

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

Year: 2024

Instructions

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

- (i) Which ideas were introduced by Dalton?
- (ii) Atoms cannot be created or destroyed.
(iii) Atoms of the same element may have different chemical properties.
(iv) Atoms of different elements may have the same chemical properties.
(v) When atoms combine, they do so in simple whole numbers to form compounds.
- A. (ii) and (iv)
B. (i) and (iii)
C. (ii) and (iii)
D. (i) and (iv)
E. (i) and (ii)

Answer:

Dalton's atomic theory introduced the ideas that atoms cannot be created or destroyed and that when atoms combine, they do so in simple whole-number ratios to form compounds. These are fundamental principles of his theory.

The correct answer is D (i) and (iv).

- (ii) A Form Four student boiled a mixture of sunflower oil and concentrated solution of sodium hydroxide for a certain period of time. After cooling, sodium chloride salt was added to the mixture. What was the aim of this experiment?
- A. To prepare an alcohol
B. To prepare a solid soap
C. To prepare sodium metal
D. To prepare a carboxylic acid
E. To prepare an organic compound

Answer:

The process described in the question is saponification, where fats or oils (like sunflower oil) react with a strong base (sodium hydroxide) to produce soap and glycerol. Sodium chloride is added to precipitate the soap.

The correct answer is B. To prepare a solid soap.

- (iii) In the Periodic Table, hypothetical elements X and Y are found in Group VI and II respectively. What is the correct formula for the compound formed between the two elements?
- A. XY
B. YX
C. X₂Y₂
D. Y₂X₆
E. X₃Y

Answer:

Element X in Group VI has a valency of 2, and element Y in Group II has a valency of 2. To form a neutral compound, their ratio in the formula must reflect their valencies. Therefore, the correct formula is X₂Y₂.
The correct answer is C. X₂Y₂.

(iv) How does Mendeleev's Periodic Table differ from the modern Periodic Table?

- A. Mendeleev's Periodic Table does not include noble gases while Modern Periodic Table includes them.
- B. Mendeleev's Periodic Table does not include non-metals while Modern Periodic Table includes them.
- C. Mendeleev's Periodic Table does not include halogens while Modern Periodic Table includes them.
- D. Mendeleev's Periodic Table has only 7 groups while Modern Periodic Table has 8 groups.
- E. Mendeleev's Periodic Table organizes elements by increasing atomic mass while the Modern Periodic Table organizes them by atomic number.

Answer:

Mendeleev's Periodic Table organized elements by their atomic masses, while the Modern Periodic Table is organized by atomic number. This correction addressed inconsistencies in Mendeleev's arrangement. The correct answer is E. Mendeleev's Periodic Table organizes elements by increasing atomic mass while the Modern Periodic Table organizes them by atomic number.

(v) To investigate the solubility of sodium chloride, a technician dissolved different amounts of sodium chloride in a specific volume of water while altering the temperature of water. What does temperature represent in this experiment? A. Dependent variable

- B. Intermediate variable
- C. Independent variable
- D. Controlled variable
- E. Fixed variable

Answer:

The temperature is the factor that the technician changes to observe its effect on solubility, making it the independent variable.

The correct answer is C. Independent variable.

(vi) Which property is used to confirm the presence of pure water? A.

It turns white anhydrous copper (II) sulphate blue.

- B. It dissolves all other substances.
- C. It freezes at 0°C.
- D. It is neutral to litmus paper.
- E. It turns blue cobalt (II) chloride paper pink.

Answer:

Pure water has a fixed freezing point at 0°C under standard conditions. This property can confirm its purity.

The correct answer is C. It freezes at 0°C.

(vii) In which type of oxides does aluminum oxide belong?

- A. Metal oxides
- B. Insoluble oxides

- C. Soluble oxides
- D. Amphoteric oxides
- E. Basic oxides

Answer:

Aluminum oxide is amphoteric, meaning it can react with both acids and bases to form salts. The correct answer is D. Amphoteric oxides.

(viii) What is the amount of charge when a current of 2 amperes flows through a certain point in an electrolyte for 0.5 seconds?

- A. 2 coulombs
- B. 1 coulomb
- C. 2.5 coulombs
- D. 1.5 coulombs
- E. 10 coulombs

Answer:

Charge (Q) is calculated using the formula $Q = I \times t$, where I is the current and t is the time in seconds. $Q = 2 \times 0.5 = 1$ coulomb.

The correct answer is B. 1 coulomb.

(ix) How can you prevent a hoe from getting rust?

- A. By painting and oiling them
- B. By exposing them to air
- C. By keeping them in moisture
- D. By cleaning them with water after use
- E. By leaving them in the garden after use

Answer:

Rusting is caused by exposure to air and moisture. Painting or oiling prevents rust by creating a protective barrier.

The correct answer is A. By painting and oiling them.

(x) When 2.45 g of zinc granules are dropped in 50 cm³ of acid 'Y', zinc sulphate is formed along with the evolution of gas 'M' which burns with a pop sound when kept close to a burning candle. Which one of the following pairs represent the acid Y and gas M?

- A. Sulphuric acid and Carbon dioxide gas
- B. Sulphuric acid and Hydrogen gas
- C. Hydrochloric acid and Oxygen gas

D. Hydrochloric acid and Hydrogen gas E. Sulphuric acid and Oxygen gas Answer:

The reaction between zinc and sulphuric acid produces zinc sulphate and hydrogen gas. Hydrogen gas burns with a pop sound when ignited.

The correct answer is B. Sulphuric acid and Hydrogen gas.

2. Match the effects of environmental pollution in List A with the respective causes in List B by writing the letter of the correct response besides the item number in the answer booklet provided.

List A

- (i) Ozone layer depletion
- (ii) Greenhouse effect
- (iii) Eutrophication
- (iv) Terrestrial pollution
- (v) Acidic rain
- (vi) Water pollution

List B

- A. Biological Oxygen Demand
- B. Biomass sludge
- C. Sulphur dioxide
- D. Chlorine atom
- E. Liquid effluents
- F. Calcium Ammonium Nitrate
- G. Methane
- H. Ultra Violet Radiation

Answer:

(i) Ozone layer depletion - H. Ultra Violet Radiation

Explanation: Ozone layer depletion is primarily caused by exposure to ultraviolet radiation, which destroys ozone molecules.

(ii) Greenhouse effect - G. Methane

Explanation: Methane is one of the key greenhouse gases that trap heat in the atmosphere, contributing to the greenhouse effect.

(iii) Eutrophication - F. Calcium Ammonium Nitrate

Explanation: Eutrophication is caused by the excessive presence of nutrients like nitrates from fertilizers such as calcium ammonium nitrate, leading to algal blooms in water bodies.

(iv) Terrestrial pollution - E. Liquid effluents

Explanation: Terrestrial pollution occurs due to the disposal of liquid effluents into the soil, contaminating the land.

(v) Acidic rain - C. Sulphur dioxide

Explanation: Acid rain forms when sulfur dioxide reacts with water in the atmosphere to form sulfuric acid.

(vi) Water pollution - A. Biological Oxygen Demand

Explanation: Water pollution is often indicated by an increased biological oxygen demand due to organic pollutants in the water, reducing oxygen levels for aquatic life.

3. (a) The products formed when most non-metals burn in oxygen can react with water to form solutions which turn blue litmus paper red. With the aid of chemical equations, show the validity of this statement using carbon as a non-metal.

Answer:

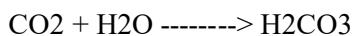
Non-metals, such as carbon, form acidic oxides when they burn in oxygen. These oxides dissolve in water to produce acidic solutions, which turn blue litmus paper red.

For example:

When carbon burns in oxygen, carbon dioxide is formed:



Carbon dioxide reacts with water to form carbonic acid:



Carbonic acid is acidic and turns blue litmus paper red, validating the statement.

(b) (i) Give three properties of oxygen gas.

Answer:

- Oxygen is a colorless, odorless, and tasteless gas.
- It supports combustion, allowing substances to burn more intensely.
- It is slightly soluble in water and supports aquatic respiration.

(ii) Give three uses of oxygen gas based on the properties mentioned in (b)(i).

Answer:

- Oxygen is used in welding and cutting metals due to its ability to support combustion.
- It is used in hospitals for medical purposes, such as aiding patients with breathing difficulties.
- It is used in water treatment plants to support aerobic microorganisms in breaking down pollutants.

4. (a) Why is Bunsen burner a preferable source of heat in the chemistry laboratory? Give four points.

Answer:

- It produces a steady and controllable flame, making it ideal for experiments requiring specific temperatures.
- The temperature of the flame can be adjusted by regulating the air supply.
- It burns cleanly without producing soot, ensuring that glassware remains clean.
- It is portable and easy to use, making it convenient for various laboratory activities.

(b) Suggest five sources of heat that can be used in a chemistry laboratory apart from Bunsen burner.

Answer:

- Alcohol burners, which provide moderate heat for small-scale experiments.

- Electric hot plates, which offer a stable and adjustable source of heat.
- Spirit lamps, often used in simple heating tasks.
- Gas burners, an alternative source similar to Bunsen burners.
- Infrared heaters, which provide uniform heat distribution for specific applications.

5. (a) Which processes can be used to separate or extract each of the following substances?

- Mixture of iodine and sand: Sublimation
- Mixture of cooking oil and water: Decantation or separation using a separating funnel
- Mixture of sodium chloride and water: Evaporation or crystallization
- Oil from seed: Pressing or solvent extraction
- Mixture of ethanol and water: Fractional distillation
- Mixture of sand and water: Filtration

(b) Briefly explain application of chromatography process in daily life. Give six points.

Answer:

- Chromatography is used in food testing to detect additives and contaminants.
- It is applied in forensic science for analyzing blood, ink, or drug samples.
- It is used in pharmaceuticals to identify and purify compounds.
- It helps in water testing to identify pollutants and their concentration.
- It is applied in environmental studies to detect toxins in air and soil samples.
- It is used in the perfume and dye industries for separating and identifying ingredients.

6. (a) What are the sources of organic acids? Give five points.

Answer:

- Fruits: Organic acids such as citric acid and malic acid are found in fruits like oranges, lemons, and apples.
- Vegetables: Oxalic acid is found in vegetables such as spinach and rhubarb.
- Microbial fermentation: Lactic acid is produced through the fermentation of lactose by bacteria.
- Animal products: Amino acids such as aspartic acid are present in proteins derived from animals.
- Industrial synthesis: Acetic acid can be synthesized from petrochemical sources or biomass.

(b) Identify two products which can be formed in each of the following processes:

(i) Reaction of sodium with ethanol:

Answer:

- Sodium ethoxide (C_2H_5ONa): Sodium reacts with ethanol to form sodium ethoxide.
- Hydrogen gas (H_2): This is a by-product of the reaction.

Chemical equation:



(ii) Partial fermentation of sucrose in the presence of yeast cells:

Answer:

- Ethanol (C₂H₅OH): Produced as the primary product of fermentation.
- Carbon dioxide (CO₂): Released as a by-product during fermentation.

Chemical equation:



7. (a) Why is it important to replace fossil fuels as an energy source?

Answer:

- Environmental impact: Burning fossil fuels releases greenhouse gases, contributing to climate change.
- Resource depletion: Fossil fuels are non-renewable and will eventually run out.
- Pollution: Fossil fuels cause air and water pollution, harming ecosystems and human health.
- Energy security: Dependence on fossil fuels can lead to geopolitical issues and price volatility.
- Sustainable development: Replacing fossil fuels with renewable energy supports long-term economic and environmental stability.

(b) Briefly explain four alternative sources of energy that can be developed to replace fossil fuels.

Answer:

- Solar energy: Capturing sunlight using photovoltaic cells for electricity or solar heaters for thermal energy.
- Wind energy: Using wind turbines to generate electricity from wind.
- Hydropower: Utilizing the flow of water to generate electricity through turbines.
- Biomass energy: Using organic materials like agricultural waste or wood to produce biofuels or biogas.

8. (a) How is the concept of mole useful in Chemistry? Give four points.

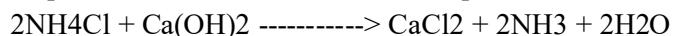
Answer:

- Quantitative analysis: The mole allows chemists to calculate the exact amount of reactants and products in a chemical reaction.
- Atomic and molecular mass: It helps relate the mass of atoms and molecules to macroscopic quantities.
- Concentration calculations: The mole concept is used to determine molarity in solutions.
- Stoichiometry: It enables the calculation of proportions in chemical equations for precise reactions.

(b) What mass of impure ammonium chloride (90%) would be needed to react completely with 14.8 g of calcium hydroxide?

Answer:

Step 1: Write the balanced chemical equation.



Step 2: Calculate the moles of calcium hydroxide.

$$\text{Molar mass of Ca}(\text{OH})_2 = 40 + (16 \times 2) + 2(1) = 74 \text{ g/mol}$$

$$\text{Moles of Ca}(\text{OH})_2 = \text{mass} / \text{molar mass} = 14.8 / 74 = 0.2 \text{ moles}$$

Step 3: Determine moles of NH₄Cl required.

From the equation, 2 moles of NH₄Cl react with 1 mole of Ca(OH)₂.

$$\text{Moles of NH}_4\text{Cl required} = 2 \times 0.2 = 0.4 \text{ moles}$$

Step 4: Calculate the mass of NH₄Cl.

$$\text{Molar mass of NH}_4\text{Cl} = 14 + (1 \times 4) + 35.5 = 53.5 \text{ g/mol}$$

$$\text{Mass of NH}_4\text{Cl} = \text{moles} \times \text{molar mass} = 0.4 \times 53.5 = 21.4 \text{ g}$$

Step 5: Adjust for impurity (90%).

$$\text{Mass of impure NH}_4\text{Cl} = 21.4 / 0.9 = 23.8 \text{ g}$$

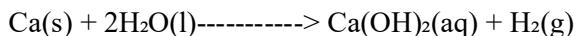
The mass of impure ammonium chloride needed is 23.8 g.

9. (a) The following diagram was used to study the reaction of calcium and water.

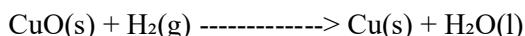
Gas X produced was passed through black copper(II) oxide, which changed color to brown. With the aid of a chemical equation, interpret this observation.

Answer:

When calcium reacts with water, it produces hydrogen gas (Gas X) and calcium hydroxide. The reaction is as follows:



When Gas X (hydrogen gas) is passed through black copper(II) oxide, it reduces the oxide to copper metal, causing the color change from black to brown. The reaction is as follows:



This observation demonstrates the reducing property of hydrogen gas, as it removes oxygen from copper(II) oxide to form metallic copper.

(b) Hydrogen atom can react by either gaining or losing electrons. In both cases, energy is involved. With the aid of the chemical equation(s) and energy level diagram, interpret this observation.

Answer:

1. Losing an electron:

When a hydrogen atom loses an electron, it forms a hydrogen ion (H⁺), which is a cation. This process requires energy, known as ionization energy. H -----> H⁺ + e⁻

2. Gaining an electron:

When a hydrogen atom gains an electron, it forms a hydride ion (H⁻), which is an anion. This process releases energy, known as electron affinity. H + e⁻ -----> H⁻

Energy level interpretation:

- In losing an electron, the hydrogen atom transitions to a higher-energy state as it requires energy to overcome the attraction between the nucleus and the electron.
- In gaining an electron, energy is released as the hydrogen atom becomes more stable with an additional electron.

This dual behavior makes hydrogen versatile, allowing it to participate in a variety of chemical reactions as both a reducing and oxidizing agent.

10. How is organic manure important to soil quality? Briefly explain by giving five points.

Answer:

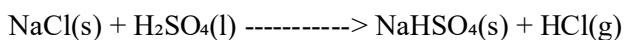
- Enhances soil fertility: Organic manure provides essential nutrients such as nitrogen, phosphorus, and potassium, improving soil fertility.
- Improves soil structure: It enhances soil aeration and water retention by improving the aggregation of soil particles.
- Increases microbial activity: Organic manure promotes the growth of beneficial microorganisms, which help in nutrient cycling and organic matter decomposition.
- Reduces soil erosion: By improving soil structure, organic manure minimizes the risk of erosion caused by water and wind.
- Eco-friendly: Organic manure is biodegradable and reduces the reliance on chemical fertilizers, minimizing environmental pollution.

11. Give the explanation on the hydrogen chloride gas based on the following:

(a) The raw material for the production of the gas.

Answer:

The raw materials for producing hydrogen chloride gas are sodium chloride (table salt) and concentrated sulfuric acid. When these react, hydrogen chloride gas is produced.



(b) Two chemical tests for hydrogen gas.

Answer:

- Combustion test: When hydrogen gas is ignited, it burns with a blue flame and produces water.

$$2\text{H}_2\text{(g)} + \text{O}_2\text{(g)} \longrightarrow 2\text{H}_2\text{O(g)}$$
- Pop test: When a glowing splint is brought near hydrogen gas, it produces a characteristic "pop" sound, confirming the presence of hydrogen.

(c) Four physical properties of hydrogen chloride.

Answer:

- Hydrogen chloride is a colorless gas with a pungent smell.
- It is highly soluble in water, forming hydrochloric acid.
- It is denser than air and can be collected by upward displacement of air.
- It is non-flammable and does not support combustion.

(d) Five uses of hydrogen chloride gas.

Answer:

- Production of hydrochloric acid, widely used in industries.
- Used in the production of PVC (polyvinyl chloride) for making plastic products.
- As a laboratory reagent in qualitative and quantitative analysis.
- Used in cleaning metals before galvanization and soldering.
- Used in the food industry for adjusting pH and producing food-grade salts.