THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

DIPLOMA IN SECONDARY EDUCATION EXAMINATION

732/1 **CHEMISTRY 1**

Time: 3 Hours **ANSWERS** **Year: 2012**

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. Give the meaning of the following terms:
(a) Radioactive decay.
It is the spontaneous disintegration of unstable atomic nuclei into more stable ones, accompanied by the emission of radiation such as alpha, beta, or gamma rays.

(b) Radioactive isotope.
A radioactive isotope is an atom with an unstable nucleus that emits radiation during its decay to a stable form. It has the same number of protons but different numbers of neutrons.

(c) Radioactivity.
Radioactivity is the process by which unstable atomic nuclei lose energy by emitting radiation.

2. What do you understand by the following terms as applied in chemistry subject tests?
(a) Standard deviation.
Standard deviation is a statistical measure that shows the amount of variation or dispersion from the average or mean in a set of data.

(b) T-score.
T-score is a type of standard score that indicates how many standard deviations a data point is from the mean. It is used in comparing scores from different distributions.

(c) Hallow effect.
Halo effect in education refers to a type of cognitive bias where the perception of a student's performance in one area affects the assessment of performance in another area.

3. (a) Define the term 'heat of solution'.
Heat of solution is the amount of heat absorbed or released when one mole of a substance dissolves in a solvent to form a solution.

(b) Giving one reason, state whether the heat change values of each of the following reactions is exothermic or endothermic:
(i) $NaCl(s) + H_2O(l) \text{ ----> } NaCl(aq)$ $\Delta H = +4.97$ kJ/mol.
This reaction is endothermic because it involves absorption of heat indicated by the positive enthalpy change.

(ii) $HCl(g) + H_2O(l) \text{ ----> } Cl^-(aq)$ $\Delta H = -72.37$ kJ/mol.
This reaction is exothermic because it involves release of heat indicated by the negative enthalpy change.

4. Giving one example for each, differentiate between homolytic bond fission from heterolytic bond fission.
In homolytic bond fission, a covalent bond breaks evenly and each atom takes one electron, forming two free radicals. Example: $Cl_2 \text{ ----> } 2Cl\bullet$
In heterolytic bond fission, the covalent bond breaks unevenly, and one atom takes both bonding electrons, forming ions. Example: $HCl \text{ ---> } H^+ + Cl^-$

5. (a) Define 'Ferromagnetic' substance.
A ferromagnetic substance is a material that can be magnetized and retains magnetism even after the external magnetic field is removed. Example: Iron.

(b) Complete the following chemical equations:
(i) $AgNO_3(aq) + NH_3(aq) \text{ ----> } [Ag(NH_3)_2]^+ + NO_3^-$
(ii) $Cu^{2+}(aq) + NH_3(aq) \text{ ----> } [Cu(NH_3)_4]^{2+}$

6. (a) Name three items which are required during preparation of the Scheme of Work.
Syllabus
Teacher's guide
Lesson plan

(b) State the use of each item named in (a) above.
Syllabus provides the content and scope of what is to be taught.
Teacher's guide provides strategies, methodologies, and references for teaching.
Lesson plan outlines the daily instructional approach and helps in classroom management.

7. (a) Imagining that you are teaching Form II class, identify the major blocks of Periodic Table.
The major blocks are s-block, p-block, d-block, and f-block.

(b) Explain one main property of elements of period 3 in:
(i) Groups I-III
They are metals and have low electronegativity and low ionization energy.

(ii) Groups VI-VII
They are non-metals and have high electronegativity and high ionization energy.

9. (a) Give three possible sources of error that may cause variation of intended concentration when preparing a dilute solution for titration.
Impure solute used in preparation
Inaccurate volume measurement of solvent or solution
Incomplete mixing of solute with solvent

(b) State three differences between Chemistry teacher's Guide and Teacher's Manual.
Teacher's Guide provides general teaching approaches and syllabus breakdown, while Teacher's Manual gives detailed steps of lesson delivery.
Teacher's Guide is used for planning over a term or year, while Manual focuses on individual lessons.
Teacher's Guide provides evaluation techniques broadly, while Manual gives sample questions and expected answers.

10. The half-reaction and Standard Reduction Potentials of Cobalt and Lead at 25°C are given as follows:

$Co^{2+}(aq) + 2e \text{ ---> } Co(s)$ $E° = 0.28$ V
$Pb^{2+}(aq) + 2e \text{ ----> } Pb(s)$ $E° = -0.13$ V

Calculate the standard e.m.f. of a cell, given that $[Co^{2+}] = 0.25$ M and $[Pb^{2+}] = 0.18$ M.
E°cell = E°cathode - E°anode
= 0.28 - (-0.13)
= 0.41 V

Giving one reason, state whether the reaction is spontaneous.
The reaction is spontaneous because the standard e.m.f. is positive (0.41 V), indicating a feasible electrochemical reaction.

11. What does the term 'order of reaction' mean?
Order of reaction is the power to which the concentration of a reactant is raised in the rate equation. It shows how the rate of reaction depends on the concentration of each reactant.

Use experimental results in the following Table to answer the questions that follow.

Experiment	[P] (mol/dm³)	[Q] (mol/dm³)	Initial rate (mol/dm³/s)
1	0.5	2.0	8.0
2	0.5	3.0	18.0
3	1.0	3.0	36.0

(i) Write the rate equation for this reaction.
Rate = k[P]^x[Q]^y

(ii) Calculate the order of reaction.
To find x and y, compare experiments:

Compare experiment 2 and 1 to find order with respect to Q:
[P] is constant, [Q] changes from 2.0 to 3.0
Rate changes from 8.0 to 18.0

(18.0/8.0) = (3.0/2.0)^y
2.25 = (3/2)^y
Take log both sides:
log 2.25 = y log(1.5)
0.352 = y × 0.176
y = 2

Compare experiment 2 and 3 to find order with respect to P:
[Q] constant, [P] changes from 0.5 to 1.0

Rate changes from 18.0 to 36.0

(36.0/18.0) = (1.0/0.5)^x
2 = (2)^x
x = 1

Overall order of reaction = x + y = 1 + 2 = 3

(iii) Find the rate constant.
Using experiment 1:
Rate = k[P]^1[Q]^2
8.0 = k × 0.5 × (2.0)^2
8.0 = k × 0.5 × 4
8.0 = k × 2
k = 4 mol^{-2} dm^6 s^{-1}

(iv) Find the rate of reaction when initial concentration of Q is decreased to 0.75 mol/dm^3 in experiment 2.
New [Q] = 0.75 mol/dm^3, [P] = 0.5 mol/dm^3, k = 4

Rate = k[P]^1[Q]^2
Rate = 4 × 0.5 × (0.75)^2
= 4 × 0.5 × 0.5625
= 1.125 mol/dm^3/s

SECTION B (40 Marks)
Answer two (2) questions from this section.
12. Account for the following facts:
(a) Iron (II) chloride cannot be prepared by heating iron in dry hydrogen chloride gas
This occurs because dry hydrogen chloride lacks water, which is necessary to facilitate the reaction between iron and HCl to form $FeCl_2$, requiring a hydrated environment for effective chemical interaction.
(b) It is unsafe to store hot concentrated sulphuric acid using an aluminium container
This is unsafe because hot concentrated sulphuric acid reacts with aluminium, forming aluminium sulphate and releasing hydrogen gas, which poses an explosion risk due to the chemical reactivity.
(c) Concentrated sulphuric acid cannot be used to dry hydrogen sulphide gas
This is due to concentrated sulphuric acid oxidizing hydrogen sulphide to sulphur or sulphur dioxide, altering the gas composition instead of drying it, unsuitable for chemical preservation.
(d) It is not possible to prepare aluminium carbonate from sodium carbonate and aqueous solution of aluminium salt
This is because aluminium carbonate is unstable and decomposes into aluminium hydroxide and carbon dioxide in aqueous solution, preventing its formation as a stable compound.

(e) Acidified potassium permanganate is decolourised by continuous addition of hydrogen peroxide
This happens because hydrogen peroxide reduces purple MnO_4^- to colourless Mn^{2+} in acidic conditions, causing the decolourisation due to the chemical redox reaction.
13. Form four students in school W conducted a project to determine the properties of soil in school garden. A 45.00 cm^3 of sample solution required 3.00 cm^3 of 0.01M sodium hydroxide for complete neutralization
(a) Calculate the pH of the soil
Moles of NaOH = concentration × volume = 0.01 M × (3.00/1000) dm^3 = 3.00×10^{-5} moles
Since NaOH neutralizes an acid, moles of H^+ in 45.00 cm^3 = 3.00×10^{-5} moles
$[H^+]$ = moles/volume = $(3.00 \times 10^{-5}) / (45.00/1000) = 6.67 \times 10^{-4}$ M
pH = $-\log[H^+] = -\log(6.67 \times 10^{-4}) \approx 3.18$
Essential for determining soil acidity and chemical properties.
(b) Giving two reasons, explain whether or not the soil is suitable for gardening
Reason 1: The pH of 3.18 is highly acidic, which can inhibit plant growth as most plants thrive in a pH range of 6-7, unsuitable for optimal chemical nutrient uptake.
Reason 2: Acidic soil may lead to aluminium toxicity, harming root systems, making it chemically challenging for gardening.
(c) Suggest three methods that can be used to raise the soil to an optimum pH
Method 1: Add agricultural lime (calcium carbonate) to neutralize acidity, raising pH by chemical reaction with H^+ ions.
Method 2: Apply wood ash, which contains potassium carbonate, to increase pH through basic compound addition.
Method 3: Use dolomite, a magnesium-calcium carbonate, to adjust pH and supply essential nutrients, enhancing soil chemical balance.
SECTION C (40 Marks)
Answer two (2) questions from this section.
14. For each of the following reactions: show, with the aid of chemical equations, the products; and name the type of reaction/method involved
(a) $C_6H_6 + C_2H_5Br \rightarrow (AlBr_3)$
Equation: $C_6H_6 + C_2H_5Br \rightarrow C_6H_5C_2H_5 + HBr$ ($AlBr_3$ catalyst)
Product: Ethylbenzene
Type: Friedel-Crafts alkylation, a substitution reaction using a Lewis acid catalyst, key for aromatic compound synthesis.
(b) $CH_2{=}CHCH_3 + Na \rightarrow$
Equation: $CH_2{=}CHCH_3 + 2Na \rightarrow CH_2{=}CHCH_3Na_2$ (simplified, forms sodium propylide)
Product: Sodium propylide
Type: Redox reaction, where sodium donates electrons to the alkene, essential for organometallic compound formation.
(c) $[CH_3CH_2]_2 + O_2 \rightarrow$
Equation: $2[CH_3CH_2]_2 + 7O_2 \rightarrow 4CO_2 + 6H_2O$
Product: Carbon dioxide and water
Type: Combustion, a rapid oxidation reaction with oxygen, critical for understanding fuel chemistry.
(d) $C_2H_6 + Cl_2 \rightarrow$ (uncontrolled)
Equation: $C_2H_6 + Cl_2 \rightarrow C_2H_5Cl + HCl$ (multiple products possible, e.g., $C_2H_4Cl_2$)

Product: Chloroethane (major)
Type: Free radical substitution, an uncontrolled halogenation process, important for alkane reactivity.
(e) $C_2H_5I + O_2(g) \rightarrow$
Equation: $2C_2H_5I + 7O_2 \rightarrow 4CO_2 + 6H_2O + I_2$
Product: Carbon dioxide, water, and iodine
Type: Combustion with iodine release, a complex oxidation reaction, relevant for halogenated compound behavior.
15. As a chemistry teacher, you are required to prepare chemistry practical for your class. Describe how you will prepare 0.05M NaOH for your 20 candidates, given that each candidate requires 100 cm^3
Step 1: Calculate total volume: 20 candidates × 100 cm^3 = 2000 cm^3 = 2 dm^3.
Step 2: Calculate moles needed: Molarity = moles/volume, so 0.05 M × 2 dm^3 = 0.1 moles.
Step 3: Molar mass of NaOH = 40 g/mol; mass = 0.1 moles × 40 g/mol = 4 g.
Step 4: Dissolve 4 g of NaOH in a small amount of distilled water in a beaker.
Step 5: Transfer the solution to a 2 dm^3 volumetric flask and add distilled water to the mark, mixing thoroughly to ensure a uniform 0.05 M NaOH solution, critical for accurate chemical preparation.
16. (a) Briefly explain the four aspects you will consider when moderating a Terminal Examination for Chemistry subject
Clarity of Questions: Ensure questions, like titration calculations, are unambiguous, aiding fair chemical assessment.
Coverage of Syllabus: Verify all topics, such as redox reactions, are represented, ensuring comprehensive chemical evaluation.
Difficulty Level: Balance easy and hard items, like pH problems, to challenge all ability levels in chemistry.
Marking Scheme: Provide detailed rubrics, such as points for each step in stoichiometry, ensuring consistent chemical grading.
(b) Describe the procedures of constructing a table of specification
Step 1: Identify syllabus topics, like acid-base chemistry, to outline content areas.
Step 2: Determine cognitive levels, such as knowledge and analysis, for chemical skills.
Step 3: Assign weightage, like 30% to reactions, based on importance in chemistry.
Step 4: Create a grid, mapping topics to levels, ensuring balanced chemical coverage.
Step 5: Review and adjust, ensuring alignment with exam goals, finalizing the chemical assessment structure.
17. Explain five ways in which Information and Communication Technology (ICT) can be used in teaching and learning of Chemistry
Simulations: Use software like PhET to model reactions, enhancing understanding of chemical processes.
Online Resources: Access databases, like PubChem, for chemical data, supporting research and learning.
Virtual Labs: Conduct experiments, such as titrations, via Labster, providing safe chemical practice.
Interactive Lessons: Use videos, like reaction animations, to illustrate concepts, improving chemical engagement.
Assessment Tools: Employ quizzes on platforms like Google Forms, facilitating chemical performance tracking.
18. Describe five fundamental principles of teaching and learning of Chemistry
One fundamental principle of teaching and learning Chemistry is the use of practical activities and experiments. Chemistry is an experimental science, and students understand better when they observe

reactions, handle apparatus, and measure outcomes themselves. Practical work helps to bridge the gap between theoretical knowledge and real-world applications, making abstract concepts more concrete and meaningful. It also stimulates curiosity and encourages scientific inquiry.

Another principle is the use of appropriate teaching aids and models. Many concepts in Chemistry, such as atomic structure, molecular geometry, and reaction mechanisms, are abstract and not visible to the naked eye. Visual aids like molecular models, charts, periodic tables, and digital simulations help students to visualize and understand these concepts better. Effective teaching involves selecting aids that simplify learning without distorting scientific facts.

A third principle is ensuring learner-centered approaches. Teaching should not just be about delivering content but should involve learners actively. Discussions, group work, problem-solving tasks, and guided discovery allow learners to take part in constructing their knowledge. Involving learners promotes deeper understanding, critical thinking, and retention of knowledge because they become engaged and responsible participants in the learning process.

Another key principle is linking Chemistry concepts to real-life situations. Students grasp and appreciate Chemistry better when they see its relevance to their everyday life. For example, teaching about acids and bases can be linked to digestion, cleaning agents, or agriculture. This connection not only motivates learners but also helps them to apply what they learn outside the classroom and see Chemistry as a useful and practical subject.

Lastly, the principle of continuous assessment and feedback is essential. Teaching and learning should be monitored regularly to ensure that students are progressing and understanding the content. Tests, quizzes, oral questions, assignments, and practical assessments provide feedback to both the teacher and learner. Through this feedback, teachers can adjust their teaching methods and learners can identify areas that need improvement, enhancing overall learning effectiveness.