



**PAMIBIA UNIVERSITY**  
OF SCIENCE AND TECHNOLOGY

**FACULTY OF HEALTH, NATURAL RESOURCES AND APPLIED SCIENCES**

**DEPARTMENT OF NATURAL AND APPLIED SCIENCES**

<b>QUALIFICATION:</b> BACHELOR OF SCIENCE	
<b>QUALIFICATION CODE:</b> 07BOSC	<b>LEVEL:</b> 7
<b>COURSE NAME:</b> ENVIRONMENTAL CHEMISTRY	<b>COURSE CODE:</b> ENC702S
<b>SESSION:</b> NOVEMBER 2022	<b>PAPER:</b> THEORY
<b>DURATION:</b> 3 HOURS	<b>MARKS:</b> 100

<b>FIRST OPPORTUNITY EXAMINATION QUESTION PAPER</b>	
<b>EXAMINER(S)</b>	Dr JULIEN LUSILAO
<b>MODERATOR:</b>	Dr JAMES ABAH

<b>INSTRUCTIONS</b>
<ol style="list-style-type: none"><li>1. Answer ALL the questions in the answer book provided.</li><li>2. Write and number your answers clearly.</li><li>3. All written work MUST be done in blue or black ink.</li></ol>

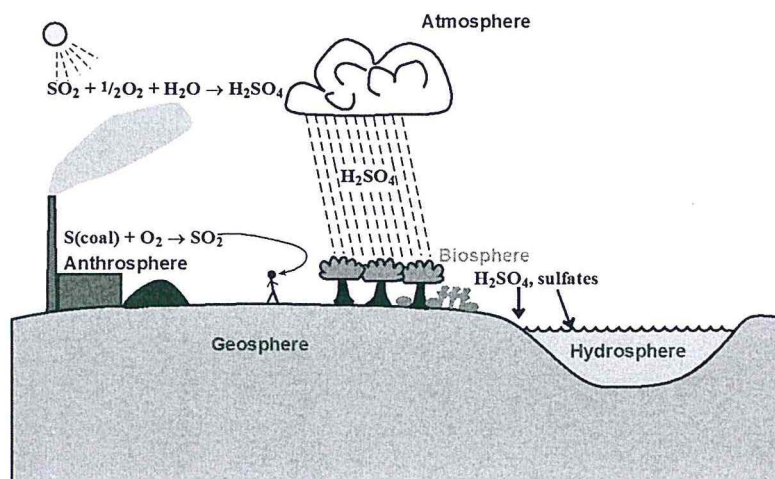
**PERMISSIBLE MATERIALS**  
Non-programmable Calculators

**THIS QUESTION PAPER CONSISTS OF 4 PAGES** (Including this front page)

## Question 1

[20]

1.1 The following figure illustrates the definition of Environmental Chemistry with respect to the five spheres of the Earth system.



Explain in detail what is described in the figure.

(6)

1.2 Define the following concepts:

(a) Biogeochemical cycles

(2)

(b) Geochemistry

(2)

(c) The Earth's natural capital

(2)

(d) The Anthropocene

(2)

1.3 What are the main types of rock formations and how are they formed?

(6)

## Question 2

[30]

2.1 Atmospheric gases are classified based on their abundance:

(a) Name the different categories of atmospheric gases.

(3)

(b) Under which category from (a) would you place the following gases:

(i) Carbon dioxide ( $\text{CO}_2$ )

(1)

(ii) Sulphur dioxide ( $\text{SO}_2$ )

(1)

(iii) Oxygen molecule (O<sub>2</sub>) (1)

2.2 Complete the following table about the main divisions of the atmospheric compartment.

Region	Altitude (km)	Temperature range (°C)
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-----	-----	-----
-----	-----	-----
-----	-----	-----

(6)

2.3 (a) How would you define air pollution? Avoid the word "pollutant" in your definition. (2)

(b) Complete the following reactions related to the formation of inorganic particles:



2.4 (a) Differentiate between classical and photochemical smog. (6)

(b) Nitrogen oxides (NO<sub>x</sub>) from car exhausts are known to be the main precursors of photochemical smog and are, therefore, heavily regulated. The main approaches used to control and limit their emissions are (i) control of combustion conditions and (ii) removal from exhaust gas after combustion.

Describe how the two approaches in (i) and (ii) are practically applied. (4)

### Question 3 [30]

3.1 Water is transparent to visible and longer-wavelength fraction of ultraviolet light, it has its maximum density as a liquid at 4°C (1 kg dm<sup>-3</sup>) and has the highest dielectric constant of any common liquid (~ 80). What are the environmental significance or effects of these three important properties of water? (6)

3.2 Through the photosynthetic activity of algae, the pH of a water body was changed from 7.0 to 10.0. If the water with alkalinity is  $2.00 \times 10^{-3}$  equivalents/liter, calculate [CO<sub>2</sub>], [HCO<sub>3</sub><sup>-</sup>], [CO<sub>3</sub><sup>2-</sup>], and [OH<sup>-</sup>] given  $K_{a1} = 4.45 \times 10^{-7}$  and  $K_{a2} = 4.69 \times 10^{-11}$ . (6)

3.3 What determines the upper and lower limits for the thermodynamic stability of Water? Show the balanced redox reactions involved. (6)

- 3.4 Give the main role of the following microorganisms in aquatic environments.
- (a) Algae (2)
  - (b) Fungi (2)
  - (c) Protozoa (2)
- 3.5 Discuss the chemical, physical and biological characteristics of Acid Mine Drainage. (6)

**Question 4**

**[20]**

- 4.1 Write the chemical formula of the following minerals:
- (a) Quartz (a silicate mineral) (1)
  - (b) Magnetite (an oxide mineral) (1)
  - (c) Calcite or limestone (a carbonate mineral) (1)
  - (d) Pyrite, (a sulphide mineral) (1)
  - (e) Gypsum (a sulphate mineral) (1)
- 4.2 Briefly describe the soil composition. (8)
- 4.3 (a) Match the soil or soil-solution constituent in (1) to (4) with the soil condition described in (A) to (D) below:

Soil conditions	Soil constituents
(A) "Cat clays" containing initially high levels of pyrite, FeS <sub>2</sub>	(1) High Mn <sup>2+</sup> content in soil
(B) Soil in which biodegradation has not occurred to a great extent	(2) Excess H <sup>+</sup>
(C) Waterlogged soil	(3) High H <sup>+</sup> and SO <sub>4</sub> <sup>2-</sup> concentrations
(D) Soil, the fertility of which can be improved by adding limestone	(4) High organic content

(4)

- (b) Explain the meaning of "internal processes" of natural hazards in the geosphere. (1)
- (c) Provide two examples natural hazards caused by internal processes. (2)

**END**