THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

DIPLOMA IN SECONDARY EDUCATION EXAMINATION

732/1 **CHEMISTRY 1**

Time: 3 Hours **ANSWERS** **Year: 2019**

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. (a) Define principal quantum number.
The principal quantum number is a quantum number denoted by n that determines the energy level or shell in which an electron resides in an atom. It also defines the average distance of the electron from the nucleus. The larger the value of n, the higher the energy level and the farther the electron is from the nucleus.

(b) Briefly describe the three principles that govern the arrangement of electrons in an atom.
The Aufbau principle states that electrons fill atomic orbitals starting from the lowest energy level before occupying higher levels.
The Pauli Exclusion Principle states that no two electrons in an atom can have the same set of four quantum numbers.
Hund's Rule states that electrons occupy degenerate orbitals singly before pairing begins, and all singly occupied orbitals must have electrons with parallel spins.

2. Find the constant of solubility product (Ksp) of Bismuth sulphide (Bi_2S_3) whose solubility is 1.0×10^{-5} mol/L at 25°C.
$Bi_2S_3 \rightleftharpoons 2Bi^{3+} + 3S^{2-}$
$Ksp = [Bi^{3+}]^2 [S^{2-}]^3$
$[Bi^{3+}] = 2 \times 1.0 \times 10^{-5} = 2.0 \times 10^{-5}$ mol/L
$[S^{2-}] = 3 \times 1.0 \times 10^{-5} = 3.0 \times 10^{-5}$ mol/L
$Ksp = (2.0 \times 10^{-5})^2 \times (3.0 \times 10^{-5})^3 = 4.0 \times 10^{-10} \times 2.7 \times 10^{-14} = 1.08 \times 10^{-23}$

3. Why $CH_3CH(CH_3)CH(CH_3)CH_3$ and $CH_3(CH_2)_4CH_3$ have different boiling points regardless of their similarity in molecular mass?
$CH_3CH(CH_3)CH(CH_3)CH_3$ is a branched chain alkane while $CH_3(CH_2)_4CH_3$ is a straight chain alkane. Branched molecules have a smaller surface area and weaker van der Waals forces than straight-chain molecules. Therefore, $CH_3(CH_2)_4CH_3$ has stronger intermolecular forces and a higher boiling point.

4. Give four demerits of demonstration strategy in teaching and learning chemistry.
It does not actively engage all learners, leading to passive learning.
It may fail to develop hands-on skills since students are only observers.
It limits individual participation and creativity.
It may not be effective for large groups due to visibility and audibility challenges.

5. Briefly explain four uses of a chemistry teachers' guide.
It provides a structured approach for lesson planning and content delivery.
It suggests appropriate teaching aids and methods for various topics.
It offers guidance on assessment and evaluation techniques.
It assists in managing time effectively during teaching sessions.

6. Outline four problems faced by the chemistry teacher with inadequate preparation.
Failure to manage class time effectively leads to incomplete coverage of topics.
Lack of confidence and clarity during lesson delivery affects student understanding.

Improper organization of experiments may lead to safety risks.
Inability to answer students' questions undermines the teacher's credibility.

7. (a) Provide the meaning of the following terms:
(i) Electrochemistry
Electrochemistry is the branch of chemistry that studies the relationship between electricity and chemical reactions.

(ii) Conduction
Conduction is the process of transferring electrical current through a material due to the movement of charged particles.

(b) Differentiate electronic from electrolytic conductors.
Electronic conductors conduct electricity through free electrons, such as metals.
Electrolytic conductors conduct electricity through ions in solution or molten state, such as acids, bases, and salts.

8. (a) Give the meaning of acid rain.
Acid rain refers to precipitation with a pH below 5.6 caused by the presence of sulfuric and nitric acids formed from sulfur dioxide and nitrogen oxides in the atmosphere.

(b) Briefly explain how primary and secondary air pollutants differ.
Primary pollutants are directly released into the atmosphere from sources like vehicles and industries, such as CO, SO_2, and NO.
Secondary pollutants are formed in the atmosphere through chemical reactions of primary pollutants, such as ozone and smog.

9. (a) List two supply systems in a chemistry laboratory.
Gas supply system
Water supply system

(b) Why it is recommended to:
(i) Add acid into water and not vice versa.
Adding acid to water allows gradual absorption of heat, reducing the risk of splashing and accidents. Adding water into acid may cause an exothermic reaction that leads to violent splashing.

(ii) Cover a container holding sodium hydroxide pellets.
Sodium hydroxide absorbs moisture and carbon dioxide from the air, forming a solution or carbonates. Covering prevents deliquescence and contamination.

10. The industrial preparation of ammonia is represented in the chemical equation:
$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ ΔH = -ve
Give four strategies of increasing the speed of the formation of ammonia.

Increase pressure to favor the side with fewer gas molecules.
Increase the concentration of reactants (N_2 and H_2) to shift equilibrium forward.
Use a suitable catalyst like iron with molybdenum promoter to increase reaction rate.
Increase temperature moderately to enhance kinetic energy, though excessive temperature reduces yield due to exothermic nature.

11. (a) Given the complex compound $[CoCl(H_2O)_2(NH_3)_3]Cl$:
(i) What is the coordination number of the central metal ion?
Coordination number is 6 (3 NH_3, 2 H_2O, 1 Cl^-)

(ii) What is the oxidation state of the central metal ion?
Let x be oxidation state of Co:
$x + (3\times0) + (2\times0) + (-1) = +1$
$x = +2$

(iii) Give the IUPAC name of the compound.
Triammineaquadichlorocobalt(II) chloride

(b) Why transition metal elements:
(i) Have variable oxidation states
They have electrons in both 3d and 4s orbitals, allowing them to lose different numbers of electrons.

(ii) Form complex ions
They have small highly charged ions that can attract ligands and form coordinate bonds.

(iii) Exhibit paramagnetism
They have unpaired electrons in their d-orbitals which give rise to magnetic properties.

12. (a) Give the meaning of the following terms:
(i) sp^3 hybridization
Mixing of one s and three p orbitals to form four equivalent hybrid orbitals as in methane.

(ii) sp^2 hybridization
Mixing of one s and two p orbitals to form three hybrid orbitals as in ethene.

(iii) sp hybridization
Mixing of one s and one p orbital to form two linear hybrid orbitals as in ethyne.

(b) Calculate the wavelength in A of a line in a Balmer series that is associated with a drop of electron from the fourth orbit.
Rydberg equation:
$1/\lambda = R_H (1/2^2 - 1/4^2) = 1.09676 \times 10^6 (1/4 - 1/16) = 1.09676 \times 10^6 (3/16)$

$1/\lambda = 2.055 \times 10^5\ cm^{-1}$
$\lambda = 1 / 2.055 \times 10^5 = 4.87 \times 10^{-6}\ cm = 4870\ Å$

13. As a chemistry teacher, the 24 hours advance instructions requires you to prepare 0.119M sulphuric acid to be used by 120 students for titration. Each student needs 100 cm^3. The commercially available acid has the following specifications: 96% purity, density = 1.82 g/cm^3 and molecular weight = 98 g.

(a) Mention two precautions you will take while handling this acid.
Always wear protective equipment such as gloves, goggles, and a lab coat while handling concentrated sulphuric acid to prevent chemical burns from accidental spills or splashes.

Always add acid to water and not water to acid to avoid the violent exothermic reaction that may cause splashing of the acid, which could lead to injury or damage.

(b) Show how you will prepare the required solution.
Total volume required = 120 students × 100 cm^3 = 12,000 cm^3 = 12 dm^3

Moles of H_2SO_4 required = molarity × volume = 0.119 mol/dm^3 × 12 dm^3 = 1.428 mol

Mass of pure H_2SO_4 required = 1.428 mol × 98 g/mol = 139.944 g

Since the acid is 96% pure, actual mass required = 139.944 g ÷ 0.96 = 145.8 g

Volume of concentrated acid needed = mass ÷ density = 145.8 g ÷ 1.82 g/cm^3 = 80.1 cm^3

To prepare the solution, measure 80.1 cm^3 of concentrated sulphuric acid and slowly add it into a volumetric flask containing some distilled water. Then fill the flask with distilled water up to the 12 dm^3 mark and mix thoroughly to obtain a uniform solution.

(c) Determine the volume of the dilute acid that will neutralize 25 cm^3 of a 0.125M sodium carbonate.

The reaction is:
$H_2SO_4 + Na_2CO_3 \text{ ----> } Na_2SO_4 + CO_2 + H_2O$

From the equation, 1 mole of H_2SO_4 reacts with 1 mole of Na_2CO_3

Moles of Na_2CO_3 = 0.125 mol/dm^3 × 25 cm^3 ÷ 1000 = 0.003125 mol

Since the molar ratio is 1:1, moles of H_2SO_4 needed = 0.003125 mol

Volume of acid required = moles ÷ concentration = 0.003125 mol ÷ 0.119 mol/dm³ = 0.02626 dm³ = 26.26 cm³

14. In six points, explain the importance of teaching and learning resources in the teaching and learning of chemistry.

Teaching and learning resources play a vital role in simplifying complex and abstract concepts in chemistry. Many topics in chemistry such as molecular structures, bonding, and reaction mechanisms are difficult for learners to understand without visual and physical representations. The use of models, charts, diagrams, and experiments helps bridge the gap between theory and practice, allowing students to grasp these ideas more effectively.

These resources stimulate interest and enhance motivation among learners. When students interact with real objects or practical demonstrations, their curiosity is aroused, making them more attentive and enthusiastic about the subject. This active involvement increases the likelihood of retention and deep understanding of concepts.

Teaching and learning materials promote hands-on experience and skill development. Practical work using laboratory equipment, chemicals, and apparatus enables students to gain procedural knowledge, manipulate tools, and build their confidence in scientific experimentation. This experience is crucial for developing scientific inquiry and problem-solving skills.

Learning resources support differentiated learning by accommodating learners with different abilities and styles. Some students learn better through visual aids such as videos and models, while others benefit more from tactile activities like experiments. Effective use of resources ensures that all learners are catered for and have equal opportunities to learn.

The use of appropriate materials helps the teacher organize and deliver lessons efficiently. Resources such as lesson guides, periodic tables, and laboratory manuals allow the teacher to sequence content logically and manage time effectively during classroom instruction.

Teaching and learning resources also aid in assessment and feedback. Tools like simulations, worksheets, and experimental setups enable both formative and summative assessment, providing feedback to both teachers and students about the learning progress and areas that require improvement.

15. Explain five procedures for moderating a chemistry test.

The first procedure in moderating a chemistry test involves reviewing the content validity of the test. This means checking whether the test items adequately reflect the intended learning outcomes and the topics specified in the syllabus. A well-moderated test must cover a wide range of content areas without bias or omission.

Another important procedure is checking the clarity and accuracy of the test questions. This involves examining the language used in the test items to ensure it is appropriate for the learners' level and free from grammatical errors, ambiguities, or confusing terminologies that might affect students' understanding and responses.

A thorough moderation process also includes evaluating the distribution of cognitive levels within the test. This involves ensuring that the questions are balanced across different levels of thinking, including knowledge, comprehension, application, analysis, and evaluation. A good chemistry test should challenge students to use both lower-order and higher-order thinking skills.

It is also necessary to verify the appropriateness and consistency of the marking scheme. This involves crosschecking that each question has a clear and objective marking guide which corresponds well with the expected responses. The marking scheme should be fair and enable uniform scoring by different examiners.

Finally, a peer review process should be conducted where the test and marking scheme are analyzed by another qualified chemistry teacher or subject expert. This step helps to identify overlooked errors, provide additional perspectives, and ensure that the test meets acceptable standards before administration.

16. Explain five advantages of using role-play in the teaching and learning of the concept "States of Matter."

Role-play in teaching the concept of states of matter helps students to understand particle behavior in a more interactive and relatable manner. By acting as particles in solids, liquids, and gases, students visualize how particles are arranged and how they move in different states. This practical representation enhances conceptual understanding far more than traditional lecture methods.

Role-play increases students' engagement and interest in the learning process. The dynamic nature of the activity captures the learners' attention and makes the learning environment lively and participatory. Students become active contributors rather than passive recipients of knowledge.

This method also encourages collaborative learning and communication among students. During role-play, students work in groups to coordinate their actions, share roles, and communicate the behaviors they are mimicking. This promotes teamwork, leadership, and interpersonal skills, which are essential in academic and real-life settings.

Role-play caters to different learning styles and needs. Kinesthetic learners, who learn best through movement and physical activity, benefit greatly from role-play. Visual and auditory learners also benefit through observation and dialogue. Thus, role-play ensures inclusive teaching that reaches all learners.

Lastly, role-play develops creativity and critical thinking skills. As students act out the behavior of particles, they are challenged to reason, explain, and justify their actions based on scientific principles. This fosters deeper learning and helps students to link theoretical knowledge with real-world application.