THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

FORM TWO NATIONAL ASSESSMENT

032 **CHEMISTRY**

Time: 2:30 Hours **ANSWERS** **YEAR: 2021**

Instructions

1. This paper consists of sections A and B with a total of **ten (10)** questions.
2. Answer **all** questions in the spaces provided.
3. Section A and C carry **fifteen (15)** marks each and section B carries **seventy (70)** mark s.
4. All writings must be in **blue** or **black** ink.
5. Communication devices and any unauthorized materials are **not** allowed in the assessment room .
6. Write your **Assessment Number** at the top right hand corner of every page.
7. The following atomic masses may be used: H = 1. C = 12, O = 16

SECTION A (20 Marks)

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

(i) Which particles contribute the net charge inside the nucleus of an atom?

A. Protons
B. Neutrons
C. Electrons
D. Nucleons

Answer: A. Protons

Reason: Protons are positively charged particles inside the nucleus that determine the net charge, while neutrons are neutral.

(ii) Which of the following is not a man-made product of applying chemistry?

A. Fertilizer
B. Milk
C. Sugar
D. Vaccines

Answer: B. Milk

Reason: Milk is a natural product, while fertilizers, sugar, and vaccines are human-engineered products involving chemical processes.

(iii) How is the amount of air entering the Bunsen burner controlled?

A. By adjusting the opening of the barrel.
B. By adjusting the opening of the collar.
C. By adjusting the opening of the jet.
D. By adjusting the opening of the base.

Answer: B. By adjusting the opening of the collar.

Reason: The collar controls the air intake by regulating the size of the air hole.

(iv) How do the chemists refer to a mixture of milk and water?

A. Emulsion
B. Suspension
C. Miscible solution
D. Immiscible solution

Answer: A. Emulsion

Reason: An emulsion is a mixture of two immiscible liquids, such as milk and water.

(v) Why is it necessary to boil drinking water?

A. To remove oxygen.
B. To remove impurities.
C. To make it tasteless.
D. To kill micro-organisms.

Answer: D. To kill micro-organisms.

Reason: Boiling kills harmful bacteria and pathogens in water, making it safe for drinking.

(vi) Which of the following indicates a pair of isotopes?
A. $^{40}_{20}X$ and $^{40}_{18}X$ B. $^{39}_{19}X$ and $^{40}_{20}X$
C. $^{12}_{6}X$ and $^{12}_{6}X$ D. $^{35}_{17}X$ and $^{37}_{17}X$
Answer: D. $^{35}_{17}X$ and $^{37}_{17}X$
Reason: Isotopes are atoms with the same number of protons (same atomic number) but different numbers of neutrons (different mass numbers).

(vii) Which of the following are the products of the reaction of sodium metal with water?
A. Sodium oxide and hydrogen gas.
B. Sodium hydroxide and water.
C. Sodium oxide and water vapor.
D. Sodium hydroxide and hydrogen gas.
Answer: D. Sodium hydroxide and hydrogen gas.
Reason: Sodium reacts with water to form sodium hydroxide and release hydrogen gas.

(viii) How does the covalent bond form?
A. By combining oppositely charged atoms.
B. By loss of electrons between ions.
C. By sharing of valence electrons.
D. By force of attraction of atoms.
Answer: C. By sharing of valence electrons.
Reason: Covalent bonds are formed when atoms share pairs of valence electrons to achieve stability.

(ix) How can one prevent rusting in fragile instruments like cameras?
A. By using silica gel.
B. By using ethanol.
C. By galvanization.
D. By using oil.
Answer: A. By using silica gel.
Reason: Silica gel absorbs moisture from the air, preventing rusting due to reduced humidity.

(x) What is the maximum number of electrons in the innermost shell of an atom?
A. 3
B. 8
C. 2
D. 1
Answer: C. 2
Reason: The first electron shell (K-shell) can hold a maximum of 2 electrons according to the $2n^2$ rule.

2. (a) Match the mixtures in List A with the methods of separation in List B by writing the letter of the correct response below the corresponding item number in the table provided.
List A:
(i) Ammonium chloride crystals in sand
(ii) Muddy water
(iii) Oil in sunflower
(iv) Sodium chloride in water
(v) Spirit in water

List B:
A. Decantation
B. Chromatography
C. Evaporation
D. Fractional distillation
E. Layer separation
F. Sublimation

Answers:
(i) F. Sublimation
(ii) A. Decantation
(iii) E. Layer separation
(iv) C. Evaporation
(v) D. Fractional distillation

(b) Answer the following items by filling in the blank spaces provided.

(i) Apart from air and fuel, what is the other component required for a flame to be produced?
Answer: Heat.
Reason: Heat is necessary to initiate and sustain combustion by increasing the energy of molecules.
(ii) How do we refer to the factors which can be adjusted in an experiment to get the desired results?
Answer: Variables.
Reason: Variables are the factors that can be controlled, changed, or measured in an experiment.
(iii) In what system through which water is continually moving above and below the Earth?
Answer: Water cycle.
Reason: The water cycle (or hydrological cycle) describes the continuous movement of water through evaporation, condensation, precipitation, and infiltration.
(iv) What process is involved in order to obtain coke and coal gas from bituminous coal in the absence of air?
Answer: Destructive distillation.
Reason: Destructive distillation involves heating coal in the absence of air to produce coke, coal gas, and tar.
(v) Which element in period 2 can share four electrons in order to acquire stability?

Answer: Carbon.
Reason: Carbon has four valence electrons and can form covalent bonds by sharing four electrons to achieve a stable octet configuration.

3. Answer the following questions with reference to the first 20 elements of the Periodic Table.

(a) Give the chemical symbol of the element having:
(i) The smallest atomic size.
Answer: He (Helium).
Reason: Helium has the smallest atomic radius due to its high nuclear charge and lack of inner shells.

(ii) The largest atomic size.
Answer: K (Potassium).
Reason: Potassium has the largest atomic radius among the first 20 elements due to its position in Group 1 and Period 4.

(b) Identify the elements which are:
(i) Metals having 3 shells of electrons each.
Answer: Na (Sodium) and Mg (Magnesium).
Reason: Both sodium and magnesium have 3 electron shells and are classified as metals.
(ii) Metals having 1 electron in the valence shell.
Answer: Li (Lithium) and Na (Sodium).
Reason: Both elements belong to Group 1, having one valence electron.
(iii) Noble gases.
Answer: He (Helium), Ne (Neon), and Ar (Argon).
Reason: These elements are noble gases due to their full outer electron shells, making them chemically inert.

4. (a) Give the IUPAC names of the following radicals:

(i) ClO_3
Answer: Chlorate.
(ii) PO_4^{3} -
Answer: Phosphate.

(b) Calculate the oxidation state of the underlined element in each of the following compounds:

(i) $NH_4\underline{Cl}$
$-3 + (1 \times 4) + x = 0$
$x = -1$
Answer: Oxidation state of Cl = -1.

(ii) $Al_2\underline{O_3}$

3 x 2 + 3X = 0
Answer: Oxidation state of O = -2.
(iii) Na_2SO_4
(+1 x 2) + x + (-2 x 4) = 0
2 + x – 8 = 0
x = +4
Answer: Oxidation state of S = +4
(iv) H_2O_2
+1 x 2 + 2x = 0
x = -1
Answer: Oxidation state of O = -1.

5. (a) Assign each of the properties to either luminous or non-luminous flame by putting a tick (✓) on the respective column in the following table.

Property of Flame	Luminous Flame	Non-luminous Flame
(i) Gives plenty of smoke and soot.	✓	
(ii) Blue in colour and almost invisible.		✓
(iii) Yellow zone is larger than blue zone.	✓	
(iv) Formed when the air holes are completely closed.	✓	
(v) Blue zone is larger than yellow zone.		✓
(vi) Produces the hottest flame.		✓

(b) Assume that you are doing an experiment in the laboratory at 07.30 pm and suddenly the lights go off. Give two reasons to justify the fact that you would consider luminous flame rather than non-luminous flame as an alternative source for lighting.
(i) Luminous flame produces more light due to its bright yellow glow, making it suitable for visibility in the dark.
(ii) Luminous flame is easier to spot and safer in the dark because of its visible yellow color, reducing the risk of accidental burns.

(c) Identify two properties of the flame produced by the Bunsen burner (air holes fully opened) that cannot be found in the flame produced by the spirit burner.

(i) The Bunsen burner flame is blue and produces a much hotter flame, ideal for heating and combustion experiments.
(ii) The Bunsen burner flame does not produce smoke or soot, ensuring a clean combustion process compared to the spirit burner.

7. (a) Distinguish the following substances:
(i) Saturated from unsaturated solution:
- Saturated Solution: Contains the maximum amount of solute that can dissolve at a specific temperature and pressure. Any additional solute added will not dissolve and may remain undissolved.
- Unsaturated Solution: Contains less solute than the maximum amount that can dissolve at a given temperature and pressure. Additional solute can still dissolve in the solution.
(ii) Miscible from immiscible liquids:
- Miscible Liquids: Liquids that can mix in any proportion to form a homogeneous solution. For example, ethanol and water are miscible.
- Immiscible Liquids: Liquids that do not mix and form separate layers when combined. For instance, oil and water are immiscible.
(iii) Homogeneous from heterogeneous mixture:
- Homogeneous Mixture: A mixture with a uniform composition throughout, where the individual components are not distinguishable. An example is a solution of salt dissolved in water.
- Heterogeneous Mixture: A mixture where the components are not uniformly distributed, and individual substances can be distinguished. An example is a mixture of sand and water.

(b) How can you separate each of the following mixtures?
(i) Pure water and muddy water:
- Filtration: Pass the mixture through a filter paper to separate the solid particles (mud) from the liquid (water).
(ii) Kerosene and water:
- Decantation: Allow the mixture to settle so that the denser water forms a separate layer at the bottom. Carefully pour off the kerosene layer from the top.
- Separating Funnel: Use a separating funnel to separate the two immiscible liquids based on their different densities.

8. Oxygen gas is one of the important gases in the atmosphere. It combines with different elements to form oxides. It can be made in the laboratory and industries.

(a) Which reagents can be used to prepare oxygen gas in the laboratory apart from hydrogen peroxide?
Reagents to prepare oxygen gas in the laboratory (apart from hydrogen peroxide):
(i) Heating potassium chlorate ($KClO_3$) in the presence of manganese dioxide (MnO_2) as a catalyst.
(ii) Heating potassium permanganate ($KMnO_4$) to decompose it into potassium manganate (K_2MnO_4) and oxygen gas.

(b) Give the name of the product formed by reacting oxygen gas with each of the following:
Products formed by reacting oxygen gas with:
(i) Carbon: Carbon dioxide (CO_2).
(ii) Phosphorus: Phosphorus pentoxide (P_4O_{10}).
(iii) Sulfur: Sulfur dioxide (SO_2).

(c) Five uses of oxygen gas:

- Respiration in living organisms.
- Combustion of fuels for energy production.
- Medical applications, such as oxygen therapy.
- Welding and metal cutting processes.
- Production of steel in the blast furnace.

9. (a) Differentiate molecular formula from empirical formula.
- Molecular Formula: Indicates the exact number of atoms of each element in a molecule. For example, the molecular formula of glucose is $C_6H_{12}O_6$, showing six carbon atoms, twelve hydrogen atoms, and six oxygen atoms.
- Empirical Formula: Represents the simplest whole-number ratio of elements in a compound. For glucose, the empirical formula is CH_2O, indicating a 1:2:1 ratio of carbon to hydrogen to oxygen atoms.

(b) (i) A pure oxide of lead (Pb) contains 13.4% of oxygen. Calculate the empirical formula of the compound.

Assume 100 g of the compound:
- Mass of oxygen = 13.4 g
- Mass of lead = 100 g - 13.4 g = 86.6 g

Calculate moles of each element:
- Moles of oxygen = 13.4 g ÷ 16 g/mol = 0.8375 mol
- Moles of lead = 86.6 g ÷ 207.2 g/mol = 0.4175 mol

Determine the simplest ratio:
- Ratio of moles of lead to oxygen = 0.4175 mol Pb ÷ 0.4175 mol = 1
- Ratio of moles of oxygen to lead = 0.8375 mol O ÷ 0.4175 mol = 2

Empirical formula: PbO_2

(b) (ii) Show how a compound can be formed between magnesium ion and chloride ions.
- Magnesium Ion (Mg^{2+}): Formed when magnesium loses two electrons, resulting in a 2+ charge.
- Chloride Ion (Cl^-): Formed when chlorine gains one electron, resulting in a 1- charge.

- Formation of Magnesium Chloride ($MgCl_2$):
  - Two chloride ions (each with a 1- charge) combine with one magnesium ion (with a 2+ charge) to balance the charges, resulting in a neutral compound.
  - The chemical formula is $MgCl_2$, indicating one magnesium ion for every two chloride ions.

10. Describe the main five approaches which chemists carry out during scientific research.
- **Observation: Identifying and describing phenomena or patterns in nature.**
- **Questioning: Formulating specific, testable questions based on observations.**
- **Hypothesis Formation: Proposing a tentative, testable explanation or educated guess to answer the research question.**
- **Experimentation: Designing and conducting controlled experiments to test the hypothesis.**
- **Analysis and Conclusion: Interpreting the data collected from experiments to determine whether it supports or refutes the hypothesis, and drawing conclusions based on the findings.**