*Candidate's Examination Number ……*

**THE UNITED REPUBLIC OF TANZANIA**
**NATIONAL EXAMINATIONS COUNCIL**
**FORM TWO SECONDARY EDUCATION EXAMINATION, 2011**

**0032** **CHEMISTRY**

**Time: 2½ HOURS** **ANSWERS**

## INSTRUCTIONS

1. This paper consists of sections A, B and C.
2. Answer **ALL** questions.
3. Write your examination number at the top right corner of every page.
4. **ALL** writing must be in black or blue ink **EXCEPT** diagrams which must be in pencil.
5. Cellphones and calculators are not allowed in the examination room.
6. The following atomic masses may be used: $H = 1$, $O = 16$, $C = 12$, $Na = 23$, $S = 32$, $Ca = 40$

| FOR EXAMINER'S USE ONLY | | |
|---|---|---|
| **QUESTION NUMBER** | **SCORE** | **INITIALS OF EXAMINER** |
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
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| **TOTAL** | | |


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## SECTION A (10 MARKS)

1. Write the letter of the correct answer from the given alternatives in the box provided.

(i) Isotopes are atoms of the same element that have different:

A. Atomic number

B. Electron arrangement

C. Mass number

D. Protons

**Correct:** C

**Reason:** Isotopes have the same atomic number (protons) but different mass numbers due to varying neutrons.

(ii) When substance A and substance B react to produce a new substance C, the reactants A and B are said to:

A. Be miscible

B. Form a mixture

C. Form a solution

D. Undergo chemical change

**Correct:** D

**Reason:** A chemical change involves reactants forming new substances with different properties, unlike mixing or forming solutions.

(iii) In the formula of the compound $F_2K_3$, the valences of F and K are respectively:

A. 2 and 3

B. 3 and 2

C. 4 and 6

D. 6 and 4

**Correct:** A

**Reason:** The formula $F_2K_3$ indicates F has a valence of 2 (3 K atoms per 2 F atoms) and K has a valence of 3 (2 F atoms per 3 K atoms).

(iv) The process by which water is converted into water vapour or steam is called:

A. Condensation

B. Evaporation



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C. Precipitation

D. Transpiration

**Correct:** B

**Reason:** Evaporation is the process where water changes from liquid to vapour, typically due to heat, unlike condensation or transpiration.

(v) In the Bunsen burner, a sooty flame is most likely to be formed when the:

A. Air holes are fully closed

B. Air holes are opened

C. Flame is noisy

D. Flame is smaller and hotter

**Correct:** A

**Reason:** Closed air holes limit oxygen, causing incomplete combustion and a sooty (luminous) flame.

(vi) The best way to separate a mixture of iodine and iron filings is by:

A. Decantation

B. Evaporation to dryness

C. Fractional distillation

D. Sublimation

**Correct:** D

**Reason:** Iodine sublimes (turns from solid to gas) when heated, allowing separation from iron filings, which remain solid.

(vii) The choice of the source of heat depends on the:

A. Colour of the flame

B. Quantity of heat produced

C. Substance to be burned or boiled

D. Type and shape of flame

**Correct:** C

**Reason:** The substance determines the heat source, as different materials require specific temperatures or flame types.

(viii) When oxygen combines with metals they:

A. Form metallic oxides



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B. Form precipitates

C. Rust

D. Sublime

**Correct:** A

**Reason:** Oxygen reacts with metals to form metallic oxides, like iron oxide, while rusting is specific to iron and water.

(ix) The pair of elements which is most likely to form a covalent bond when they react together is:

A. Carbon and oxygen

B. Magnesium and potassium

C. Nitrogen and aluminium

D. Sodium and oxygen

**Correct:** A

**Reason:** Carbon and oxygen, both non-metals, share electrons to form covalent bonds, unlike metal-non-metal pairs forming ionic bonds.

(x) A calcium ion ($Ca^{2+}$) differs from a calcium atom (Ca) because a calcium ion has:

A. Less electrons

B. Less protons

C. More electrons

D. More neutrons

**Correct:** A

**Reason:** A calcium ion ($Ca^{2+}$) has lost two electrons compared to a neutral calcium atom, resulting in a positive charge.

2. Match each item in List A with a correct response in List B by writing its letter below the number of the corresponding item in the table provided.

| LIST A | LIST B |
|---|---|
| (i) Burning gases that give out heat and light | A. Boiling and filtration |
| (ii) Coating iron objects using zinc metal | B. Class C fire |
| (iii) Domestic water treatment and purification | C. Distillation |
| (iv) Heterogeneous mixture | D. Energy shell 1 |
| (v) Holds maximum of 8 electrons | E. Energy shell 2 |
| (vi) Intelligent guess on the cause of the problem | F. Experimentation |
| (vii) Liquid metal | G. Flame |



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| | |
|---|---|
| (viii) Relights a glowing splint | H. Galvanization |
| (ix) The burning material is a liquefied gas | I. Hydrogen |
| (x) Turns white anhydrous copper (II) sulphate blue | J. Hypothesis |
| | K. Mercury |
| | L. Oxygen |
| | M. Solution |
| | N. Suspension |
| | O. Water |

**Correct:**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| LIST A | i | ii | iii | iv | v | vi | vii | viii | ix | x |
| LIST B | G | H | A | N | E | J | K | L | B | O |

3. (a) Why do atoms combine?
Atoms combine to achieve a stable electron configuration, often by gaining, losing, or sharing electrons to fill their outer shells.

(b) A metal Z with atomic number 12 combines with chlorine to produce a metal chloride. By means of diagrams, illustrate the arrangement of electrons in Z before and after the reaction.

Before reaction: Z (Mg, atomic number 12) has electron configuration 2, 8, 2. Diagram shows 2 electrons in first shell, 8 in second, 2 in third.
After reaction: $Mg^{2+}$ has configuration 2, 8 (loses 2 electrons). Diagram shows 2 electrons in first shell, 8 in second. Forms $MgCl_2$ with $Cl^-$ (2, 8, 8).

(c) An atom X of atomic number 14 combines with chlorine to form a chloride. What type of bond will be formed between the atoms?
Covalent bond
Atom X (Si, atomic number 14) is a non-metal, and chlorine is also a non-metal, so they share electrons to form covalent bonds in $SiCl_4$.

4. (a) What do you understand by the term "valency"?
Valency is the combining capacity of an element, determined by the number of electrons it can gain, lose, or share to form a compound.

(b) Calculate the oxidation number of the underlined elements:
(i) NaOH (O underlined)
Na = +1, H = +1, let O = x. Molecule is neutral: 1 + x + 1 = 0, x = -2.

(ii) $CO_3^{2-}$ (C underlined)
O = -2 (3 × -2 = -6), let C = x. Ion charge = -2: x - 6 = -2, x = +4.


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(iii) $Na_3PO_4$ (P underlined)
Na = +1 (3 × +1 = +3), O = -2 (4 × -2 = -8), let P = x. Neutral: 3 + x - 8 = 0, x = +5.
(iv) $SO_2$ (S underlined)
O = -2 (2 × -2 = -4), let S = x. Neutral: x - 4 = 0, x = +4.

(c) Explain three points on the importance of changing one state of matter to another.
(i) Purification: Boiling water to steam and condensing it purifies water.
(ii) Industrial processes: Melting metals allows molding into shapes.
(iii) Food preservation: Freezing liquids to solids extends shelf life.

5. (a) Give two reasons why water is a compound.

(i) Water has a fixed composition ($H_2O$) with hydrogen and oxygen in a 2:1 ratio.

(ii) Water's properties differ from its elements (hydrogen and oxygen are gases, water is liquid).

(b) Write IUPAC names for each of the following compounds:

(i) $CaCO_3$: Calcium carbonate

(ii) $Al_2(SO_4)_3$: Aluminium sulfate

(iii) $NaHCO_3$: Sodium hydrogen carbonate

(iv) $Mg(NO_3)_2$: Magnesium nitrate

(v) KCl: Potassium chloride

(c) Describe a chemical test for water.

Add water to anhydrous copper(II) sulphate; it turns from white to blue.

6. (a) State the law of conservation of energy.
Energy cannot be created or destroyed, only transformed from one form to another.

(b) Give two ways in which energy can be transformed from one form to another.
(i) Electrical energy to light energy in a bulb.
(ii) Chemical energy to heat energy in combustion.

(c) List down two sources of heat in the laboratory.
Bunsen burner, Hot plate
The law ensures energy transformations are consistent, like electrical to light in bulbs or chemical to heat in burning fuel. Bunsen burners and hot plates provide controlled heat for experiments.


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7. (a) Define the term "empirical formula".
The empirical formula is the simplest whole-number ratio of atoms in a compound.

(b) An organic compound contains 26.7% carbon, 2.2% hydrogen, and 71.1% oxygen. If its relative molecular mass is 90, determine its:

(i) Empirical formula
Assume 100g: C = 26.7g, H = 2.2g, O = 71.1g. Moles: C = 26.7/12 = 2.225, H = 2.2/1 = 2.2, O = 71.1/16 = 4.444.
Ratio: 2.225/2.2 ≈ 1, 2.2/2.2 = 1, 4.444/2.2 ≈ 2. Empirical formula: $CH_2O$.

(ii) Molecular formula
Empirical mass ($CH_2O$) = 12 + 2 + 16 = 30. Molecular mass = 90. n = 90/30 = 3. Molecular formula: $C_3H_6O_3$.

(c) State three points of modern atomic theory that amend Dalton's ideas.
(i) Atoms are divisible into subatomic particles (electrons, protons, neutrons).
(ii) Isotopes exist with different mass numbers for the same element.
(iii) Atoms can undergo nuclear reactions, changing their identity.
The empirical formula calculation uses percentage composition to find the simplest ratio, and the molecular formula scales it to match the molecular mass. Modern atomic theory corrects Dalton's assumptions with discoveries about subatomic particles, isotopes, and nuclear reactions.

8. (a) Differentiate between:
(i) An atom and an element
An atom is the smallest unit of an element; an element is a pure substance made of one type of atom.

(ii) Combustion and rusting
Combustion is a rapid reaction with oxygen producing heat and light; rusting is a slow oxidation of iron with water and oxygen.

(iii) A solute and a solvent
A solute is the substance dissolved; a solvent is the substance that dissolves the solute.

(iv) A compound and a mixture
A compound has a fixed composition and new properties; a mixture retains the properties of its components.

(b) Give two applications of chemistry in everyday life.

(i) Medicine production for treating diseases.

(ii) Water purification for safe drinking.


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(c) Why most laboratory apparatuses are made of glass?
Glass is chemically inert, transparent, and heat-resistant, suitable for observing reactions and heating substances.
Differentiations clarify fundamental concepts, like atoms vs. elements or compounds vs. mixtures. Chemistry's applications, like medicine and water treatment, show its practical impact. Glass's properties make it ideal for lab use, preventing contamination and allowing clear observation.

9. (a) Below is part of the periodic table and the numbers represent atomic numbers. Study the table carefully then answer the questions that follow:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | | | | | | | 2 |
| 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 19 | 20 | | | | | | |

(i) Write T in the space where a noble gas in period 3 would occupy.
T at 18 (Argon).

(ii) Write U in the space where the most active metal would occupy.
U at 19 (Potassium).

(iii) Write W in the space where the most active non-metal would occupy.
W at 17 (Chlorine).

(iv) Write X in the space which would be occupied by an element in period 3 capable of forming a compound XW.
X at 13 (Aluminium).

(v) Write Y in group II period 4 element.
Y at 20 (Calcium).

(vi) Write Z in group VI period 3 element.
Z at 16 (Sulphur).

(b) Write the chemical symbols of the following elements:
(i) Argon: Ar
(ii) Sulphur: S
(iii) Boron: B
(iv) Silicon: Si
(v) Phosphorus: P


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(c) Write the formula of each compound formed between:
(i) Aluminium and chlorine: $AlCl_3$
(ii) Potassium and oxygen: $K_2O$

10. (a) (i) Name two reagents normally used for preparation of hydrogen in the laboratory.
Zinc, Hydrochloric acid

(ii) Write a word equation for the reaction in (i) above.
Zinc + Hydrochloric acid → Zinc chloride + Hydrogen

(b) (i) Why is hydrogen gas used for filling balloons?
Hydrogen is lighter than air, providing lift for balloons.

(ii) Describe a chemical test for hydrogen gas.
A lit splint near hydrogen produces a “pop” sound due to rapid combustion.

(c) Explain safety measures that should be taken when handling chemicals with the following warnings:

(i) Flammable: Store away from ignition sources, use in well-ventilated areas.

(ii) Corrosive: Wear protective gloves and goggles, avoid skin contact.

(iii) Irritant or Harmful: Use in a fume hood, avoid inhalation or prolonged exposure.

(iv) Toxic: Handle with extreme care, use protective equipment, dispose of properly.


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