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)

Duration: 3 Hours **SOLUTIONS** **Year: 2025**

Instructions

1. This paper consists of sections A, B and C with a total of **eleven (11)** questions.
2. Answer **all** questions in section A and B and **two (2)** questions from section C.
3. Section A carries **sixteen (16)** marks, section B carries **fifty four (54)** marks and section C **thirty (30)** marks.
4. Communication devices and any unauthorised materials are **not** allowed in the examination room.
5. Write your **Examination Number** on every page of your answer booklet(s)
6. All writing must be in blue/black ink except diagrams which must be drawn in pencil.
7. Nom-programmable calculators may be used.

SECTION A

1. (i) Which relationship supports the existence of water in three states of matter?

   A Ice → gas → solid → Ice

   B Liquid → ice → gas → ice → liquid

   C Gas → ice → liquid → liquid → ice → gas

   D Ice → gas → liquid → gas → ice

   E Ice → liquid → gas → gas → liquid → ice

Answer: E Ice → liquid → gas → ice

Water exists naturally in three states: solid (ice), liquid (water), and gas (steam). The correct relationship shows the transitions between these states: ice melts to liquid, liquid evaporates to gas, and gas condenses back to ice.

(ii) Which one is the molecular formula of a hydrocarbon having 20% hydrogen and vapor density of 15?

A CH_3

B H_3C

C H_6C_2

D C_2H_6

E C_3H_6

Answer: C C_2H_4

A hydrocarbon with 20% hydrogen by mass corresponds to ethene (C2H4). The vapor density of 15 indicates a molar mass of 30 g/mol (since vapor density × 2 = molar mass), which matches C2H4.

(iii) A chemist prepared hydrogen gas by mixing zinc granules with dilute hydrochloric acid. Which one of the following is correct about zinc reaction?

A It is oxidized

B It is an oxidizing agent

C It undergoes both oxidation and reduction

D It is reduced

E It undergoes decomposition

Answer: A It is oxidized

Zinc reacts with hydrochloric acid to produce hydrogen gas: $Zn \rightarrow Zn^{2+} + 2e^{-}$. Zinc loses electrons, meaning it is oxidized.

(iv) A student exposed anhydrous copper(II) sulphate crystals in a watch glass over a whole night. In the next morning the colour of copper(II) sulphate had changed from L to M. Which pair represents the colours of L and M?

A L-green and M-blue

B L-blue and M-green

C L-white and M-blue

D L-blue and M-white

E L-white and M-green

Answer: C L-white and M-blue

Anhydrous copper(II) sulphate is white; when it absorbs water from the air it becomes hydrated, turning blue.

(v) Suppose a truck carrying flammable gas gets an accident and a fire breaks out. How will you extinguish the fire?

A By using water and foam extinguisher

B By using dry powder and carbon dioxide extinguisher

C By using dry powder extinguisher and water

D By using wet chemical extinguisher and foam extinguisher

E By using water and carbon dioxide extinguisher

Answer: B By using dry powder and carbon dioxide extinguisher

Flammable gas fires react violently with water. Dry powder and CO_2 extinguishers are safe and effective for such fires.

(vi) Why is methane used as a source of fuel at homes and industries?

A It burns in air to give out energy

B It burns in air to give out water vapour

C It burns in air to absorb energy

D It burns in air to absorb water vapour

E It burns in air to give out carbon dioxide

Answer: A It burns in air to give out energy

Methane is an efficient fuel because it combusts readily in air to release heat energy for domestic and industrial use.

(vii) Why is it essential to allow the first supply of oxygen gas to escape during laboratory preparation of oxygen?

A The gas jar contains impurities

B The gas jar contains hydrogen peroxide

C The gas jar contains some air in it

D The gas jar is wet

E The gas jar does not have a lid

Answer: C The gas jar contains some air in it

The initial gas collected may contain air; allowing it to escape ensures the gas collected is pure oxygen.

(viii) A mass of zinc metal weighing 90 g was reacted with hydrochloric acid. The reaction stopped after 7 minutes; 17.5 g of zinc remained unreacted. How many moles of hydrochloric acid reacted with zinc?

A 1.13 moles

B 2.23 moles

C 3.33 moles

D 4.43 moles

E 5.53 moles

Answer: B 2.23 moles

Reacted zinc = 90 − 17.5 = 72.5 g

Moles of Zn = 72.5 / 65 ≈ 1.115 moles

Reaction: $Zn + 2HCl \rightarrow ZnCl2 + H2$

Moles of HCl = 1.115 × 2 ≈ 2.23 moles

(ix) Why is wind said to be the promising source of energy for the future?

A It does not produce harmful gases

B It can easily be stored

C It is harnessed without chemical reaction

D It is a renewable source of energy

E It is the cheapest source

Answer: D It is a renewable source of energy

Wind energy is sustainable and renewable, making it ideal for long-term energy generation.

(x) Why is calcium oxide useful during preparation of ammonia?

A It removes water from the reaction

B It prevents the removal of water in the reaction

C It removes nitrogen gas from the reaction

D It prevents the loss of nitrogen from the reaction

E It increases the production of ammonia

Answer: A It removes water from the reaction

Calcium oxide acts as a dehydrating agent, absorbing water and driving the reaction toward ammonia formation.

2. Match the parts of the electrolytic cell in List A with the respective terms in List B

List A	**List B**
i	A Anode
ii	B Electrolysis
iii	C Cathode
iv	D Current
v	E Ammeter
vi	F Electrons
	G Electrolyte
	H Cell

Answers:

List A	i	ii	iii	iv	v	vi
List B	F	D	A	G	C	E

3. Briefly explain six economic activities that depend on water.

Fishing is an economic activity that relies heavily on water, as it provides livelihoods for communities living near rivers, lakes, and oceans. Water bodies support both commercial and subsistence fishing, contributing to food security and income generation.

Agriculture depends on water for irrigation, livestock, and crop production. Without adequate water supply, yields of crops like rice, maize, and vegetables would decrease, affecting both local consumption and trade.

Hydropower generation is another economic activity that relies on water. Flowing water in rivers is harnessed to generate electricity, which powers industries, homes, and businesses, promoting economic growth.

Transportation and shipping use water bodies as routes for moving goods and people. Rivers, lakes, and coastal waters facilitate trade and reduce transportation costs, making water essential for commerce.

Tourism and recreation activities such as boating, swimming, and water sports depend on clean and sufficient water. These activities generate revenue and employment in areas with lakes, rivers, and coastal beaches.

Industrial processes in sectors such as manufacturing, textiles, and food processing require water for cooling, cleaning, and as a raw material. Reliable water supply ensures smooth operation and productivity in these industries.

4. (a) Justify the fact that hydrogen has both properties of group I and group VII elements.

Hydrogen exhibits properties similar to group I elements because it has one electron in its outermost shell, like the alkali metals, allowing it to form positive ions (H^+) in reactions. This explains its ability to react with non-metals and form hydrides, such as NaH with sodium.

Hydrogen also resembles group VII elements because it can gain one electron to form a negative ion (H^-), similar to halogens. This allows hydrogen to react with metals to form ionic hydrides, showing its non-metallic behavior.

This dual behavior makes hydrogen unique, as it can either lose or gain an electron depending on the reaction conditions, demonstrating both metallic and non-metallic characteristics.

(b) Given that element G has electron arrangement 2:8:8:7 and element H has atomic number 17, place element G in its suitable period and compare the reactions of sodium metal with element G and H.

Element G has 25 electrons 2+8+8+7=25.

Element H has atomic number 17, thus it is chlorine.

G's configuration corresponds to period 4, group 17.

Sodium reacts vigorously with both G and H because they are halogens, forming ionic salts like NaG and NaH,

but reactions with G (period 4) may be slightly less vigorous than with H (chlorine) due to atomic size and bond strength.

(b) Hydrogen is placed in group I rather than group VII in the periodic table because it has a single electron in its outer shell, similar to alkali metals, allowing it to form H^+ ions. Its placement emphasizes electron configuration rather than reactivity with halogens.

5. (a) A laboratory technician investigated the solubility of sodium chloride by dissolving different amounts in a fixed volume of water while altering the temperature. Categorize each variable.

The independent variable is the temperature of water, as it is deliberately changed to observe effects. The dependent variable is the solubility of sodium chloride, measured as the outcome. Controlled variables include the fixed volume of water and the quantity of sodium chloride used for each trial.

(b) Identify six steps to follow when conducting a scientific investigation.

Formulating a clear research question or problem statement is the first step, which guides the study. Conducting a literature review or background research helps understand existing knowledge.

Designing a controlled experiment involves selecting variables, materials, and procedures. Collecting data accurately through observation or measurement ensures reliable results.

Analyzing the data using tables, graphs, or calculations allows interpretation of findings. Finally, drawing conclusions and reporting results summarize the investigation and its implications.

6. (a) Suggest three advantages and three disadvantages of using hydrogen gas as a fuel.

Advantages include hydrogen producing clean energy with water as the only by-product, reducing pollution. It has high energy content per unit mass, providing efficient fuel. Hydrogen can be produced from renewable sources, making it sustainable.

Disadvantages include the high cost of production and storage, making it less economically viable. Hydrogen is highly flammable, posing safety risks. Infrastructure for distribution and refueling is limited, hindering widespread adoption.

(b) Chemists prefer zinc granules and dilute hydrochloric acid to pure zinc and concentrated acid for laboratory hydrogen preparation because granules increase surface

area, allowing controlled reaction rates. Dilute acid minimizes violent reactions, improving safety and efficiency.

7. (a) Identify six steps to follow in lighting a Bunsen burner to produce a non-luminous flame.

Connect the Bunsen burner to the gas supply securely. Ensure the air hole is open to allow sufficient oxygen. Use a match or lighter to ignite the gas at the top of the barrel. Adjust the gas flow to control the flame size. Observe the flame and ensure it turns blue, indicating complete combustion. Maintain supervision throughout the experiment to prevent accidents.

(b) Four uses of a non-luminous flame with the property of the flame concerned.

Heating chemicals gently without soot formation, property: clean combustion. Sterilizing inoculating loops, property: high temperature. Boiling liquids uniformly, property: even heat distribution. Performing flame tests for metal ions, property: non-interfering flame color.

8. (a) Four alternative chemicals to make soft water suitable for experiments.

Adding calcium chloride, magnesium sulfate, sodium carbonate, or washing soda to adjust hardness. These chemicals provide ions necessary to simulate hard water.

(b) Temporary hardness can be removed by boiling because calcium bicarbonate decomposes on heating: $Ca(HCO_3)_2 \rightarrow CaCO_3 + CO_2 + H_2O$. Permanent hardness can be removed by adding washing soda (Na_2CO_3), which reacts with calcium and magnesium ions to form insoluble carbonates: $Ca^{2+} + Na_2CO_3 \rightarrow CaCO_3\downarrow + 2Na^+$.

(c) Three advantages of hardness of water in daily life include providing essential minerals like calcium and magnesium for health, reducing corrosion of pipes, and giving better taste to drinking water.

9. (a) Briefly explain Le Chatelier's principle.

Le Chatelier's principle states that when a system at equilibrium is subjected to a change in concentration, temperature, or pressure, the system adjusts itself to counteract the change and restore a new equilibrium. For example, if the concentration of a reactant is increased, the system will shift towards the products to reduce the effect of the added reactant.

(b) A certain company wants to increase production of one of its products Z. Product Z is formed by reacting substance X and Y as shown in the equation. By applying Le Chatelier's principle, explain four technical ways the company can achieve a high yield of product Z.

Increasing the concentration of reactant X or Y will shift the equilibrium towards the formation of more product Z, enhancing yield.

Removing product Z continuously as it forms will also shift the equilibrium to the right, promoting more production of Z.

Decreasing the concentration of any by-products that might inhibit the reaction will favor the forward reaction, increasing the yield.

Adjusting temperature according to whether the reaction is exothermic or endothermic: for an exothermic reaction, lowering temperature favors product formation; for an endothermic reaction, raising temperature favors more product.

10. Describe the chemical properties of ethanol with respect to each of the following treatments.

(a) Combustion in air: Ethanol burns with a blue flame producing carbon dioxide and water: $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$. This demonstrates its flammability and energy content.

(b) Reaction with sodium metal: Ethanol reacts slowly with sodium to form sodium ethoxide and hydrogen gas: $2C_2H_5OH + 2Na \rightarrow 2C_2H_5ONa + H_2$. This shows ethanol has acidic hydrogen in the hydroxyl group.

(c) Reaction with concentrated sulfuric acid at 170°C: Ethanol undergoes dehydration to form ethene: $C_2H_5OH \rightarrow C_2H_4 + H_2O$. This illustrates its ability to eliminate water under strong acid conditions.

(d) Oxidation by acidified potassium dichromate(VI): Ethanol is oxidized to ethanoic acid: $C_2H_5OH + [O] \rightarrow CH_3COOH$. This property shows ethanol's potential as a primary alcohol that can be oxidized.

(e) Reaction with ethanoic acid: Ethanol reacts with ethanoic acid in the presence of an acid catalyst to form ethyl ethanoate and water: $C_2H_5OH + CH_3COOH \rightarrow CH_3COOC_2H_5 + H_2O$. This demonstrates its esterification ability.

11. A certain person with no background in chemistry is interested in extraction of sulphur. How can you guide the investor based on the following points?

(a) Equipment needed for extraction: A furnace for heating, a crucible or reaction container, collecting flue pipes, a condenser for vapors, and molds or containers for molten sulphur. A diagram should show heating sulphur-containing ore, collection of vapors, and condensation into solid sulphur.

(b) Process involved during extraction: Sulphur ore is heated in a furnace, subliming the sulphur. The vapors are directed through pipes and condensed into molten sulphur in a cooled container.

(c) Conversion of rhombic sulphur to monoclinic sulphur: Rhombic sulphur is heated to 120°C, where it melts and then cools slowly to form monoclinic crystals, which are stable at higher temperatures.

(d) Two commercial uses of sulphur: Production of sulfuric acid, which is widely used in fertilizer and chemical industries. Vulcanization of rubber to improve elasticity and durability.