

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: 10 OCTOBER 2022 TIME: 3 Hours	EXAMINER: S Swanepoel MODERATOR: JJ van Staden TOTAL MARKS: 100 PASS MARK: 60%
---	---

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.

1. Question 1: Hazardous Chemical substances / Airborne Pollutants

(20 marks)

1.1 Definition: explain and define the following:

1.1.1 Acute exposure:

A short duration, high dose exposure of which the results may cause unconsciousness, shock, collapse, severe inflammation of the lungs or sudden death.

(2)

1.1.2 Biological Exposure Indices (BEI):

BEI's are advisory biological limit values, usually based on urine, blood or expired air samples. The limit may apply to the substance itself or may refer to a level of metabolite and is usually coupled to the value of that determinant obtained from a worker exposed at the 8-hour TLV(TWA) for the substance in question.

(2)

1.2 Indicate if the following statements are true or false:

1.2.1 In the lung, the bronchioles are responsible for gas exchange to and from the blood vessels.

False

(1)

1.2.2 Teratogens are substances that change the genetic material of the body, resulting in hereditary malformation or dysfunction.

False

(1)

1.3 What are the three (3) main routes that a hazardous chemical substance may enter the human body?

- Inhalation
- Ingestion
- Skin absorption

(3)

1.4 The effects of exposure to toxic airborne substances can be categorized in 4 main categories. Please list the 4 categories:

- Irritation
- Asphyxiation
- Central nervous system depressants (CNSD's)
- Cardiac sensitization

(4)

1.5 An employee's 8-hour exposure to respirable coal dust and silica are given as:

- Respirable Coal Dust: 0,82 mg/m³
- Respirable Silica Quartz: 0,06 mg/m³

Calculate the Air Quality Index (AQI) and comment on the result.

Coal dust: OEL = 2,0 mg/m³
Silica: OEL = 0,1 mg/m³

Coal Dust: $0,82 / 2,0 = 0,41$ ✓
Silica: $0,06 / 0,1 = 0,6$ ✓

AQI: $0,41 + 0,6 = \underline{1,01}$ ✓

Even though the individual OEL's were not exceeded, the AQI limit of 1,0 (or 100%) was exceeded. ✓

(4)

1.6 How much fresh air containing 0,75 mg/m³ of dust should be mixed with 13,5 m³/s of air containing 3,2 mg/m³ of dust to reduce the dust concentration to 2,5 mg/m³.

$$\begin{aligned}(13,5 \times 3,2) + (X \times 0,75) &= (13,5 + X)2,5 && \checkmark \\43,2 + 0,75X &= 2,5X + 33,75 \\43,2 - 33,75 &= 2,5X - 0,75X && \checkmark \\9,45 &= 1,75X \\X &= 9,45/1,75 \\X &= 5,4 \text{ m}^3/\text{s of fresh air will be required.} && \checkmark\end{aligned}$$

(3)

2. Question 2: Noise and Vibration

(20 marks)

2.1 Definition: explain and define the following:

2.1.1 Noise

Unwanted sound

(1)

2.2 Indicate if the following statement is true or false:

2.2.1 With regards to hearing, the term Presbycusis refers to the natural hearing loss that occurs as a person ages.

True

(1)

2.3 What are the two (2) primary functions of hearing:

- Communication
- Serve as an alarm system

(2)

2.4 What are the main purposes of industrial audiometry?

- To establish quantitatively the hearing status of an individual and to monitor hearing during the period of employment to control the risk of occupational hearing loss.
- It also provides the ultimate test of success of a hearing conservation program in that it demonstrates the benefit of personal hearing protection in maintaining hearing acuity.

(2)

2.5 Mathematically calculate the noise emitted from a source if the measured value is 102 dB(A) and the background noise is 89 dB(A):

$$= 10 \log_{10} (10^{LM/10} - 10^{LA/10})$$

$$= 10 \log (10^{10,2} - 10^{8,9}) \quad \checkmark$$

$$= 101,78 \text{ dB(A)} \quad \checkmark$$

(2)

2.6 Mathematically calculate the average L_{eq} noise exposure given that:

- Exposure 1: 92 dB(A) for 3,0 Hours
- Exposure 2: 103 dB(A) for 1,5 Hours
- Exposure 3: 88 dB (A) for 3,5 Hours

$$L_{eq} = 10 \log \frac{(10^{9,2} \times 3) + (10^{10,3} \times 1,5) + (10^{8,8} \times 3,5)}{8} \quad \checkmark$$

$$L_{eq} = 10 \log \frac{(3,689196501 \times 10^{10})}{8} \quad \checkmark$$

$$L_{eq} = 10 \log (4611495626) \quad \checkmark$$

$$L_{eq} = 96,64 \text{ dB(A)} \quad \checkmark$$

(4)

2.7 Define vibration and list seven (7) adverse physiological effects caused by vibration.

Vibration are mechanical oscillations, produced by either regular or irregular periodic movements of a body around its resting position.

- It affects visual perception and psychomotor performance
- The skeletal, circulatory, muscle and respiratory systems are affected to a lesser extent
- Mental performance is affected
- Breathing is affected
- Pains in the chest, abdomen, rattling of jaw, muscular reactions and severe discomfort
- Backache
- Muscular tension, headaches, eyestrain, speech disturbance, intestinal irritation and bladder

(8)

3. Question 3: Temperature and radiation

(20 marks)

3.1 Definition: explain and define the following:

3.1.1 Heat stress:

Acute or chronic exposures to high environmental temperature that may result in ill health and death.

(1)

3.2 Calculate the wind chill equivalent temperature given the following:

- Wind speed: 10m/s
- Measured dry bulb temperature: 9 °C

$$T = 33 - \frac{(10,45 + 10\sqrt{V} - V) \times (33 - T)}{22,04} \quad \checkmark$$

$$T = 33 - \frac{(10,45 + 10\sqrt{10} - 10) \times (33 - 9)}{22,04} \quad \checkmark$$

$$T = 33 - \frac{769,75}{22,04} \quad \checkmark$$

$$T = 33 - 34,9 \quad \checkmark$$

$$T = -1,92^\circ\text{C} \quad \checkmark$$

(5)

3.3 With regards to ionizing radiation, list four (4) factors that will affect the rate or degree of injury?

- Total dose received
- Rate at which the dose was received
- The type of radiation received
- The body part receiving the radiation

(4)

- 3.4 As per the Mandatory Code of Practice for an occupational health programme on thermal stress guideline promulgated in February 2022 specify the required monitoring frequency and general action requirements as per specific temperature ranges in the table below.

(10)

Classification	Temperature range	Required Monitoring frequency	General action /programme requirements
A	WB $\geq$ 32.5°C or DB $\geq$ 37.0°C or GT $\geq$ 37.0°C or WBGT index $\geq$ 34	Continuously monitor until the environmental conditions have improved to acceptable limit(s). ✓	- No normal work should be undertaken except work to rectify the condition(s). ✓ - Work to rectify the condition(s) must be undertaken only on a basis of risk assessment, supervision and protocols. ✓
B	WB $\geq$ 27.5°C - < 32.5°C and/or DB $\geq$ 32.0°C - < 37.0°C, and/or GT $\geq$ 32.0°C - < 37.0°C and/or WBGT index $\geq$ 30 - < 34	Monitoring must be conducted within every 30 days. ✓	HSM mandatory. ✓
C	WB $\geq$ 25.0°C - < 27.5°C and/or DB $\geq$ 32.0°C < 37.0°C and/or GT $\geq$ 32.0°C - < 37.0°C and/or WBGT index $\geq$ 25 - < 30	Monitoring must be conducted within every 45 days. ✓	HSM mandatory. ✓
D	< 25.0°C and/or DB < 32.0°C and/or GT < 32.0°C and/or WBGT index < 25	As determined by the risk assessment ✓	No special precautions. - Environmental monitoring must be sufficiently sensitive to detect critical upward drifts in the environmental heat load. ✓ - The monitoring programme to satisfy this requirement should be specified. ✓

4. Question 4: Ergonomics

(10 marks)

4.1 Definition: explain and define the following:

4.1.1. Ergonomics:

Ergonomics is defined as the study of human characteristics for the appropriate design of the living and work environment.

(1)

4.2 Indicate if the following statement is true or false:

4.2.1 Anthropometry is an important part of ergonomics and is defined as the measurement of human strength.

False

(1)

4.3 Occupational stress is an important part of ergonomic studies. List eight (8) stressors in the work environment that contribute to occupational stress?

- Lack of job control
- Lack of social support
- Job dissatisfaction
- Task and performance demands
- Job Security
- Responsibility (for others and equipment)
- Physical environmental stressors
- Complexities associated with the job

(8)

5. Question 5: Illumination

(10 marks)

5.1 Definition: explain and define the following:

5.1.1 Glaucoma:

The most common form of glaucoma is when the fluid that normally fills the eye fails to drain properly, resulting in a pressure build-up which damages the optic nerve.

(1)

5.2 A workstation is illuminated by a roof lamp 2 meters above the workstation, positioned at 36° off the vertical, producing light at an intensity of 600 cd. Calculate the illumination level on the workstation and comment on the adequacy if the specific task required a level of 125 lux.

At 2 meters:

$$600 \text{ lm} / 2^2 = 150 \text{ Lux} \quad \checkmark$$

The angle of the light:

$$\cos 36 = 0,809 \text{ or } 0,81 \text{ (hence 81\%)} \quad \checkmark$$

81% of 150 Lux

$$= \underline{121,5 \text{ Lux}} \quad \checkmark$$

The illumination on the workstation is not sufficient for a task requiring 125 lux. $\checkmark$

(4)

5.3 List the factors which influence good illumination

- Quantity (amount of illumination that produces brightness on the task and surroundings.
- Quality: distribution of brightness in a visual environment and includes:
 - colour of light
 - diffusion
 - its direction
 - degree of glare

(5)

6. Question 6: Skin and skin exposure

(10 marks)

6.1 Indicate if the following statement is true or false:

6.1.1 With regards to occupational skin disorders, Botanical refers to fungal or yeast infections.

False

(1)

6.2 The skin provides a defense mechanism to several hazards, list four (4):

- **Bacteria** – the skin is a host to a number of bacteria which tend to destroy pathogenic bacteria. Free fatty acids and oils can also have some anti-bacterial value.
- **Sunlight** – the ability of the skin to form additional pigmentation and grow thicker (stratum corneum) with exposure to sunlight (especially ultraviolet radiation) assists in developing defenses against this source of non-ionizing radiation.
- **Primary irritants** – The skin resists acids but is sensitive to alkalis. Sweat can act as a dilutant but can also reduce the resistance to absorption if it softens the skin.
- **Injury** – the skin provides a degree of protection against forceful impact and provides sensory information designed to reduce the risk of injury.
- **Heat and Cold Stress** – through its thermoregulatory mechanism, the skin acts as a degree of protective measure against excesses of heat and cold.
- **Chemicals** – the stratum corneum provides a natural barrier against the ingress of chemical agents into and an egress of water from the body.

(4)

6.3 List five (5) factors that will influence the absorption rate of a substance through the skin.

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

(5)

7. Question 7: Exposure assessment and control strategies

(10 marks)

7.1 Name the basic 3 steps that the occupational exposure assessment consists of:

- Identification of potential exposure and/ or hazards (list the substances).
- Determination of workplace factors (things that influence the degree of risk of exposure).
- Assessment of exposures (the actual measurement and interpretation of results).

(3)

7.2 List the five (5) basic components of a local exhaust system?

- Hood
- Ducting
- Filtration
- Fan
- Stack or chimney

(5)

7.3 List two (2) scenarios where the use of respirators should be recommended?

- It is not possible to implement effective engineering controls for airborne particulates or other compounds which may have a detrimental effect on workers.
- Where it is not cost effective to do otherwise.
- Whilst maintenance or installation of control measures occur.

(2)