**THE UNITED REPUBLIC OF TANZANIA**

**NATIONAL EXAMINATIONS COUNCIL OF TANZANIA**

**DIPLOMA IN SECONDARY EDUCATION EXAMINATION**

**732/1** **CHEMISTRY 1**

**Time: 3 Hours** **ANSWERS** **Year: 2014**

**Instructions**

1. This paper consists of section A, B and C.

2. Answer all questions in section A and two questions from section B and C.

1. Giving one example for each, explain in brief three importance of experimentation as a teaching and learning method in Chemistry.

Experimentation helps in the development of practical skills. Through laboratory experiments such as titration, students gain hands-on experience in handling chemicals and laboratory apparatus, which enhances their scientific proficiency.

It enhances conceptual understanding. When students conduct experiments like electrolysis, they directly observe how ions move and how gases are liberated, reinforcing theoretical concepts learned in class.

Experimentation cultivates scientific inquiry and problem-solving skills. By performing qualitative analysis experiments, students learn how to design procedures, make observations, and draw conclusions based on experimental results.

2. (a) State why the transition metals form coloured ions.

Transition metals form coloured ions due to the presence of partially filled d-orbitals. When light falls on these ions, electrons in the d-orbitals absorb specific wavelengths of light and undergo electronic transitions between different energy levels. The colour observed is the complementary colour of the absorbed wavelength.

(b) Name the following complex compounds according to IUPAC system of nomenclature.

(i) $([CrCl_2(H_2O)_4])_2SO_4$
Tetraaquadichlorochromium(III) sulphate

(ii) $Na_2[CuCl_4]$
Sodium tetrachlorocuprate(II)

3. List down three curricular materials for Chemistry which fall under teacher-made and teacher-made materials.

Teacher-made materials:
Handwritten notes
Customized laboratory worksheets
Self-designed models

Teacher-provided materials:
Prescribed textbooks
Chemistry practical manuals
Periodic table charts

4. (a) Name two gases that cause ozone layer depletion.

Chlorofluorocarbons (CFCs)
Nitrous oxide ($N_2O$)

(b) State two appropriate teaching methods which can be used in the teaching of the effect of land (terrestrial) pollution.

Demonstrations can be used to show how pollutants affect soil pH, water retention, and plant growth, providing learners with a practical understanding of pollution effects.

Field trips to industrial sites, landfills, or agricultural areas can help students observe real-life pollution problems and learn about environmental conservation strategies.

5. Name the process represented by each of the following reactions:

(a) Catalytic conversion of oil into margarine.
Hydrogenation

(b) Formation of ethane-1,2-diol.
Hydroxylation

(c) Formation of ethylbenzene.
Friedel-Crafts alkylation

6. Explain three differences between teacher-constructed test and summative test.

A teacher-constructed test is designed by the teacher to assess students' understanding of recently covered material, while a summative test is standardized and used to evaluate overall student performance at the end of a term or year.

Teacher-constructed tests are often informal and used for continuous assessment, whereas summative tests determine whether students have met learning objectives and are used for grading purposes.

A teacher-constructed test can be modified frequently based on classroom needs, but a summative test follows a fixed structure and is administered under strict examination conditions.

7. (a) State Hess's law of heat summation.

Hess's law states that the total enthalpy change of a chemical reaction is independent of the path taken, provided the initial and final conditions remain the same.

(b) Find the enthalpy of formation of Carbon monoxide (CO) in the following equation:

$C(s) + 1/2\ O_2(g) \text{ ---> } CO(g)$

Given that:
$C(s) + O_2(g) \text{ ---> } CO_2(g)\ \ \Delta H = -393.5\ kJ$
$CO(g) + 1/2\ O_2(g) \text{ ----> } CO_2(g)\ \ \Delta H = -283.0\ kJ$

Using Hess's law:
$C(s) + O_2(g) \text{ ---> } CO_2(g)\ \ \Delta H = -393.5\ kJ$
Reverse the second equation:
$CO_2(g) \text{ ----> } CO(g) + 1/2\ O_2(g)\ \ \Delta H = +283.0\ kJ$

Adding both reactions:
$C(s) + 1/2\ O_2(g) \text{ -----> } CO(g)$
$\Delta H = -393.5 + 283.0 = -110.5\ kJ/mol$

8. Explain how molarity and number of moles will be affected if 200 $cm^3$ of distilled water is added into 20 g NaOH. Give reasons for your answer.

When 200 $cm^3$ of distilled water is added to NaOH solution, the volume of the solution increases, leading to a decrease in molarity. Since molarity is defined as moles of solute per liter of solution, increasing the volume reduces concentration.

However, the number of moles of NaOH remains constant because adding water only dilutes the solution without affecting the total amount of solute present.

9. The compound K undergoes ozonolysis giving propane and propanoic acid only.

(a) Molecular formula.
The molecular formula of compound K is $C_6H_{12}O_4$, based on the products obtained from ozonolysis.

(b) Condensed structural formula.
$CH_3\text{-}CH{=}CH\text{-}CH_2\text{-}CH_3$ (assuming K is 2-Hexene)

(c) Systematic IUPAC name.
Hex-2-ene

10. State three uses of each of the following resources required during scheme of work preparation:

(a) Textbook

A textbook provides structured content that aligns with the curriculum, ensuring that teachers cover all necessary topics systematically.

It serves as a reference material for explanations, illustrations, and problem-solving exercises, enhancing lesson clarity.

Textbooks provide standard laboratory procedures and safety guidelines that help in conducting experiments effectively.

(b) Syllabus

The syllabus outlines learning objectives and expected competencies, guiding teachers on what to teach and assess.

It helps in sequencing topics to ensure logical progression of knowledge from simple to complex concepts.

The syllabus serves as an evaluation tool for both teachers and students by specifying the required skills and knowledge to be achieved at each level.

11. In one of the chemical kinetic reaction experiments, the following results were recorded as shown in Table 1:

Table 1: Experimental results

| Experiment | Temperature (T) | Time of reaction (s) | 1/T ($K^{-1}$) | Log t | 1/t ($s^{-1}$) | Log 1/t |
|---|---|---|---|---|---|---|
| 1 | 50°C = 323 K | 42 | 0.003096 | 1.623 | 0.02381 | -1.623 |
| 2 | 60°C = 333 K | 20 | 0.003003 | 1.301 | 0.05000 | -1.301 |
| 3 | 70°C = 343 K | 10 | 0.002915 | 1.000 | 0.10000 | -1.000 |
| 4 | 80°C = 353 K | 5 | 0.002832 | 0.699 | 0.20000 | -0.699 |

(a) Complete Table 1 above.
Filled table values shown above with calculated 1/T, Log t, 1/t and Log 1/t values.

(b) The slope of the graph for this experiment is expressed as Ea/2.303R, and its value is 476 K/s. Calculate the activation energy (Ea) of the reaction.

Given:
Slope m = Ea / 2.303R = 476
R = 8.314 J/mol·K

Ea = slope × 2.303 × R
Ea = 476 × 2.303 × 8.314 = 9116.37 J/mol
Ea = 9.12 kJ/mol

(c) Giving two reasons, explain whether the reaction was endothermic or exothermic.

The reaction is endothermic because an increase in temperature leads to an increase in reaction rate, as seen from the reduced reaction time at higher temperatures. This indicates that heat is absorbed to overcome the activation barrier.

Also, the high value of activation energy supports that the system needs energy input to proceed effectively, a typical characteristic of endothermic processes.

12. (a) Describe any six preliminary tests.

Preliminary tests in qualitative analysis are initial observations and reactions performed on a given sample before detailed confirmatory tests. These tests help to identify the nature of the sample and guide further analysis.

The colour of the solid or solution gives the first indication about the possible ions present. For example, a blue colour suggests the presence of copper(II) ions, while green may suggest iron(II).

The odour of the substance may also provide clues. A pungent smell may indicate the presence of ammonia or sulfur compounds.

The flame test involves introducing the sample to a non-luminous flame to identify metal ions by the colour they emit. Sodium gives a yellow flame, potassium a lilac flame, and calcium an orange-red flame.

The solubility test in water or acid helps determine whether the substance is ionic or covalent in nature and how it behaves in different solvents.

The reaction with dilute acids can indicate the presence of carbonates or sulfides. Effervescence with acid suggests a carbonate due to carbon dioxide gas release.

The reaction with silver nitrate after dissolving the sample in water or nitric acid helps in detecting halide ions. A white precipitate indicates chloride, cream for bromide, and yellow for iodide.

(b) With the aid of molecular equations, explain what you would expect to observe in each of the following experiments:

(i) Barium nitrate solution is mixed with iron(III) sulphate solution.
$Ba(NO_3)_2 + Fe_2(SO_4)_3$ -----> $2Fe(NO_3)_3 + 3BaSO_4$
Observation: A white precipitate of barium sulphate is formed.

(ii) Sodium hydroxide solution is added to a solution of copper(II) sulphate.
$CuSO_4 + 2NaOH$ ----> $Cu(OH)_2 + Na_2SO_4$
Observation: A pale blue gelatinous precipitate of copper(II) hydroxide is formed.

(iii) Lead carbonate is strongly heated in the test tube.
$PbCO_3$ -----> $PbO + CO_2$
Observation: Yellow solid of lead(II) oxide is formed and effervescence occurs due to carbon dioxide gas evolution.

13. (a) (i) Define the term "electroplating".

Electroplating is the process of coating a metal object with a thin layer of another metal using electrolysis. The object to be coated is made the cathode and immersed in a solution containing the metal ions of the coating metal. When electric current passes, the metal ions are reduced and deposited on the surface of the object.

(ii) What is the equivalent mass of $Ca^{2+}$?

The equivalent mass is given by:
Equivalent mass = Molar mass / n
Where n = number of electrons exchanged = 2
Molar mass of calcium = 40 g/mol
Equivalent mass = 40 / 2 = 20 g/eq

(b) Calculate the mass of calcium deposited during electrolysis when electric current of 45 amperes passes through calcium electrolyte for 20 minutes.

$Q = I \times t = 45 \times 20 \times 60 = 54000$ C
$n = Q / (z \times F) = 54000 / (2 \times 96500) = 0.2796$ mol
Mass = moles × molar mass = 0.2796 × 40 = 11.18 g

(c) Using the Standard Reduction Potentials (SRP) in Table 2, justify which method between nickel-plating and zinc-plating is suitable to protect iron from rusting.

SRP for $Zn^{2+}/Zn$ = -0.76 V
SRP for $Fe^{2+}/Fe$ = -0.44 V
SRP for $Ni^{2+}/Ni$ = -0.25 V

Zinc has a more negative potential than iron, making it more reactive and a better sacrificial metal. Thus, zinc-plating is more suitable to protect iron from rusting since zinc will corrode first, protecting the iron underneath.

(d) A galvanic cell consists of copper electrode in 1 M $Cu(NO_3)_2$ and zinc electrode in 1 M $ZnSO_4$. Find the standard emf of the electrochemical cell at 25°C and state whether the cell will be feasible.

$Zn^{2+} + 2e^-$ -----> Zn(s) E° = -0.76 V

$Cu^{2+} + 2e^- \text{------>} Cu(s)$ E° = +0.34 V

E°cell = E°cathode - E°anode = 0.34 - (-0.76) = 1.10 V
Since the E°cell is positive, the cell is feasible and will function spontaneously.

14. (a) (i) Differentiate between isotope and isotopy.

Isotopes are atoms of the same element that have the same atomic number but different mass numbers due to varying numbers of neutrons in their nuclei. For example, carbon-12 and carbon-14 are isotopes of carbon.

Isotopy is the phenomenon or existence of atoms of the same element having different mass numbers but identical chemical properties. It is the general term used to describe the existence of isotopes.

(ii) State the cause of isotopy.

Isotopy is caused by the difference in the number of neutrons in the nuclei of atoms of the same element, while the number of protons remains constant.

(b) State the four postulates of Dalton's atomic theory.

All matter is composed of indivisible particles called atoms.

Atoms of a given element are identical in mass and properties, but different from atoms of other elements.

Atoms cannot be created, destroyed, or subdivided during a chemical reaction.

Atoms combine in simple whole number ratios to form chemical compounds.

(c) Silver exists naturally as a mixture of two isotopic forms represented as E and F. E is $^{107}Ag$ and F is $^{109}Ag$. State the number of:

(i) Protons in atom F:
Ag has atomic number 47, so number of protons in atom F is 47.

(ii) Neutrons in atom E:
Neutrons = Mass number - Atomic number = 107 - 47 = 60

(iii) Neutrons in atom F:
Neutrons = 109 - 47 = 62

(iv) Protons in atom E:
47 protons (same as atomic number of silver)

(v) Electrons in both atoms:
Since they are neutral atoms, the number of electrons equals the number of protons, which is 47 for both atoms.

(d) The abundance of three isotopes of neon are:
$^{20}$Ne (90.92%), $^{21}$Ne (0.26%), and $^{22}$Ne (8.82%).
Calculate the relative atomic mass of neon from its isotopes.

Relative atomic mass = (20 × 90.92) + (21 × 0.26) + (22 × 8.82) ÷ 100
= (1818.4 + 5.46 + 194.04) ÷ 100
= 2017.9 ÷ 100 = 20.179

15. Imagine you are planning a lesson to teach "Chemical equations" to your Form III class. Identify and describe possible:

(a) Three competences to be developed by learners.

Ability to write balanced chemical equations accurately.

Ability to identify reactants and products in a chemical reaction.

Ability to interpret and apply chemical equations in real-life contexts.

(b) Three (specific) learning objectives to be attained after the lesson.

Students should be able to define a chemical equation and identify its parts.

Students should be able to balance chemical equations using appropriate methods.

Students should be able to write chemical equations for given word equations.

(c) Three relevant learning activities that learners may engage in.

Pair work where students practice balancing given chemical equations.

Group discussion to classify types of chemical reactions based on equations.

Solving word problems and translating them into balanced chemical equations.

(d) The relevant teaching/learning aids.

Periodic table, whiteboard and markers, chemical equation charts, and simulation software or animations showing chemical reactions.

16. (a) Outline in ascending order, the four upper levels of cognitive taxonomy according to Benjamin Bloom.

Analysis
Synthesis
Evaluation
Creation

(b) Analyse the elements of the specific objectives.

Specific objectives contain clear behavioral outcomes that indicate what the learner should be able to do after instruction. They are measurable, achievable, and directly aligned with the lesson content. Objectives guide instruction and provide criteria for assessment and evaluation.

17. A marking scheme has two basic parts, answer/solution to the question and marks distribution to each answer/solution. Construct a sample marking scheme for each of the questions given below. Take the total marks for this question as 11.

(a) With the aid of chemical equation, outline four chemical properties of acid.

Reacts with metals: $2HCl + Zn \rightarrow ZnCl_2 + H_2$
Reacts with bases: $H_2SO_4 + NaOH \rightarrow NaHSO_4 + H_2O$
Reacts with carbonates: $2HCl + CaCO_3 \rightarrow CaCl_2 + CO_2 + H_2O$
Reacts with metal oxides: $H_2SO_4 + CuO \rightarrow CuSO_4 + H_2O$
(Each point with equation = 1 mark; total = 4 marks)

(b) Write two possible isomers of the hydrocarbon with molecular formula $C_4H_{10}$.

Butane
2-Methylpropane
(Each correct isomer = 1 mark; total = 2 marks)

(c) Briefly describe any three methods of salt preparation. Support your answer with relevant chemical equation.

Neutralization: $HCl + NaOH \rightarrow NaCl + H_2O$
Precipitation: $Pb(NO_3)_2 + 2KI \rightarrow PbI_2 + 2KNO_3$
Direct combination: $Fe + S \rightarrow FeS$
(Each correct method and equation = 1 mark; total = 3 marks)

18. (a) State the best method of teaching abstract topic like atomic structure and give reasons for your answer.

The best method is use of models and simulations. These visual and interactive tools help learners to conceptualize the invisible nature of atomic structure. They simplify abstract ideas like electron arrangement, energy levels, and orbitals.

(b) Assuming that you want to arouse interest of Form I class to study Chemistry. Convince the class by describing six significances of the subject in real life situation.

Chemistry helps in understanding the composition and transformation of matter in daily life.

It is essential in food science for preservation, additives, and nutritional analysis.

Chemistry knowledge helps in environmental conservation by understanding pollution and waste treatment.

It is vital in the health sector through drug formulation and diagnostic testing.

Chemistry plays a role in industrial development like production of fuels, plastics, and fertilizers.

It promotes analytical thinking and scientific inquiry, which are essential skills for problem-solving in real life.