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

732/1 **CHEMISTRY 1**

Time: 3 Hours **ANSWERS** **Year: 2022**

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).

SECTION A (40 Marks)

Answer all questions from this section. Each question carries 4 marks.

1. In an experiment to determine the structure of an atom, Rutherford bombarded positively charged alpha particles to the atoms of a gold foil and observed the following:

(a) *Most of the alpha particles passed through the gold foil without suffering any deflection.*
Interpretation: This showed that most of the atom is empty space. Since alpha particles are massive and positively charged, their ability to pass through the foil without deflection indicated that electrons and other atomic components occupy very little space within the atom.

(b) *Very few particles rebounded completely on hitting the gold foil.*
Interpretation: This revealed the presence of a small, dense, positively charged nucleus at the center of the atom. The repulsion and deflection occurred when alpha particles came very close to or directly struck this concentrated positive center.

2. Write the order of reaction with respect to Br_2 and H_2, together with overall order of reaction in rate equation:
Given: Rate = $k[Br_2]^2[H_2]^1$
Order with respect to Br_2 = 2
Order with respect to H_2 = 1
Overall order = 2 + 1 = 3

3. (a) A chemistry teacher instructed his students to dissolve exactly 20 g of sodium hydroxide (NaOH) pellets in one dm^3 of solution. Name and explain such kind of a solution.
Name: Standard Solution
Explanation: A standard solution is one whose exact concentration is known. In this case, a known mass of NaOH is dissolved in a known volume (1 dm^3) of solvent to prepare a solution with a precise, calculable concentration.

(b) What is the molarity of a solution that has 0.491 g of NaOH dissolved in 400 cm^3 of solution?

Steps:
Molar mass of NaOH = 23 + 16 + 1 = 40 g/mol
Moles of NaOH = 0.491 g / 40 g/mol = 0.012275 mol
Volume in dm^3 = 400 cm^3 = 0.400 dm^3
Molarity (M) = moles / volume = 0.012275 mol / 0.400 dm^3 = 0.03069 mol/dm^3

Final answer: 0.0307 mol/dm^3

4. Given HA (aq) ⇌ H^+ (aq) + A^- (aq), show that the degree of dissociation (α) is given by $\alpha = \sqrt{(Ka/c)}$
Derivation:

At equilibrium:
Initial concentration of HA = c
Concentration of dissociated HA = cα

From the equilibrium expression:
$K_a = [H^+][A^-] / [HA]$
But $[H^+] = [A^-] = c\alpha$
And $[HA] = c(1-\alpha) \approx c$ (if α is small)
So:
$K_a = (c\alpha)(c\alpha) / c$
$K_a = c\alpha^2$
Therefore:
$\alpha = \sqrt{(K_a / c)}$

5. Briefly explain why ammonia molecule readily coordinates with cations of the transition metals but ammonium ion (NH_4^+) does not.

Ammonia (NH_3) has a lone pair of electrons on the nitrogen atom, which it can donate to form a coordinate (dative covalent) bond with a transition metal cation.

In contrast, ammonium ion (NH_4^+) has no available lone pair because all the lone pair on nitrogen has already been shared to bond with four hydrogen atoms, leaving no free electrons to coordinate.

6. (a) Complete the reactions:
(i) **Methylbenzene + Br_2 / $FeBr_3$**
$C_6H_5CH_3 + Br_2 \rightarrow C_6H_4CH_3Br + HBr$
(ii) **Methylbenzene + Br_2 / UV light**
$C_6H_5CH_3 + Br_2 \rightarrow C_6H_5CH_2Br + HBr$

(b) Account for the formation of products:
In (i), under $FeBr_3$ catalyst, an electrophilic substitution occurs on the benzene ring because the methyl group activates the ring towards electrophilic attack.

In (ii), under UV light, a free radical substitution takes place at the methyl group, where bromine replaces a hydrogen atom in the side chain, forming benzyl bromide.

7. Give six activities on how to prepare a lesson by using an inquiry-based learning approach to teach the topic of acids and bases.

- Identify real-life problems involving acids and bases, like stomach acidity or cleaning agents, to stimulate curiosity.
- Prepare experimental setups for students to test the pH of various household substances using indicators.
- Formulate open-ended questions for students to investigate, such as "What happens when vinegar is mixed with baking soda?"
- Organize group discussions where students predict outcomes before performing experiments.
- Guide students to classify substances based on their acidic, basic, or neutral properties through observation and reasoning.
- Facilitate reflective sessions where students explain their findings and relate them to everyday life situations.

8. Account for the use of methyl orange indicator during titration of HCl against Na_2CO_3, and phenolphthalein in titration of HCl against NaOH.

In titrating HCl against Na_2CO_3, methyl orange is suitable because the reaction involves a weak base (carbonate) and a strong acid, and methyl orange changes color in the acidic range, detecting the endpoint reliably.

In titrating HCl against NaOH, phenolphthalein is used because it changes color in a slightly basic to neutral range, which is ideal for a strong acid-strong base titration, giving a clear color change at the equivalence point.

9. Give three factors to consider when preparing a chemistry lesson for Form One class.

Learners' Prior Knowledge: Ensure the concepts are built from basic science experiences from primary school.

Available Resources: Select experiments and teaching aids that match the school's laboratory facilities.

Safety Considerations: Choose safe experiments and demonstrations appropriate for beginners, with minimal risk.

10. Study the reaction for benzene against electrophile-nucleophile molecule E-NU under catalyst to form benzene substituted with E together with molecule H-NU. Propose a reaction mechanism involving three steps for the reaction.

Mechanism:

Step 1: Generation of electrophile (E^+)
The catalyst reacts with E-NU to produce E^+, which is the active electrophile.

Step 2: Electrophilic attack on benzene ring
The benzene π-electrons attack E^+, forming an unstable intermediate (arenium ion) where one carbon carries a positive charge.

Step 3: Deprotonation
The arenium ion loses a proton (H^+), which combines with NU^- to form H-NU. The aromaticity of the benzene ring is restored, and the final substituted benzene (with E) is formed.

SECTION B (60 Marks)
Answer all questions from this section. Each question carries 15 marks.

11. Calculate the standard heat of formation of propane given that the heat of combustion of propane (C_3H_8) is $-2220.2\ kJmol^{-1}$ and the heat of formation of CO_2 and H_2O as $-393\ kJmol^{-1}$ and $-285\ kJmol^{-1}$ respectively.

Combustion equation for propane:

$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$

Using the formula:

$\Delta H\_combustion = [\text{sum of } \Delta H\_f \text{ products}] - [\text{sum of } \Delta H\_f \text{ reactants}]$

Substituting known values:

$-2220.2 = [(3 \times (-393)) + (4 \times (-285))] - [\Delta H\_f\ C_3H_8 + (5 \times 0)]$

First, calculate the sum of products:

$(3 \times -393) = -1179$
$(4 \times -285) = -1140$

$\text{Sum} = -1179 + (-1140) = -2319$

Now substitute:

$-2220.2 = (-2319) - \Delta H\_f\ C_3H_8$

Rearrange:

$\Delta H\_f\ C_3H_8 = (-2319) + 2220.2$
$\Delta H\_f\ C_3H_8 = -98.8\ kJmol^{-1}$

Final Answer:
Standard heat of formation of propane = **$-98.8\ kJmol^{-1}$**

12. Illustrate with four points, the causes of soil pH in the garden soil which has been tested and found to have a pH value of 4.10.

Acid Rain: The presence of acidic rainwater containing dissolved sulfur dioxide and nitrogen oxides can lower soil pH by adding hydrogen ions into the soil.

Use of Acidic Fertilizers: Continuous application of fertilizers like ammonium sulfate and urea can release hydrogen ions when they decompose, increasing soil acidity.

Leaching of Basic Ions: Heavy rainfall can wash away essential basic cations like calcium, magnesium, and potassium, leaving behind acidic components, which lowers soil pH.

Decomposition of Organic Matter: As organic matter decays, it produces organic acids, such as humic and fulvic acids, which contribute to soil acidity.

13. Give the importance of analyzing chemistry syllabus before the commencement of teaching in five points.

Clarifies Learning Objectives: It helps the teacher understand what competencies and skills students are expected to achieve by the end of each topic or term.

Ensures Proper Lesson Planning: The teacher can allocate appropriate time and select suitable teaching methods and resources for each topic.

Aligns Assessment with Objectives: By analyzing the syllabus, the teacher ensures that the assessments and assignments directly test the intended learning outcomes.

Identifies Key Content Areas: It helps the teacher focus on essential topics, avoiding unnecessary or less relevant material, and ensuring syllabus coverage.

Guides Resource Preparation: Knowing the syllabus content in advance allows the teacher to prepare experiments, models, teaching aids, and other materials on time.

14. Analyze five points on the significance of keeping records of continuous assessment.

Monitors Student Progress: Continuous assessment records help track individual student performance over time, identifying areas of strength and weakness.

Informs Instructional Decisions: The teacher can adjust teaching strategies and content delivery based on assessment outcomes to improve learning effectiveness.

Provides Feedback to Students: It offers regular feedback, enabling students to recognize their achievements and areas that need improvement.

Supports Fair Grading: Continuous assessment ensures that final grades reflect consistent performance rather than a single exam, promoting fairness.

Aids in Parental Communication: Well-kept assessment records provide factual, reliable information to discuss a student's academic progress with parents or guardians.