THE UNITED REPUBLIC OF TANZANIA
NATIONAL EXAMINATIONS COUNCIL OF TANZANIA
DIPLOMA IN SECONDARY EDUCATTION EXAMINATION

732 **CHEMISTRY 1**

Time: 3 Hours **ANSWERS** **Year: 2024**

Instructions.

1. This paper consists of sections A and B with a total of **Fourteen (14)** questions.
2. Answer **all** questions from section A and **four (4)** questions from section B.
3. Section A carries **forty (40)** marks and section B Carries **sixty (60)** marks.
4. Cellular phones are **note** allowed in the examination room.
5. Write your **examination Number** on every page of your answer booklet(s).
6. The following constants can be used:

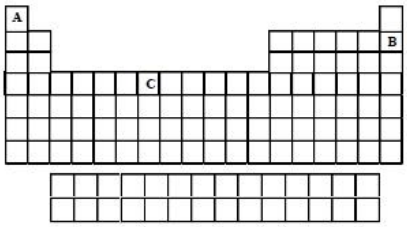
   Atomic Masses: H = 1 ; N = 14; O = 16; Zn = 65

   1Farady = 1 F = 96500C; Vm of gas at stp = 22.4 dm^3. 1 litre= 1 dm^3 = 1000 cm^3

SECTION A (40 Marks)

Answer **All** questions from this section. Each question carries **four (4)** marks.

1. The following diagram represents the modern periodic table with representative elements lettered A, B and C. Use the electronic configuration of each element to identify their blocks.



Identification of the blocks of elements A, B and C depend on their outermost orbital with highest quantum number in their electronic configuration last electron n(s):
Element A: has atomic number = 1 Electronic configuration = $1s^1$ Now, element A is located at the s-block

Element B: has atomic number = 10 Electronic configuration = $1s^2 2s^2 2p^6$ Now, element B is located at the p-block

Element C has atomic number = 25 Electronic configuration = $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$ Now, element C is located at the d-block

2. **Use Hess's law to calculate the standard enthalpy of the reaction A + B -----> C given the following standard enthalpy values:**
   ΔH_f^θ (A) = +411 kJ mol^{-1}
   ΔH_f^θ (B) = -252 kJ mol^{-1}
   ΔH_f^θ (C) = +525 kJ mol^{-1}

   According to Hess's law, the enthalpy change of a reaction is the difference between the sum of the enthalpy of formation of products and that of reactants.
   $\Delta H^\theta = \Sigma \Delta H_f^\theta$ (products) - $\Sigma \Delta H_f^\theta$ (reactants)
   = $[\Delta H_f^\theta (C)] - [\Delta H_f^\theta (A) + \Delta H_f^\theta (B)]$
   = [+525] - [+411 + (-252)]
   = 525 - (411 - 252)
   = 525 - 159
   = 366 kJ mol^{-1}
   Therefore, the standard enthalpy change of the reaction is +366 kJ mol^{-1}.

3. (a) **Student A carried ten moles of water in liquid form while student B carried the same number of moles of water in vapour form. Who carried heavier weight than the other? Briefly explain.**
   Both students carried the same number of moles, and since one mole of any substance has the same mass regardless of its state, the total mass remains constant. Ten moles of water weigh 180 grams whether in liquid or vapour form. Therefore, neither carried a heavier weight than the other.

   (b) **How many moles of nitrogen gas are there in 3.5×10^{20} molecules of the gas?**
   Using Avogadro's number (6.022×10^{23} molecules/mol):

Number of moles = Number of molecules / Avogadro's number
= $(3.5 \times 10^{20}) / (6.022 \times 10^{23})$
= 5.81×10^{-4} moles
Thus, there are 5.81×10^{-4} moles of nitrogen gas.

4. **Triamminetriaquachromium(III) chloride is one of the complex compounds. Briefly explain two conditions which favour formation of such a compound.**

   The presence of suitable ligands is essential. In this case, ammonia (NH_3) and water (H_2O) serve as ligands that can donate lone pairs of electrons to the chromium ion, forming stable coordinate bonds. A suitable oxidation state of the central metal ion also favours complex formation. Chromium in the +3 oxidation state (Cr^{3+}) has an appropriate size and charge density to attract ligands and stabilize the complex through strong coordinate bonds.

5. (a) **4-nitrophenol is more acidic than 4-methylphenol. Justify.**

   The nitro group ($-NO_2$) in 4-nitrophenol is an electron-withdrawing group that stabilizes the phenoxide ion formed after deprotonation, making it easier for the molecule to lose a hydrogen ion (H^+). On the other hand, the methyl group in 4-methylphenol is electron-donating, which destabilizes the phenoxide ion, reducing acidity.

   (b) **Reactions of phenylamine favour more electrophilic substitution at para and ortho positions than at meta position. Justify.**
   The amino group ($-NH_2$) is an electron-donating group through resonance and inductive effects, increasing electron density at the ortho and para positions on the benzene ring. This makes these positions more reactive towards electrophilic attack compared to the meta position.

6. **Suppose you determined the pH of soil and found it to be 9.5; how would you correct it to a pH below 7.0? Give four ways.**

   You can add acidic fertilizers such as ammonium sulfate or urea which release acids upon decomposition and lower soil pH.

   Application of organic matter like compost and manure helps produce organic acids during decomposition, reducing alkalinity.

   Incorporating elemental sulfur into the soil allows bacteria to convert sulfur to sulfuric acid, lowering soil pH over time.

   Use of gypsum (calcium sulfate) indirectly reduces alkalinity by replacing sodium ions with calcium, improving soil acidity.

7. **Four considerations emphasized by principles of teaching Chemistry with regards to student learning.**

   Learners must actively participate in experiments and problem-solving activities, ensuring they acquire knowledge through discovery.

Content must be related to daily life applications so that learners appreciate the relevance of Chemistry in their surroundings.

Practical and theoretical aspects should be integrated to develop balanced cognitive, psychomotor, and affective skills.

Teachers should assess learners progressively through observation, tests, and practical activities to track performance and correct misconceptions.

8. **Standard volumetric apparatus and indicator for titration between HCl and $NaHCO_3$.**
   A burette would be used to accurately deliver hydrochloric acid into a conical flask containing sodium bicarbonate.

   A pipette would measure a precise volume of sodium bicarbonate solution.

   A conical flask would be used to contain the reaction mixture during titration.

   Phenolphthalein would be an appropriate indicator, turning from pink in alkaline solution to colorless at the end point in acidic medium.

9. **Four points to help differentiate a syllabus and a curriculum.**
   A curriculum is a broad framework outlining all learning experiences provided by the education system, while a syllabus is a detailed outline of topics, objectives, and content within a specific subject.

   The curriculum covers all educational activities, including co-curricular and extra-curricular aspects, whereas a syllabus focuses on academic content alone.

   A curriculum determines overall teaching approaches, learner assessment methods, and resources, while a syllabus mainly guides lesson planning and content delivery for a subject.

   A curriculum is designed at national or institutional levels and affects the entire education system, while syllabi can vary from one subject or grade to another within the same curriculum framework.

10. (a) **Write an expression for the rate of reaction with respect to Fe^{3+}.**
    Rate = $- \Delta[Fe^{3+}] / \Delta t$

    (b) **If initial concentrations of $Fe^{3+} = Fe^{2+} = 0.001$ M, prove the average rate of reaction of Fe^{3+} and Fe^{2+} is the same after 38.5 seconds.**
    From the balanced ionic equation:
    $2Fe^{3+} + Sn^{2+} \text{-----> } 2Fe^{2+} + Sn^{4+}$
    The molar ratio of Fe^{3+} consumed to Fe^{2+} produced is 1:1. Therefore, for every mole of Fe^{3+} consumed, an equal mole of Fe^{2+} is produced.
    Thus:
    Rate of decrease of $[Fe^{3+}]$ = Rate of increase of $[Fe^{2+}]$
    $\Delta[Fe^{3+}]/\Delta t = \Delta[Fe^{2+}]/\Delta t$
    This means after any time, including 38.5 seconds, the average rate of reaction for both Fe^{3+} and Fe^{2+} remains equal.

SECTION B (60 Marks)

Answer all questions from this question. Each question carries **fifteen (15)** marks.

11. (a) **Draw a well-labeled diagram of this electrochemical cell.**

This electrochemical cell consists of two half-cells. One half-cell contains aluminium metal dipped into a solution of Al^{3+} ions with a concentration of 0.125 M, while the other half-cell contains tin metal dipped into a solution of Sn^{2+} ions with a concentration of 0.352 M.

The aluminium half-cell acts as the anode because it has a lower (more negative) standard electrode potential. Here, oxidation occurs where aluminium metal loses electrons to form Al^{3+} ions.

The tin half-cell serves as the cathode because it has a higher (less negative) electrode potential. At this electrode, Sn^{2+} ions gain electrons to form tin metal by reduction.

The two half-cells are connected via a salt bridge which allows the movement of ions and maintains electrical neutrality by completing the circuit.

A voltmeter is connected externally between the aluminium and tin electrodes to measure the electromotive force (e.m.f) generated by the cell.

(b) **Calculate the e.m.f. of this cell using the provided data.**
To calculate the e.m.f. of the cell, use the formula:
$E_{cell} = E\theta(cathode) - E\theta(anode)$
Given:
$E\theta(cathode) = E\theta(Sn^{2+}/Sn) = -0.13$ V
$E\theta(anode) = E\theta(Al^{3+}/Al) = -1.66$ V
Now substitute:
$E_{cell} = (-0.13) - (-1.66)$
$E_{cell} = 1.53$ V
Therefore, the electromotive force (e.m.f.) of the cell is 1.53 volts.

12. (a) **Complete the following organic reactions and determine the type of reaction involved.**

(i) $CH_3CH=CH_2 + HBr$ (with hydrogen peroxide) $\rightarrow CH_3CH_2CH_2Br$
This is a free radical addition reaction.

(ii) $CH_3CH=CH_2 + Cl_2$ (in presence of H^+) $\rightarrow CH_3CHClCH_2Cl$
This is an electrophilic addition reaction.

(iii) $CH_3CH=CH_2 + Cl_2$ (in u.v. light) $\rightarrow CH_2ClCH=CH_2$ or $CH_3CH=CHCl$
This is a free radical substitution reaction.

(iv) $CH_3CH=CH_2 + Cl_2$ (in darkness) $\rightarrow CH_2ClCHClCH_3$
This is an electrophilic addition reaction.

(v) $CHI=CHI$ + alcoholic NaOH $\rightarrow HC\equiv CH + 2NaI + 2H_2O$
This is an elimination reaction.

(b) **Write the expanded structural formulae:**

(i) 2,3-dibromopentane
CH_3-CHBr-CHBr-CH_2-CH_3

(ii) 3,3-diethylpentane
CH_3-CH_2-C(C_2H_5)$_2$-CH_2-CH_3

(iii) 3-methylbut-2-ene
CH_3-C(CH_3)=CH-CH_3

(iv) 2-bromo-3-chloropent-2-ene
CH_3-CHBr-C(Cl)=CH-CH_3

(v) But-2-yne
CH_3-C≡C-CH_3

13. **Six features of a well-prepared teaching and learning resource made from local materials**

A good improvised resource should be safe for both the teacher and learners. It must not have sharp edges, toxic materials, or cause any physical harm during handling or experimentation.

It must be simple and easy to use. Learners and teachers should operate the resource comfortably without needing sophisticated knowledge or special skills.

Durability is essential for an improvised resource. It should withstand handling and usage for a reasonable period without quick damage or wear.

The material used must be easily available and affordable within the local environment to ensure teachers can access and reproduce the resource without financial strain.

The resource must effectively serve the intended educational purpose. It should represent or demonstrate the concept clearly, enhancing understanding of the topic being taught.

Lastly, it should encourage active learner participation and curiosity. A well-prepared resource should be interactive, interesting, and motivate learners to engage in learning activities.

14. (a) **Four steps to accomplish the preparation of a monthly Chemistry test for Form One students**

The first step is to review the topics covered during the month to identify the concepts that need to be assessed. This ensures the test aligns with the syllabus and the material taught.

Next is to design a table of specification that guides the distribution of questions across different cognitive levels such as knowledge, comprehension, and application.

Afterward, develop a variety of test items including multiple-choice, short-answer, and structured questions that fairly represent the covered topics.

Finally, proofread and moderate the test to check for clarity, fairness, and alignment with objectives, then prepare marking guidelines before administering the test.

(b) **Three steps to follow in developing guidelines for a quality end-year Chemistry test**

The first step is to establish clear objectives and learning outcomes that the test should evaluate. This ensures the test focuses on both syllabus coverage and essential competencies.

Secondly, set criteria for question distribution, difficulty levels, and types of items to balance the assessment and provide equal opportunities for all learners.

Lastly, plan for the moderation process, including internal review by other Chemistry teachers and the preparation of marking schemes to ensure fairness, accuracy, and consistency in grading.