

PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

ENTRANCE EXAMINATIONS - 2023

CHEMISTRY – GRADE 12

TIME ALLOWED: 3 HOURS

INFORMATION FOR CANDIDATES:

1. You have 10 minutes to read the exam questions. **You must not answer any question during this time.**
2. ANSWER ALL QUESTIONS IN SECTION A & SECTION B. Section A consists of 20 multiple-choice questions worth 1 mark each.
3. All answers must be written in the Exam Answer Booklet that is provided.
4. WRITE YOUR NAME CLEARLY ON THE FRONT PAGE. **DO IT NOW.**
5. Calculators are permitted in the examination room. **Mobile phones, notes and textbooks are not allowed.**
6. Show all workings and calculations.

MARKING SCHEME:

Section A: [20 Marks]

Section B: [80 Marks]

DO NOT ANSWER ANY QUESTION UNTIL YOU ARE INSTRUCTED TO START.

Section A Multiple Choice

Choose and write the correct answer either A, B, C, D or E in the exam answer booklet provided for each question.

Question 1

Which of the statement below describes a gas kinetic theory?

- A. Particles of different weights and sizes can be attracted to each other.
- B. Temperature is related to the rate of movements of particles.
- C. Tiny particles constitute a matter.
- D. B & C above.
- E. All of the above.

Question 2

Which of the properties of matter listed below is not a chemical property?

- A. Hydrolysis of Lithium.
- B. Electrolysis of water.
- C. Inertness of Neon gas.
- D. None of the above.

Question 3

A mixture of oil and vinegar is an example of:

- (A) Emulsion
- (B) Solution
- (C) Suspension
- (D) A & B
- (E) A & C

Question 4

In a general chemical reaction between substance A and substance B, which of the following statement applies?

- A. Substance A changes more than substance B.
- B. Substance A changes but substance B does not.
- C. Both substances A and B undergo changes.
- D. Substance A and substance B are completely used up in the reaction.

➤ Question 5.

Which of the following is true of electrolysis of aqueous solutions?

- A. Some species are oxidized while others are reduced.
- B. The kind of species present have no effect on electrolysis reactions.
- C. The species present are oxidized.
- D. The species present are reduced.

Question 6

For the reaction that follows: $2\text{Mg(s)} + \text{O}_2\text{(g)} \longrightarrow 2\text{MgO(s)}$, the rate of reaction could be decreased by

- A. using bigger particle sizes of magnesium.
- B. increasing the temperature of the reaction.
- C. using a catalyst in the reaction.
- D. using finely powdered magnesium.

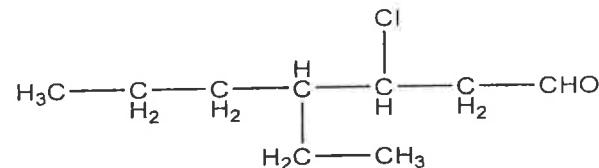
➤ Question 7

The formula of ethyl ester derived from ethanoic acid is

- A. $\text{CH}_3\text{COOCH}_2\text{CH}_3$
- B. $\text{CH}_3\text{COOCH}_2\text{CH}_3$
- C. $\text{CH}_3\text{CH}_2\text{COOCH}_2\text{CH}_3$
- D. $\text{CH}_3\text{CH}_2\text{COOCH}_3$

Question 8

The IUPAC name of the following organic structure is



- A. 3-chloro-4-propylhexanal.
- B. 2-chloro-3-propylpentanal.
- C. 3-chloro-4-ethylheptanal.
- D. 4-ethyl-3-chloroheptanal.
- E. 4-ethyl-3-chloroheptanal

Question 9

The conjugate base of pentanoic acid is

A. OH^- B. $\text{CH}_3\text{CH}_2\text{COO}^-$
C. $\text{CH}_3\text{CH}_2\text{CH}_2\text{COO}^-$ D. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{COO}^-$
E. None of the above

Question 10

Florine, chlorine, bromine and iodine are elements belonging to the same group on the periodic table. Which of the following statements is **False** about the properties of these elements?

A. They are non-metals. B. They are colorless.
C. They are poisonous. D. They react similarly with metals.

Question 11

A sample of unknown organic compound was found to contain 0.36 g of carbon and 0.06 g of hydrogen. What is the ratio of carbon to hydrogen atoms (C:H) in the sample?

A. 2:1 B. 1:6 C. 1:1 D. 1:4
E. 1:2

Question 12

The three isotopes of silicon (Si) include ^{28}Si , ^{29}Si , ^{30}Si . How many electrons does ^{29}Si have?

A. 14 B. 29 C. 58 D. 28

Question 13

Sulphur dioxide and nitrogen dioxide are two gases that are found in the atmosphere. Which of the following statements about both gases is TRUE.

A. Both gases are colorless soluble in water. B. SO_2 is colorless while NO_2 is brown.
C. NO_2 is colorless while SO_2 is brown. D. SO_2 is yellow while NO_2 is brown.
E. None of the above.

Question 14

What gas listed below will have the second slowest diffusion rate at a constant temperature?

- A. Ammonia (NH_3)
- B. Hydrogen chloride (HCl).
- C. Oxygen (O_2).
- D. Argon (Ar)
- E. Fluorine (F_2).

Question 15

A gas law states: The volume of a gas changes with changes in temperature when the pressure is kept constant. What is this gas law?

- A. The Ideal Gas Law.
- B. Charles' Gas Law.
- C. Boyle's law.
- D. Combined Gas Law.
- E. None of the above.

Question 16

Chlorine gas (Cl_2) is an example of:

- A. A pure substance.
- B. A mixture.
- C. An element.
- D. All of these.
- E. A & C above.

Question 17

H_2 is an example of:

- A. An element.
- C. Diatomic molecule.
- B. A mixture.
- D. Monatomic molecule.

Question 18

What is the number of valence electrons in Cr^{3+} ?

- A. 27
- B. 24
- C. 23
- D. 21

Question 19

The total number of non-bonding electron pairs in CH₃OH is:

- A. 6
- B. 8
- C. 2
- D. 0
- E. 4

Question 20

Which statement is TRUE about the equation given below where the system is at equilibrium and N₂ is added.



- A. The equilibrium shifts to the left.
- B. Concentration of NH₃ decreases.
- C. Concentration of H₂ increases.
- D. The equilibrium remains the same.
- E. None of the above.

Section B**Short Answers**

Answer all questions in the exam answer booklet provided. All equations must be correctly balanced, and must include the states of the reactants and products.

Question 21

(a) Write the correct IUPAC name of each of the formula given below.

(i)	Ca(NO ₃) ₂	[1 mark]
(ii)	ZnCl ₂	[1 mark]
(iii)	Mn ₂ O ₃	[1 mark]
(iv)	NH ₄ (NO ₃)	[1 mark]
(v)	PBr ₅	[1 mark]

(b) Write the correct formula of the compounds listed below.

(i)	Calcium chloride	[1 mark]
(ii)	Lead (III) nitrate	[1 mark]
(iii)	Sodium hydrogen carbonate/Sodium bicarbonate	[1 mark]
(iv)	Titanium (IV) oxide	[1 mark]
(v)	Sulfur hexafluoride	[1 mark]

Question 22

(a) Complete and balance the chemical equations below.

(i)	ZnO + HCl \longrightarrow	[2 marks]
(ii)	H ₂ CO ₃ + 2KOH \longrightarrow	[2 marks]

(b) For the following chemical statements, write the corresponding balanced equations.

(i)	Propanol (C ₃ H ₈ O) burns in air and produces carbon dioxide and water.	[3 marks]
(ii)	When magnesium burns in the air, it forms magnesium oxide powder and releases bright white light.	[3 marks]

Question 23

(a) From the information provided below, identify the respective isotopes with appropriate elemental symbol.

(i)	26 protons and 58 neutrons	[1 mark]
(ii)	22 electrons and 47 neutrons	[1 mark]

(b) Calculate the gram formula weight of Iron (III) Sulphate.

[2 marks]

(c) Determine the moles of 3.77 grams of Ca(NO₃)₂.

[2 marks]

(d) How many grams of Na_2SO_4 are there in 0.0018 moles? [2 marks]
 (e) Calculate the number of atoms in 2.4 grams of zinc (Zn). [2 marks]

Question 24

(a) A student is required to prepare 100 mL of 0.200 mol $^{-1}$ solution of sodium carbonate.
 (i) How many moles of sodium carbonate is required? [2 marks]
 (ii) What grams of sodium carbonate should the student weigh out? [2 marks]

(b) What is the molarity (M) of 10 grams of silver nitrate dissolved in 500 mL of distilled water? [3 marks]

(c) 2.42 litres of a gas measured at 22°C, are heated to 45°C at constant pressure. What will be the new volume of the gas? [2 marks]

Question 25

(a) For the electrolysis of copper sulphate solution with copper electrodes:
 (i) Write the equation for the reaction at the cathode. [2 marks]
 (ii) Write the equation for the reaction at the anode. [2 marks]
 (iii) What would be the observation at the electrodes? [2 marks]

(b) Isotopes of elements have similar chemical behavior. Hydrogen has three Isotopes: ${}_1^1\text{H}$, ${}_1^2\text{H}$, ${}_1^3\text{H}$.
 (i) Name the two heavier isotopes? [2 marks]
 (ii) Which of the isotope is unstable and radioactive. [1 mark]
 (iii) Give the reason for the similar chemical behavior of the isotopes. [1 mark]

Question 26

(a) Determine the percentage composition of hydrogen in $(\text{NH}_4)_2\text{SO}_4$. [2 marks]
 (b) 100 grams of an unknown sample was found to contain 85.7% carbon and 13.3% hydrogen.
 (i) Determine the mole ratio of carbon to hydrogen in the sample. [2 marks]
 (ii) Determine the empirical formula of the substance. [1 mark]

(c) Calculate the pH of the following:
 (i) 0.01 mol $^{-1}$ of hydrochloric acid (HCl). [1 mark]
 (ii) 0.02 mol $^{-1}$ of methanoic (HCOOH) acid given
 $K_a(\text{HCOOH}) = 1.78 \times 10^{-4}$. [2 marks]

*R
 Gain $\text{O}_2 \text{ e}^-$
 H^+
 Loss of O_2*

An OIC RLG OAT

(d) pH value can be calculated from the expression of water dissociation equilibrium constant, K_w .

(i) Calculate the concentration of $\text{OH}^{-\text{(aq)}}$ in a solution of HCl with a pH of 3.7, given $K_w = 1 \times 10^{-14}$. [2 mark]

(ii) Give the formula for the conjugate base of HCl. [1 mark]

Question 27

(a) Below is the balanced chemical equation for the reaction between potassium hydroxide and aluminium nitrate.



(i) Express the chemical equation above in the ionic form. [3 marks]

(ii) Write the net ionic equation for this reaction. [2 marks]

(b) These questions relate to the periodic properties of elements.

(i) State the trend in atomic radii across the periodic table from the left to the right. [1 mark]

(ii) State the electronegative trend from right to the left of the periodic table. [1 mark]

(iii) State the trend in reactivity of group I elements going down the periodic table and explain the reason for this trend. [3 marks]

Question 28

(a) Give the scientific names of the organic compounds shown below.

(i) $\text{CH}_3(\text{CH}_2)_3\text{CH}_3$ [1mark]

(ii) $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$ [1marks]

(iii) $\text{CH}_3\text{CH}_2\text{COH}$ [1 marks]

(iv) $\text{CH}_3(\text{CH}_2)_4\text{CO}_2\text{H}$ [1 marks]

(b) Draw the structure of the organic molecules listed below.

(i) 2-Butanone. [2 marks]

(ii) n-Propanol. [2 marks]

(iii) cyclopentane [2 marks]