

**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.

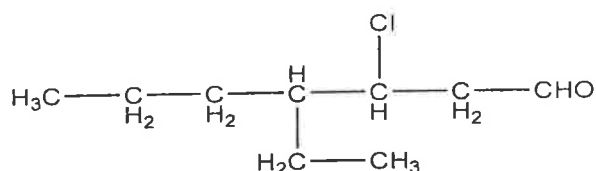
## ✧ Question 7

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

**Question 10**

Fluorine, 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  $^{28}_{14}\text{Si}$ ,  $^{29}_{14}\text{Si}$ ,  $^{30}_{14}\text{Si}$ . How many electrons does  $^{29}_{14}\text{Si}$  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.  $\text{SO}_2$  is colorless while  $\text{NO}_2$  is brown.
- C.  $\text{NO}_2$  is colorless while  $\text{SO}_2$  is brown.
- D.  $\text{SO}_2$  is yellow while  $\text{NO}_2$  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 ( $\text{NH}_3$ )
- B. Hydrogen chloride ( $\text{HCl}$ )
- C. Oxygen ( $\text{O}_2$ )
- D. Argon ( $\text{Ar}$ )
- E. Fluorine ( $\text{F}_2$ )

**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 ( $\text{Cl}_2$ ) is an example of:

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

**Question 17**

$\text{H}_2$  is an example of:

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

**Question 18**

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

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

**Question 19**

The total number of non-bonding electron pairs in CH<sub>3</sub>OH 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 N<sub>2</sub> is added.



- ✓ A. The equilibrium shifts to the left.
- B. Concentration of NH<sub>3</sub> decreases.
- C. Concentration of H<sub>2</sub> 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)  $\text{Ca}(\text{NO}_3)_2$  [1 mark]
- (ii)  $\text{ZnCl}_2$  [1 mark]
- (iii)  $\text{Mn}_2\text{O}_3$  [1 mark]
- (iv)  $\text{NH}_4(\text{NO}_3)$  [1 mark]
- (v)  $\text{PBr}_5$  [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)  $\text{ZnO} + \text{HCl} \longrightarrow$  [2 marks]
- (ii)  $\text{H}_2\text{CO}_3 + 2\text{KOH} \longrightarrow$  [2 marks]

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

- (i) Propanol ( $\text{C}_3\text{H}_8\text{O}$ ) 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  $\text{Ca}(\text{NO}_3)_2$ . [2 marks]

- (d) How many grams of  $\text{Na}_2\text{SO}_4$  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 molL<sup>-1</sup> 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:  $^1_1\text{H}$ ,  $^2_1\text{H}$ ,  $^3_1\text{H}$ .
- (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 molL<sup>-1</sup> of hydrochloric acid (HCl). [1 mark]
- \* (ii) 0.02 molL<sup>-1</sup> of methanoic (HCOOH) acid given  $K_a(\text{HCOOH}) = 1.78 \times 10^{-4}$ . [2 marks]

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

(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)  $\text{CH}_3(\text{CH}_2)_3\text{CH}_3$  [1 mark]  
(ii)  $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$  [1 mark]  
(iii)  $\text{CH}_3\text{CH}_2\text{COH}$  [1 mark]  
(iv)  $\text{CH}_3(\text{CH}_2)_4\text{CO}_2\text{H}$  [1 mark]

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

- (i) 2-Butanone. [2 marks]  
(ii) n-Propanol. [2 marks]  
(iii) cyclopentane [2 marks]

-END OF EXAM -