Chamber of Mines of South Africa

MEMORANDUM

SUBJECT: OCCUPATIONAL HYGEINE CHAMBER OF MINES OF SOUTH AFRICA – INTERMEDIATE CERTIFICATE IN MINE ENVIRONMENTAL CONTROL PAPER 5 **SUBJECT CODE: COMIMEC** **EXAMINATION DATE: MAY 2019** **TIME**: 14:30 – 17:30	**EXAMINER: JJ van Staden** **MODERATOR: C Badenhorst** **TOTAL MARKS:** [100] **PASS MARK:** (60%)

NUMBER OF PAGES:

SPECIAL REQUIREMENTS:

THIS IS NOT AN **OPEN BOOK EXAMINATION**. THERE IS NO FORMULA HANDOUT

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

Define the following:

1.1 Describe the primary objective of an occupational health and safety program? (1)

To prevent occupational injury and illness by anticipating, recognizing, evaluating, and controlling occupational health and safety hazards

1.2 Elaborate on what your company's occupational hygiene program should consist of? (4)

Several key components: a written program/policy statement, hazard recognition procedures, hazard evaluation and exposure assessment, hazard control, employee training, employee involvement, program evaluation and audit, with recordkeeping (Any 4)

1.3 The various environmental factors or stresses that can cause sickness, impaired health, or significant discomfort in workers can be classified as chemical, physical, biological, or ergonomic. Please describe your understanding of the following stressors with relation to origin & health effect.;

1.3.1 Chemical Hazard? (2)

These arise from excessive airborne concentrations of mists, vapours, gases, or solids in the form of dusts or fumes. In addition to the hazard of inhalation, some of these materials may act as skin irritants or may be toxic by absorption through the skin

1.3.2 Ergonomic hazards? (2)

These include improperly designed tools, work areas, or work procedures. Improper lifting or reaching, poor visual conditions, or repeated motions in an awkward position can result in accidents or illnesses in the occupational environment. Designing the tools and the job to fit the worker is of prime

importance. Engineering and biomechanical principles must be applied to eliminate hazards of this kind *preventing RSI, Musculosketall disorders and carpal tunnel syndrome*

1.4 Airborne chemical agents as part of a respiratory hazard enter the lungs and can pass directly into the bloodstream and be carried to other parts of the body. The respiratory system consists of organs contributing to normal respiration or breathing. List 6 of the 7 organs where oxygen is passed into the blood and carbon dioxide is given off. (3)

The nose, mouth, upper throat, larynx, trachea, and bronchi (which are all air passages or airways) and the lungs.

1.5 Oxygen-deficient atmospheres may exist in confined spaces as oxygen is consumed by chemical reactions such as oxidation (rust, fermentation). What would be the first physiological signs of an oxygen deficiency and what should an employee wear before entering such an oxygen deficient confined space (3)

Increased rate and depth of breathing – NEVER enter without a supplied-air or self-contained respirator

1.6 A recent finding from the inspectorate revealed that sanitation/sewage workers are exposed to biological hazards of which the risk assessment did not cater for. Describe your recommendation to the Occupational medical practitioner as part of a screening campaign & risk based medical surveillance program. (2)

Sewage and compost workers can be exposed to enteric bacteria, hepatitis A virus, infectious or endotoxin-producing bacteria, parasitic protozoa, and allergenic fungi. Immunisation of these worker to HEP A should be part of the screening process.

1.7 Fill in the missing words/numbers: A STEL is a ……min TWA exposure that should not be exceeded at any time during a workday, even if the eight hour TWA is within the OEL-TWA. Exposures above the OEL-TWA up to the STEL should not be longer than …….minutes and should not occur more than …….times per day. There should be at least ……..minutes between successive exposures in this range. (4)

15-minute

15 - minutes

Four

60 minutes

1.8 Several of the substances in the MHSA Schedule 22.9(2)(a) OEL list are followed by the designation SK (Skin Notation). What is your understanding of this? (2)

Skin Notation refers to potential significant exposure through the cutaneous route, including mucous membranes and the eyes, either by contact with vapours or, of probably greater significance, by direct skin contact with the substance.

1.9 What is your understanding of Pleurisy? (2)

Pleurisy is caused when the outer lung lining (the visceral pleura) and the chest cavity's inner lining (the parietal pleura) lose their lubricating properties. The resultant friction causes irritation and pain. The thin, glistening layer of pleura that is inseparably bound to the lung has no pain fibres, but the opposing pleura is richly supplied. Normally the pleural layers glide over each other on a thin film of lubricating fluid. Disease may cause the pleura to become inflamed and

adherent, or fluid may accumulate in the pleural space (effusion), separating the layers Alveoli

1.10 An employee claims to be exposed to Carbon monoxide (CO) when he passed a substation which flashed underground releasing a large cloud of smoke and gas, explain in your own words what this toxic gas will do once inhaled. (2)

CO is transferred from the lungs into the bloodstream but does not damage the lungs. Carbon monoxide passes through the alveolar walls into the blood, where it binds hemoglobin so the hemoglobin cannot accept oxygen, thus causing oxygen starvation.

1.11 What does the following mean to you LC50? (2)

LC50 means that when a defined experimental animal population is exposed to a calculated concentration of a sub stance, that concentration (expressed in mg/m3 or ppm) is expected to kill 50 percent of the animals in a stated length of time

1.12 Explain what is meant by a “Simple Asphyxiant”, give an example of such substance. (2)

Simple asphyxiants are most often inert gases that dilute or displace atmospheric oxygen from the breathing zone or air supply. Blood levels become insufficient for normal tissue respiration. Common examples are carbon dioxide, ethane, helium, hydrogen, methane, and nitrogen. However, any substance in gaseous form can replace oxygen in the breathing zone and, in excessive quantity, cause asphyxiation.

1.13 Briefly discuss the effects of shift work on employees (5)

Eating habits – tend to have poor eating habits and loss of appetite.

Digestive system disorders – generally have more digestive and nervous system disorders.

Substances abuse – tend to misuse drugs (i.e. to sleep or stay awake).

Chronic fatigue – night shift workers tend to suffer mostly.

Occupational sickness – often exhibit symptoms of weariness, mental depression, loss of vitality and disinclination to work.

Circadian rhythm – waking / sleeping cycle (organs are ready to operate during daylight while at night time they want to recuperate)

1.14 Explain your understanding of “Mutagens” (2)

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

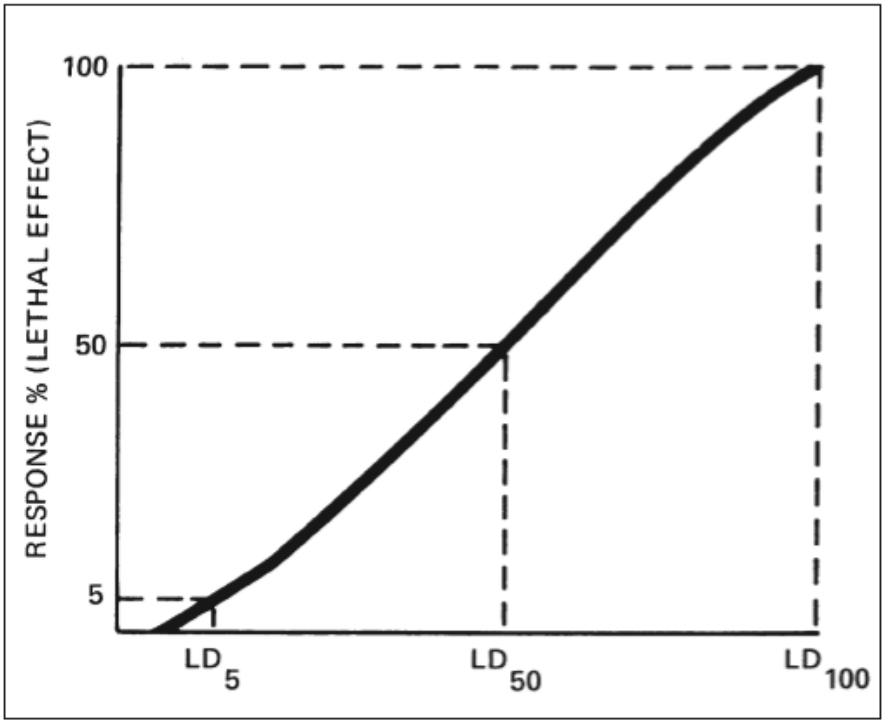
1.15 Explain your understanding of the “Biological exposure index” (BEI) (2)

“biological exposure indices (BEI)” are guidance values for assessing biological monitoring results. BEIs represent the levels of determinants that are most likely to be observed in specimens collected from healthy workers who have been exposed to a specific substance

[40]

QUESTION 2

2.1 Explain in your own word the following diagrams meaning.

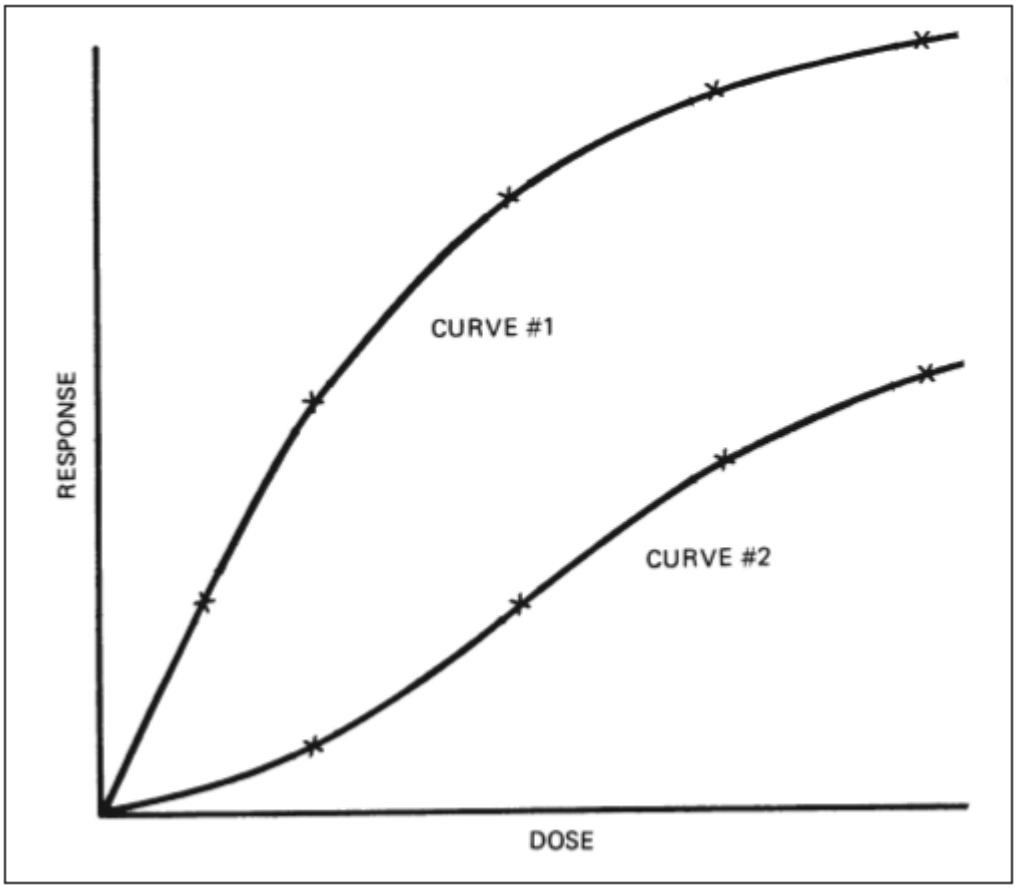


(4)

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.)

2.2 The diagram below depicts 2 chemical curves, which one of the 2 curves represents a lower margin of safety – please explain your answer (3)

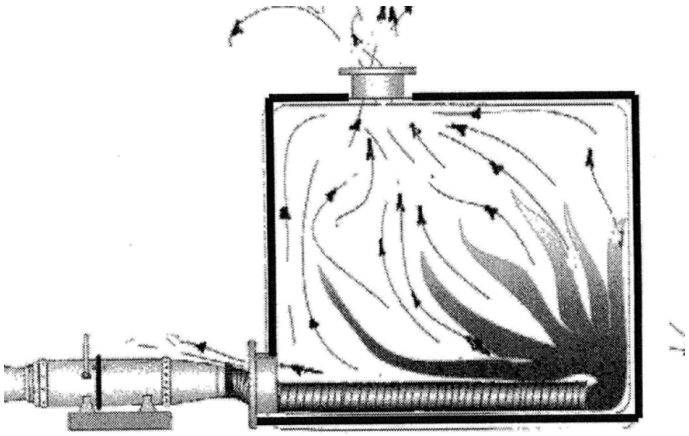


The chemical represented by curve #1 has a lower margin of safety and greater toxicity than the curve #2 chemical. In curve #1, the response increases more rapidly as dose increases

2.3 When measured at the same location, four noise sources have sound pressure levels of 89, 87, 78, and 81 dB, respectively. What would the sound pressure level at this location be if all four sources were running concurrently? (3)

Using the calculated method,
Lp = 10 log (108.9 + 108.7 + 107.8 + 108.1) = 91.7 dB

2.4 The confined space below requires a total amount of 30 Air Changes per hour as per operational standard, Calculate the actual air changes and compare to the required standard of 30 per hour, has this been met? (6)



Diameter of the ventilation ducting = 0.25m

Velocity measured at duct discharge = 15m/s

Volume of confined space = 40m3

Answer

Area = $A = \pi r^2$

A = 3.14 (0.125)

= 0.049 m2

Q = V x A

= 15m/s v 0.049 m2

= 0.735 m3/s

Air changes = volume fan x 1hour in seconds / volume of confined space

Number of air changes/hr = Volume of air supplied by fan X 3600 seconds

Volume of space being worked in

Number of air changes/hr = 0.735 m3/s X 3600 seconds

40m3

AC = 66 air changes *per hour – yes the requirement has been met.*

2.5 List the factors which influence good illumination (4)

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

[20]

Question 3

3.1 A thermal stress survey on a Tailings Dam has yielded the following results:

Wet-bulb temperature = 28°C

Dry-bulb temperature = 37°C

Globe temperature = 41°C

Calculate the WBGT index and comment of the result (4)

WBGT = (0.7 x WB) + (0.2 x GT) + (0.1 x DB)

= (0.7 x 28) + (0.2 x 41) + (0.1 x 37)

= 19.6 + 8.2 + 3.7

= 31.5

Exceed the limit of WBGT 30. Control measures to be introduced.

3.2 Calculate the wavelength (in air) for a noise source of frequency 2800 Hz. (3)

Answer

$$\lambda = \frac{c}{f}$$

$$\lambda = \frac{344}{2800}$$

= 0.1229 metres

3.3 A noise source of an intensity of 25 W/m^2 is present in a position where the air density is known to be 1.2 kg/m^3. Determine the sound pressure level of this source (4)

Answer

$$I = \frac{p^2}{wc}$$

$$p = \sqrt{Iwc}$$

$$p = \sqrt{25x1.2x344}$$

$$p = \sqrt{10320}$$

P = 101.59 pa

3.4 You are performing a ventilation survey on an exhaust hood with duct work, with reference to the tables below fill in the possible causes against the problems observed. (5)

Exhaust Hood	
Problems	**Possible Cause(s)**
Low Capture Velocity	Any 4 causes
Reduced Face Velocity	Name of possible cause

Answer

Exhaust Hood	
Problems	**Possible Cause(s)**
Low Capture Velocity	• Hood located too far away from process or operation generating point. • Cross drafts or turbulence close to hood. • Blocked duct work. • Fan malfunction. • Increased resistance through air-cleaning equipment.
Reduced Face Velocity	• Unauthorized enlargement of the opening of an existing hood. The face velocity at the hood will decrease resulting

	in the escape of contaminants held back by the original face velocity.

3.5 Comment on the table below against the problem observed (4)

Ducts	
Problems	**Possible Cause(s)**
Constant restriction	• Any possible 4 answers

Answer

Ducts	
Problems	**Possible Cause(s)**
Constant restriction	• Ducts handling particulates with inadequate transport velocity (speed). • Flexible ducts used in place of rigid ducts (results in extra friction loss). • Condensation of salts. • Elbows with sharp turns. • Holes in ducts. • Disconnected or broken branch connections. • Closed or partially closed dampers (blast gates). • Addition of hoods and branches to system without making adjustments to rebalance the ventilation system

3.5 What types of vventilation strategies can be used to remove welding fume from a welder breathing zone, also state the most effective method? (4)

Ventilation strategies fall into three general categories:

- Natural Dilution Ventilation (least effective)
- Mechanical Dilution Ventilation
- Local Exhaust Ventilation (most effective)

3.6 A fan is in the centre of a large flat area free of obstructions. Measurements taken on the surface of an imaginary hemisphere of radius 5 meter centred at the fan indicated a sound pressure of 0,8 Pa.

Indicate all assumptions made and calculate:

- the sound pressure level on the surface of the hemisphere, and
- the sound power level of the fan. (16)

Assumptions:

- The ground is a perfect reflector (0.5)
- All the acoustic energy radiated by the fan flows through the surface of the hemisphere (0.5)
- Density = 1,2 kg/m^3 (0.5)
- Duty of fan does not change materially the sound power level be assumed to be constant. (0.5)

3.6.1

$$SPL = 10 \log \frac{(\text{pressure})^2}{(2 \times 10^{-5})^2} \text{ dB} \quad (1)$$

$$= 10 \log \frac{0,8^2}{4 \times 10^{-10}} \quad (1)$$

$$= 10 \times 9,20 \quad (1)$$

$$= 92 \text{ dB} \quad (2)$$

$$I = \frac{p^2}{wc} \quad (1)$$

$$= \frac{0,82}{1,2 \times 344} \quad (1)$$

$= 0{,}00155\ W/m^2$ (1)

The surface area of a hemisphere of radius 5m
$= 2\pi 5^2$ (0.5)
$= 157\ m^2$ (0.5)

The acoustic power is therefore 0,00155 x 157
= 0,2435 W (1)

$$SWL = 10 \log \frac{\text{power}}{10^{-12}} \quad (1)$$

$$= 10 \log \frac{0{,}2435}{10^{-12}} \quad (1)$$

= 10 x 11,39 (1)
= 113.9 dB (1)

[44]

TOTAL MARKS: [100]