 \text{ mg (1)}$$

Concentration (1):

$$0.05 \text{ mg} \div 1.1 \text{ m}^3 = 0.045 \text{ mg/m}^3$$

TWA dust concentration (2)

$$\text{TWA} = \text{concentration} \times (\text{total sample time in minutes} \div 480)$$

$$0.045 \text{ mg/m}^3 \times (500 \text{ min} \div 480 \text{ min}) = 0.047 \text{ mg/m}^3 \text{ (1)}$$

Pollutant index (1)

$$\text{Pollutant Concentration (mg/m}^3\text{)} = \frac{\% \text{ pollutant}}{100} \times \text{TWA}$$

$$5 \% / 100 \times 0.047 \text{ mg/m}^3 = 0.00235 \text{ mg/m}^3$$

Air Quality Index (1):

$$\text{TWA} \div \text{OEL}$$

$$= 0.002 \div 0.1$$

$$= 0.02$$

1.3 Explain the concept of dose response and lethal dose 50 (LD₅₀)

- A fundamental consideration in toxicology is the dose – response relationship.
- In animal studies, a dose is administered to test animals and increased or decreased until a range is found where at the upper end all animals show a pre-selected health effect (e.g., death, injury) and, at the lower end, all animals are absent the health effect.
- The data collected are used to prepare a dose response curve relating health effect incidence to dose administered.
- Dose response curves for a chemical agent administered to a uniform population of test animals. (LD = lethal dose; number shown after LD indicates the percent of exposed animals that are affected).
- LD50 is the dose given at which 50 percent of exposed animals died.

(5)

QUESTION 2: Noise and Vibration

(20 Marks)

2.1 The human ear is subject to a number of potential disorders. From an industrial perspective, the most important is noise induced hearing loss. List six (6) other important causes of this disorder.

(any 6)

- Physical blockage
- Traumatic damage
- Disease induced damage
- Hereditary/ genetic damage
- Drug induced
- Presbycusis / age
- Tinnitus (perception of sound arising in the head)

(6)

2.2 List the control measures for noise reduction.

- Substitution
- Reduction at source,
- Screening,
- Isolation,
- Attenuation, and
- Personal protection equipment

(6)

2.3 Mathematically calculate the noise exposure taking into account the background noise level

- Measured noise 98dB(A)
- Background noise level 90 dB(A)

$$\begin{aligned}L_B &= 10 \log_{10} (10^{LM/10} - 10^{LA/10}) \\&= 10 \log (10^{9.8} - 10^{9.0}) \\&= 97.25 \text{ dB(A)}\end{aligned}$$

(3)

2.4 From a vibration perspective, heavy vehicle operators and pneumatic drill operators are most at risk. What control measures will you apply to protect them against the potential damage.

- Driving seats should be dampened through the vertical plane.
- Damping elements should be build into hand power tools.
- Provide workers with damping gloves.
- Avoid operating tools with bare hands under extremely cold conditions.
- Administrative exposure duration control

(5)

QUESTION 3: Ergonomics and fatigue

(20 Marks)

3.1 Ergonomics is defined as “the study of human characteristics for the appropriate design of the living environment” List ten (10) important points, which play a role in the understanding and application of ergonomics to the workplace.

(any 10)

- The role of fatigue and stressors
- Anthropometry
- Work physiology
- Design of workstations
- Visual rules e.g. line of sight
- Posture
- Tactile feedback
- Environmental conditions and stressors
- Load handling
- Skilled work requirements
- Man/ machine interfaces
- Muscular fatigue
- Boredom (monotonous tasks)
- Working hours
- Eating habits
- Shift work
- Illumination
- Noise
- Vibration
- Indoor climate (comfort)
- Effect of daylight/ colour and music

(10)

3.2 Several types of fatigue occur, list five (5).

(any 5)

- Visual
- Bodily
- Mental
- Central nervous system
- Chronic
- Circadian
- Fatigue caused by monotonous activity

(5)

3.3 List five (5) symptoms of fatigue

(any 5)

- Feeling of weariness
- Sluggish thinking
- Reduced awareness
- Poor or slow perception
- Loss of motivation / unwillingness to work
- General decline in bodily and mental performance

(5)

QUESTION 4: Indoor air quality and radiation

(20 Mark)

4.1 List the four (4) climatic factors that influence the perception of comfort.

- Air Temperature
- Temperature of adjacent surfaces
- Air humidity
- Air movement

(4)

4.2 What is deemed as the ideal air temperature range for comfort? (zone of vasomotor regulation)

20 to 23 °C (ambient / dry bulb temperature)

Also accepted (20 to 21 °C in winter and 20 to 24 °C in summer)

(1)

4.3 Air pollution and ventilation: what will cause the deterioration of indoor air quality due to the presence of people?

- Release of odours
- Formation of water vapour
- Heat release
- Carbon dioxide production
- Air pollution (imported from outside or released by activities and products on the inside)

(5)

4.4 List the factors that will influence the absorption rate of a substance through the skin.

(Any 5)

- Temperature
- Perspiration
- Concentration
- Skin surface area exposed
- Anatomical region
- Damage to the skin
- Barriers (barrier cream / gloves)

(5)

4.5 Define ionizing radiation and list the four (4) emission categories.

Radiation is energy in the form of waves or particulates

Emission categories:

- Alpha particles
- Beta particles
- Gamma waves and
- Neutron particles

(5)

QUESTION 5: Occupational exposure assessment and control strategies
(20 Marks)

5.1 List the three (3) steps of an occupational exposure assessment:

- Identification of potential exposure
- Determination of workplace factors
- Assessment of exposure

(3)

5.2 Measurement procedure: list seven (7) aspects a measurement procedure should address and identify in order to ensure correct exposure measurement of a worker at the workplace.

(Any 7)

- Agents
- Sampling procedure
- Analytical procedure
- Sampling location
- Duration of sampling
- Timing and interval between sampling / measurement
- Technical instruction concerning measurements
- Jobs/ occupations to be monitored

(7)

5.3 List the main types of particulate collectors for the removing of particulate from waste streams.

(Any 5)

- Settling chambers
- Inertial collectors
- Cyclones
- Spray towers
- Venturi scrubbers
- Fabric filters
- Electrostatic Precipitators

(5)

5.4 List the factors that will determine respirator selection (type of respirator)

- The contaminant involved
- Conditions of exposure (loading / contaminant concentration)
- Human capabilities
- Respirator fit
- Ambient environmental conditions

(5)