THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

032/1 **CHEMISTRY 1**

(For Both School and Private Candidates)

Time: 3 Hours **ANSWERS** **Year: 2012**

Instructions

1. This paper consists of sections A, B and C with total of thirteen questions

1. For each of the items (i) - (x), choose the correct answer among the given alternatives and write its letter beside the item number in the answer booklet provided.

(i) Which one of the following sets of laboratory apparatus are used for measuring volume?

A Crucible, U-tube and volumetric flask
B Test tubes, beakers and glass jar
C Thistle funnel, separating funnel and beaker
D Burette, pipette and measuring cylinder
E Conical flask, test tube and measuring cylinder.

Burette, pipette, and measuring cylinder are all used to measure liquid volumes with precision.

Correct answer: D

(ii) The empirical formula of a certain compound is CH_3. Its molar mass is 30 g. What will be its molecular formula?

A CH_4
B C_2H_4
C C_2H_6
D C_4H_{12}
E C_2H_8

Step 1: Calculate the empirical formula mass
C = 12, H = 1
$CH_3 = 12 + (3 \times 1) = 15$ g/mol

Step 2: Determine the molecular formula
Molecular formula = (molar mass) / (empirical formula mass)
= 30 / 15 = 2
Molecular formula = C_2H_6

Correct answer: C

(iii) In order to produce the greatest amount of hydrogen in a short time, one gram of magnesium ribbon should react with

A 10 cm^3 of 0.5 M sulfuric acid
B 40 cm^3 of 0.5 M acetic acid solution
C 40 cm^3 of 0.5 M sulfuric acid solution
D 20 cm^3 of 1 M sulfuric acid solution
E 20 cm^3 of 1 M acetic acid solution.

Sulfuric acid is a strong acid, and increasing its molarity increases the rate of reaction.

Correct answer: D

(iv) Fractional distillation process of a mixture of water and ethanol is possible because

A water and ethanol have the same boiling point
B water has lower boiling point than ethanol
C ethanol has lower boiling point than water
D water and ethanol form partially immiscible liquid solution
E water and ethanol are immiscible liquids.

Ethanol boils at a lower temperature than water, allowing separation through fractional distillation.

Correct answer: C

(v) Which of the following substances represent a group of acidic oxides?

A Carbon dioxide, carbon monoxide and sulphur dioxide
B Sulphur trioxide, nitrogen dioxide and nitrogen monoxide
C Carbon dioxide, sulphur dioxide and dinitrogen oxide
D Sulphur trioxide, carbon dioxide and nitrogen dioxide
E Carbon monoxide, nitrogen oxide and sulphur dioxide.

Acidic oxides react with water to form acids.

Correct answer: D

(vi) What will the molarity of a solution which contains 26.5 g of anhydrous sodium carbonate in 5 dm^3 of solution?

A 0.05 M
B 0.25 M
C 5.30 M
D 0.025 M
E 0.50 M.

Step 1: Molar mass of Na_2CO_3 = (2 × 23) + (12) + (3 × 16) = 106 g/mol
Moles = 26.5 g / 106 g/mol = 0.25 moles

Step 2: Molarity = moles / volume (dm^3)
= 0.25 / 5

= 0.05 M

Correct answer: A

(vii) The Brownian movement is taken to be the evidence of the:

A theory of association of water molecules
B theory of ionization of electrolytes
C theory of colloidal suspensions
D kinetic theory of behavior of substances
E Brownian theory.

Brownian motion proves that particles are in constant motion, supporting the kinetic theory.

Correct answer: D

(viii) One of the isotopes of an element X has an atomic number Z and a mass number A. What is the number of neutrons contained in the nucleus of the element X?

A Z
B A
C A + Z
D A - Z
E Z - A.

Number of neutrons = Mass number - Atomic number = A - Z

Correct answer: D

(ix) C_2H_4Cl can be represented in different structures which are called

A homologous series
B isomers
C structural formulae
D identical structures
E condensed structures.

Isomers have the same molecular formula but different structural arrangements.

Correct answer: B

(x) _____ is the general term used to explain a mixture of different metals.

A Alloy
B Allotrope
C Amphoteric
D Amorphous
E Isotope.

An alloy is a mixture of two or more metals.

Correct answer: A

2. Match the items in List A with the responses in List B by writing the letter of the correct response beside the item number in the answer booklet provided.

List A

(i) Its hydride is the only alkaline gas.
(ii) Possesses 11 electrons.
(iii) Most electronegative element.
(iv) Extracted by Frasch process.
(v) A noble gas.
(vi) Exists in oxidation state of +3 in haematite.
(vii) Least reactive metal in the reactivity series of metals.
(viii) A non-metal which is a good conductor of heat and electricity.
(ix) Vital for all living things.
(x) Its oxide is yellow when hot and white when cold.

List B

A Sodium
B Aluminum
C Iron
D Gold
E Oxygen
F Fluorine
G Sulphur
H Argon
I Ozone
J Iodine
K Mercury
L Chlorine
M Magnesium
N Calcium
O Nitrogen

P Carbon
Q Lithium
R Potassium
S Hydrogen
T Zinc

(i) S
(ii) Q
(iii) F
(iv) G
(v) H
(vi) C
(vii) D
(viii) P
(ix) E
(x) K

3. (a)

With the help of chemical equations, what will be observed when ammonia reacts with

(i) Hydrogen chloride.

When ammonia gas (NH_3) reacts with hydrogen chloride gas (HCl), a white smoke of ammonium chloride (NH_4Cl) is formed.

Equation:
$NH_3(g) + HCl(g) \rightarrow NH_4Cl(s)$

(ii) Copper(II) oxide.

When ammonia gas reacts with hot copper(II) oxide (CuO), the black copper(II) oxide is reduced to reddish-brown copper metal, and nitrogen gas and water vapor are released.

Equation:
$3CuO(s) + 2NH_3(g) \rightarrow 3Cu(s) + N_2(g) + 3H_2O(g)$

(b)

It is not advisable to sleep inside a house which is not well ventilated with a burning wooden charcoal. Give a reason for that and write the chemical equation to represent your answer.

Burning charcoal in a poorly ventilated room produces carbon monoxide (CO), a colorless and odorless gas that is highly toxic. CO binds to hemoglobin in the blood, reducing its ability to carry oxygen, leading to suffocation and death.

Equation:
$2C(s) + O_2(g) \rightarrow 2CO(g)$

4. Study the following part of the periodic table and then answer the questions that follow.

(a) Identify and write down the electronic configuration for the elements K, N, P, and L.

- K (Group II): 2, 8, 2
- N (Group VII): 2, 8, 7
- P (Group O/Noble gases): 2, 8, 8
- L (Group I): 2, 8, 1

(b)

What type of bond will exist in a compound formed when Q combines with L? Write the chemical formula for the compound formed and list two chemical properties for the compound formed.

- The bond formed will be an ionic bond because L (Group I) donates an electron to Q (Group VI), forming a stable ionic compound.
- The chemical formula of the compound formed is L_2Q.

Chemical properties:
1. It is a crystalline solid with high melting and boiling points.
2. It dissolves in water to form an electrolyte that conducts electricity.

5. (a)

A solution of sodium hydroxide was electrolyzed using platinum electrodes. Write the reactions which took place at the electrodes and give a reason why the solution becomes alkaline.

At the cathode:
$2H_2O + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$

At the anode:
$4OH^-(aq) \rightarrow O_2(g) + 2H_2O + 4e^-$

The solution becomes alkaline because hydroxide ions (OH^-) accumulate in the solution, increasing the pH.

(b) Electric current was passed through a solution of sodium hydroxide using platinum electrodes. Draw a labeled electrolytic cell for this electrolysis. Indicate the directions of the movement of ions.

(Diagram showing an electrolytic cell with NaOH solution, platinum electrodes, migration of Na^+ towards the cathode and OH^- towards the anode.)

6. (a)

Give the name of the process of making coke from coal. Write one characteristic which makes coke a better fuel than coal.

- The process is called carbonization.
- Coke is a better fuel than coal because it has a higher carbon content and burns with less smoke and higher efficiency.

(b) (i) State the difference between physical strength and chemical strength of metals.

- Physical strength refers to the ability of a metal to withstand mechanical forces such as tension, compression, and bending.
- Chemical strength refers to a metal's resistance to corrosion and chemical reactions.

(ii) Giving an example, explain why preparation of metallic oxides by the direct method is not intensively used.

The direct method involves heating a metal in oxygen to form a metallic oxide. However, this method is not widely used because some metals, such as iron and aluminum, form protective oxide layers that prevent further oxidation.

Example:
$4Al + 3O_2 \rightarrow 2Al_2O_3$ (Forms a protective layer)

7. (a)

(i) People suffering from heartburn usually use wood ashes for relief. Mention a characteristic which makes the ashes to be used for heartburn relief.

Wood ashes are alkaline, which helps to neutralize excess stomach acid, relieving heartburn.

(ii) Give four compounds found in laboratories which show the same characteristics as ashes.

1. Sodium bicarbonate ($NaHCO_3$)
2. Magnesium hydroxide ($Mg(OH)_2$)
3. Calcium carbonate ($CaCO_3$)

4. Sodium hydroxide (NaOH)

(b) How many molecules are there in 11.2 liters of carbon dioxide at STP?

Molar volume of a gas at STP = 22.4 L/mol

Moles of CO_2 = 11.2 L / 22.4 L/mol = 0.5 moles

Number of molecules = $0.5 \times 6.022 \times 10^{23}$

= 3.011×10^{23} molecules

8. (a) (i) Name the products formed when nitrates of potassium and zinc decompose by heat.

- Potassium nitrate (KNO_3): $KNO_2 + O_2$
- Zinc nitrate ($Zn(NO_3)_2$): $ZnO + NO_2 + O_2$

(ii) Suggest why the nitrates of zinc and potassium behave differently on heating.

Potassium nitrate decomposes into nitrite (KNO_2) and oxygen because it is a Group I metal nitrate, which decomposes less readily. Zinc nitrate decomposes more completely, forming zinc oxide and nitrogen dioxide, because transition metal nitrates decompose more easily.

(b)Mention two uses of sodium nitrate.

1. Used as a fertilizer to supply nitrogen to plants.
2. Used in the manufacture of explosives and gunpowder.

9. (a) Two experiments were carried out using the same mass of magnesium ribbon and the same volume of acids of the same concentration. The acids were 1M hydrochloric acid and 1M ethanoic acid.

(i) If the experiments were conducted within the same time, is there a difference in volumes of hydrogen gas collected at the same room temperature and pressure? Give reasons for your answer.

Yes, the volume of hydrogen gas collected will be higher in hydrochloric acid because it is a strong acid that fully ionizes, providing more H^+ ions for reaction. Ethanoic acid is a weak acid that only partially ionizes, producing fewer H^+ ions, leading to a slower reaction rate.

(ii) When the same mass, volume, and concentration of powdered magnesium and ethanoic acid are allowed to react, a new graph is formed. Giving reasons, suggest the position of that graph whether it will be above, between, or below graphs A and B.

The new graph will be between graphs A and B because powdered magnesium has a larger surface area than ribbon magnesium, increasing reaction rate, but ethanoic acid still reacts slower than hydrochloric acid.

10. (a) (i) Name three gases which should not be produced in order to prevent the destruction of the ozone layer.

1. Chlorofluorocarbons (CFCs)
2. Nitrous oxide (N_2O)
3. Carbon tetrachloride (CCl_4)

(ii) List and explain three effects of ozone layer depletion.

1. Increased skin cancer – More UV radiation reaches the Earth's surface, increasing skin cancer rates.
2. Cataracts – UV radiation can damage the eyes, leading to vision problems.
3. Climate impact – Changes in atmospheric chemistry can disrupt weather patterns.

(b) Lack of safe water for domestic and industrial uses is a serious problem in most Tanzanian towns. The major cause of this problem is pollution in the water sources. State three methods that could make water from a pond or a well safe for drinking.

1. Boiling – Kills harmful bacteria and pathogens.
2. Filtration – Removes suspended particles and impurities.
3. Chlorination – Kills microbes and prevents waterborne diseases.

11. (a)The chemical properties of concentrated sulfuric acid can be grouped into oxidizing property and dehydrating property. In which property should sulfuric acid be grouped when it reacts with copper metal? Give a reason and write the equation of the reaction.

Sulfuric acid acts as an oxidizing agent when it reacts with copper metal. Copper is a relatively unreactive metal and does not react with dilute sulfuric acid under normal conditions. However, concentrated sulfuric acid is a strong oxidizing agent, and it reacts with copper by oxidizing it to copper(II) sulfate while reducing itself to sulfur dioxide gas.

Equation:
$Cu(s) + 2H_2SO_4(conc) \rightarrow CuSO_4(aq) + SO_2(g) + 2H_2O(l)$

Reason: Copper does not react with non-oxidizing acids like dilute sulfuric acid because it is below hydrogen in the reactivity series. However, concentrated sulfuric acid has a strong oxidizing nature, which enables it to oxidize copper to Cu^{2+} while being reduced to sulfur dioxide.

(b) The preparation of chlorine gas can be represented by the following equation:
$MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$.
Calculate the number of moles of HCl which are needed to react with 20 g of MnO_2 and list two main chemical properties of chlorine gas.

Step 1: Calculate the number of moles of MnO_2
Molar mass of $MnO_2 = 55 + (2 \times 16) = 87$ g/mol
Moles of MnO_2 = mass / molar mass = 20 g / 87 g/mol = 0.23 moles

Step 2: Use mole ratio to determine the moles of HCl
From the balanced equation:
1 mole of MnO_2 reacts with 4 moles of HCl
So, 0.23 moles of MnO_2 will react with:
$0.23 \times 4 = 0.92$ moles of HCl

Two main chemical properties of chlorine gas:
1. It is a strong oxidizing agent – chlorine readily reacts with metals and non-metals, forming chlorides.
2. It is a disinfectant – chlorine is widely used for water purification as it kills bacteria and microorganisms by breaking down cell structures.

12. Consider a four-carbon hydrocarbon (C_4H_n), where n is an integer. Give the name of homologous series, molecular formula, and structural formula for different isomers of the compound formed by each homologous series. In each case, indicate the causes of isomerism.

Hydrocarbons with four carbon atoms can belong to different homologous series.

1. Alkanes (saturated hydrocarbons)
- Molecular formula: C_4H_{10}
- Example of isomers:
  - n-butane: CH_3-CH_2-CH_2-CH_3
  - iso-butane (methylpropane): CH_3-$CH(CH_3)$-CH_3
- Cause of isomerism: Structural isomerism due to different arrangements of carbon atoms in the chain.

2. Alkenes (unsaturated hydrocarbons with a double bond)
- Molecular formula: C_4H_8
- Example of isomers:
  - 1-butene: CH_2=CH-CH_2-CH_3
  - 2-butene: CH_3-CH=CH-CH_3
  - 2-methylpropene: CH_2=$C(CH_3)$-CH_3
- Cause of isomerism: Position isomerism (double bond position) and chain isomerism (branching).

3. Alkynes (unsaturated hydrocarbons with a triple bond)

- Molecular formula: C_4H_6
- Example of isomers:
  - 1-butyne: $CH{\equiv}C\text{-}CH_2\text{-}CH_3$
  - 2-butyne: $CH_3\text{-}C{\equiv}C\text{-}CH_3$
- Cause of isomerism: Position isomerism due to the different positions of the triple bond.

Isomerism occurs due to variations in the arrangement of atoms within a molecule while maintaining the same molecular formula. This can be due to chain branching, the position of functional groups, or the type of bonding (double or triple bonds).

13.Describe four common stages for the extraction of metals. Does the extraction of gold follow all four stages? Give reasons.

Metals are extracted from their ores through different processes depending on their reactivity and occurrence in nature. The four common stages of metal extraction are:

1. Concentration of the ore
   - This involves removing impurities such as sand and clay from the ore to increase its metal content. Methods include gravity separation, froth flotation, and magnetic separation.
   - Example: Copper ore (chalcopyrite) is concentrated by froth flotation.

2. Reduction of the ore to obtain the metal
   - The concentrated ore is chemically reduced to extract the metal. The method used depends on the reactivity of the metal.
   - Metals like iron are reduced in a blast furnace using carbon, while reactive metals like aluminum are extracted by electrolysis.

3. Refining or purification of the metal
   - The crude metal obtained contains impurities and is further purified through processes like electrolysis, distillation, or liquation.
   - Example: Copper is purified by electrolysis, where impure copper acts as an anode, and pure copper is deposited at the cathode.

4. Shaping and alloying
   - The extracted metal is processed into desired shapes or combined with other metals to form alloys that enhance its properties.
   - Example: Steel is an alloy of iron with carbon and other elements.

Does the extraction of gold follow all four stages?

No, gold does not follow all four stages because:
- Gold occurs in a free elemental state in nature, meaning it does not require chemical reduction from an ore.

- It is extracted using physical methods such as panning, sluicing, or cyanide leaching rather than traditional smelting or electrolysis.
- Gold is naturally pure and does not require extensive purification like other metals.

However, gold is sometimes refined further through electrolysis or aqua regia purification to achieve high purity for commercial and industrial applications.