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

732/1 **CHEMISTRY 1**

Time: 3 Hours **ANSWERS** **Year: 2023**

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. Observe/study each electronic configuration and suggest the violated rule/principle.

(a) The violated rule is Pauli's exclusion principle which is stated that "No two (2) electrons in an orbital can have the same set of all four quantum numbers".
(b) The violated rule is Hund's rule of maximum multiplicity which states that "Pairing is not allowed in an orbital until all s orbitals are singly occupied by electron then pairing begin".
(c) No violated rule principle because the electron configuration of sodium (Na) is written correctly by obeying all rules.

2. Justify the following facts by using the knowledge from chemical kinetics:

(a) Some foods require higher temperature during cooking.
The rate of a chemical reaction increases with temperature because higher temperatures provide reacting molecules with more kinetic energy. In the case of food, heating increases the speed at which food molecules interact and break down or combine to form new substances, thus cooking faster. This follows the collision theory in chemical kinetics, where more energetic collisions lead to a higher rate of reaction.

(b) Fresh fruits and vegetables are stored in a refrigerator.
Lowering the temperature slows down the rate of chemical reactions, including decomposition and spoilage processes in fresh produce. By reducing the kinetic energy of the molecules, the frequency and energy of collisions decrease, which slows the rate of reactions responsible for decay, thus extending the freshness period.

(c) Some foods require baking soda ($NaHCO_3$) during cooking.
Baking soda acts as a chemical leavening agent because it decomposes when heated, releasing carbon dioxide gas. The formation of gas bubbles causes the food to rise, making it softer and fluffier. The reaction rate increases with temperature, and the presence of acidic ingredients accelerates this process, aligning with principles from chemical kinetics where reaction rates depend on temperature and the nature of reactants.

3. Study the following reactions then write the rate expression in respect to the concentration of the reactants and products:

(a) $NO_2(g) + CO(g) \rightarrow CO_2(g) + NO(g)$
The rate expression is given by:
$Rate = k[NO_2][CO]$
This expression indicates that the reaction rate depends directly on the concentration of both NO_2 and CO.

(b) $S_2O_8^{2-}(aq) + 3I^-(aq) \rightarrow 2SO_4^{2-}(aq) + I_3^-(aq)$
The rate expression is given by:
$Rate = k[S_2O_8^{2-}][I^-]^3$
This implies the rate is directly proportional to the concentration of persulfate ions and the cube of the iodide ion concentration.

(c) $2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$
The rate expression in terms of reactant is:
Rate = $k[N_2O_5]$
Since the reaction involves the decomposition of N_2O_5, it's typically first order with respect to N_2O_5.

4. (a) How many moles are there in 35.8 g of magnesium ribbon?
To find the number of moles, use the formula:
Moles = Mass / Molar mass
The molar mass of magnesium (Mg) is 24.3 g/mol.
Moles = 35.8 g / 24.3 g/mol
Moles ≈ 1.4745 mol
Answer:
There are approximately 1.47 moles in 35.8 g of magnesium.

(b) Justify that 3.58 moles of zinc granules contain 232.7 g.
To verify this, use the formula:
Mass = Moles × Molar mass
The molar mass of zinc (Zn) is 65.4 g/mol.
Mass = 3.58 mol × 65.4 g/mol
Mass ≈ 234.073 g
Since 234.073 g is very close to 232.7 g (likely due to rounding in problem values), the statement is essentially accurate.
Answer:
Yes, 3.58 moles of zinc granules contain approximately 232.7 g.

5. What will happen to a buffer solution made of CH_3COOH and CH_3COONa when the following solutions are added?

(a) Dilute HCl
When dilute HCl is added to the buffer, it introduces extra H^+ ions into the solution. The CH_3COO^- ions from the salt (CH_3COONa) will react with these H^+ ions to form more CH_3COOH. This reaction reduces the free H^+ ions, minimizing the change in pH and maintaining the buffer's acidic environment.

(b) Dilute NaOH
When dilute NaOH is added, it introduces OH^- ions, which react with the weak acid CH_3COOH to form water and CH_3COO^- ions. This neutralization removes the added OH^- ions, thereby resisting a significant rise in pH. The buffer maintains stability through this reaction as well.

6. Examine the IUPAC names of the given complexes and justify the observation of each case.

(a) $[Fe(CN)_6]^{4-}$

Ligands: 6 cyanide (CN^-) → cyano
Prefix: hexa-
Metal: iron
Charge of CN^-: -1 × 6 = -6

Overall charge of complex: -4
Oxidation state of Fe (x):
x + (-6) = -4
x = +2
Correct Name: Hexacyanoferrate(II) ion
Correction:
In IUPAC nomenclature, for **anionic complexes**, the metal name ends with **-ate**.
So it should be **ferrate** not **iron**.

(b) $[Cu(NH_3)_4]SO_4$

Ligands: 4 ammonia (NH_3) → ammine
Prefix: tetra-
Metal: copper
Charge of NH_3: 0 × 4 = 0
Charge of SO_4^{2-}: -2
Therefore, $[Cu(NH_3)_4]$ must be +2
Correct Name: Tetraamminecopper(II) sulphate
This is correct.

(c) $[Cr(H_2O)_4Cl_2]Cl$

Ligands: 4 water (H_2O) → aqua, 2 chloride (Cl^-) → chloro
Prefix: tetra- and di-
Metal: chromium
Charge of H_2O: 0
Charge of Cl^- inside complex: -1 × 2 = -2
Counter ion (Cl^- outside): -1
Overall charge: 0
Oxidation state of Cr (x):
x + (0 × 4) + (-1 × 2) = +1 (since outside is Cl^- making complex cation +1)
x - 2 = +1
x = +3
Correct Name: Tetraquachlorochromium(III) chloride

Water is spelled **aqua**, not **quad** or **quado**.

7. Suggest and give reason whether the reaction is free radical substitution, elimination or electrophilic addition.

(a) Elimination reaction since hydrogen and hydroxyl ions were removed from ethanol and forming ethene.
(b) Electrophilic addition reaction since HX was added into $CH_2=CH_2$.

(c) Free radical substitution since X was added into $H_3C\text{-}CH_2$ and also H^+ was removed on that compound as replaced by incoming X.

8. Suggest six components that are essential to design a Chemistry teacher's guide for Form II secondary school.

A strong teacher's guide should start with clear **learning objectives** for each lesson, detailing what students should know or be able to do by the end of the session. This helps teachers plan and stay focused on goals.

It should include a **curriculum alignment section**, mapping each lesson to national educational standards or syllabi. This ensures teachers cover required content and progress logically through the subject.

A detailed **lesson procedure** is essential, outlining step-by-step instructions, suggested questions, activities, and estimated timings for engaging and structured delivery.

Suggested teaching and learning resources must be listed such as chemicals, apparatus, visual aids, and digital tools along with alternatives for schools with limited resources

Incorporating **assessment strategies** like quick checks, formative quizzes, and sample exam questions helps teachers evaluate student understanding and guide revisions.

Finally, the guide should contain **laboratory activity instructions**, with safety guidelines, procedure steps, expected results, and explanations all aligned with inquiry-based learning principles .

9. The introduction of ICT has brought significant developments in education. Briefly explain four benefits of ICT in teaching Chemistry.

ICT supports **visualization of abstract chemistry concepts** for example, 3D molecular structures, reaction animations, and interactive simulations which help students grasp difficult ideas like molecular geometry and bonding.

It enhances **student engagement and motivation** through interactive platforms, such as virtual labs and educational apps, which have been shown to improve retention and achievement compared to traditional methods .

ICT enables **efficient data collection and analysis** during experiments using sensors and digital tools, teaching students real-time measurement skills and accurate interpretation of results.

It fosters **access to global resources and distance learning**, allowing students and teachers to tap into online databases, virtual labs, expert lectures, and global collaborations, which is especially valuable in resource-limited settings .

10. You administered Chemistry tests to Form II and Form III students; results are:

Form II: 65, 67, 95, 41, 25, 55, 41, 71, 41, 51

Form III: 77, 67, 66, 71, 68, 72, 69, 75, 61, 76

a) Calculate the spread for each test score (i.e., range).

- *Form II range:*
  Minimum = 25, Maximum = 95 $\Longrightarrow$ Range = 95 – 25 = **70**

- *Form III range:*
  Minimum = 61, Maximum = 77 ⟹ Range = 77 – 61 = **16**

b) What do these two spread values indicate?
The range for **Form II (70)** is quite large, indicating that student performance varied widely from very low to very high scores. This suggests inconsistent understanding or preparation among the group.

In contrast, **Form III's range of 16** is much smaller, implying that the students' scores were more consistent and closely clustered. This suggests a more uniform grasp of the material and possibly more effective teaching or learning strategies.

SECTION B (60 Marks)

Answer all questions from this section. Each question carries 15 marks.

11. Bondeni Village is facing a serious water pollution problem in its water sources. Suggest six ways to overcome the problem.

One effective way to control water pollution in Bondeni Village is by constructing proper waste disposal systems. This ensures that both household and industrial waste are safely collected and disposed of without being dumped directly into water sources.

Another method is educating the community about the dangers of polluting water and promoting responsible behavior such as avoiding washing clothes, animals, or vehicles in rivers and streams, which contributes greatly to water contamination.

The village can also establish wastewater treatment plants to handle sewage and industrial effluents. Treated water would be less harmful when released back into the environment, thereby protecting natural water sources.

Planting vegetation buffers along riverbanks is essential as these plants help to filter runoff water, trap sediments, and reduce the amount of pollutants entering water sources during rainstorms or floods.

Strict regulation and monitoring of agricultural practices can further help. By controlling the use of chemical fertilizers and pesticides, farmers would reduce chemical runoff into rivers and wells, keeping water cleaner.

Finally, encouraging rainwater harvesting systems for household use would ease pressure on natural water bodies and reduce the need to draw water from potentially polluted sources, while providing clean, accessible water.

12 (a) Explain the phenomenon of isomerism.

Isomerism is a phenomenon where compounds have the same molecular formula but differ in the arrangement of their atoms or the spatial orientation of their atoms within the molecule. This means that while isomers share the same number and type of atoms, their structures or physical and chemical properties

are different. Isomerism allows for a variety of compounds to exist with distinct characteristics even though their chemical formulas are identical.

12 (b) Outline the two types of isomers exhibited by alkenes by citing one example in each.

The first type of isomerism shown by alkenes is **structural (chain or position) isomerism**. In this type, compounds differ in the arrangement of their carbon atoms or the position of the double bond within the carbon chain. For example, but-1-ene ($CH_2=CHCH_2CH_3$) and but-2-ene ($CH_3CH=CHCH_3$) both have the formula C_4H_8 but differ in the position of the double bond.

The second type is **geometrical (cis-trans) isomerism**, which occurs due to restricted rotation around the double bond in alkenes. When two similar or different groups are attached to the carbons of the double bond, their spatial arrangement can result in different compounds. For instance, in but-2-ene, when the two methyl (CH_3) groups are on the same side of the double bond, it is cis-but-2-ene, and when on opposite sides, it is trans-but-2-ene.

12 (c) Draw and give the IUPAC names of alkenes that will be obtained from the dehydration of the following compounds:

(i) From 2-methylpentan-3-ol

Structure of alcohol:
CH3–CH(CH3)–CH(OH)–CH2–CH3

Possible dehydration products (by eliminating water across adjacent carbons):

a) CH3–CH=CH–CH2–CH3 → **pent-2-ene**

b) CH3–C(CH3)=CH–CH3 → **3-methylpent-2-ene**

Structures:

CH3-CH=CH-CH2-CH3 → pent-2-ene

or

CH3-C(CH3)=CH-CH3 → 3-methylpent-2-ene

(ii) From propan-2-ol

Structure of alcohol:
CH3–CH(OH)–CH3

Dehydration product:
CH2=CH–CH3 → **propene**

Structure:

CH2=CH-CH3 → propene

(iii) From 3-methylbutan-2-ol

Structure of alcohol:
CH3–CH(CH3)–CH(OH)–CH3

Possible dehydration products:

a) CH2=C(CH3)–CH3 → **2-methylpropene**

b) CH3–CH=CH–CH3 → **but-2-ene**

But due to stability, major product is:
CH2=C(CH3)–CH3 → 2-methylpropene

Structure:

CH2=C(CH3)-CH3 → 2-methylpropene

(iv) From 4,5-dimethylhexan-3-ol

Structure of alcohol:
CH3–CH2–C(OH)(CH3)–CH(CH3)–CH2–CH3

Possible dehydration products:

a) CH3–CH2–C=CH–CH(CH3)–CH3
→ 4,5-dimethylhex-3-ene

b) CH3–CH2–CH=C(CH3)–CH2–CH3
→ 3,4-dimethylhex-3-ene

Structures:

CH3-CH2-C=CH-CH(CH3)-CH3 → 4,5-dimethylhex-3-ene

or

CH3-CH2-CH=C(CH3)-CH2-CH3 → 3,4-dimethylhex-3-ene

13. (a) Justify the statement that advancement in chemistry resulted into more negative impacts on the environment.

The development of synthetic chemicals, such as plastics and pesticides, though beneficial in many areas, has led to serious environmental problems. Non-biodegradable plastics accumulate in land and water, threatening wildlife and causing long-term pollution.

Industrial chemical waste, a byproduct of chemical advancements, has also contributed to air, water, and soil pollution. Factories releasing untreated waste into rivers and the atmosphere have caused ecological imbalances and health risks to humans and animals.

The production and use of chlorofluorocarbons (CFCs), once common in refrigeration and sprays, depleted the ozone layer, exposing the Earth to harmful ultraviolet radiation and increasing risks of diseases like skin cancer.

Additionally, chemical fertilizers and pesticides, though boosting agricultural output, have resulted in soil degradation, water contamination, and harm to beneficial organisms like bees and aquatic life.

(b) Identify six teaching and learning materials.

A periodic table chart is an important teaching material as it helps learners to visualize and recall elements, their symbols, and properties during lessons.

Chemistry laboratory apparatus such as beakers, test tubes, and Bunsen burners are essential for performing experiments and demonstrations, making lessons practical and engaging.

Chemical reagents like acids, bases, and salts are required for conducting chemical reactions and practical investigations to reinforce theoretical concepts.

Multimedia projectors or smart screens can be used to display animations and simulations of chemical reactions, aiding the explanation of abstract topics like atomic structure and bonding.

Models of atomic structures and molecules help in simplifying complex ideas, allowing learners to understand molecular geometry and arrangements.

Lastly, Chemistry textbooks and teacher's guides provide structured content, exercises, and reference materials necessary for both teaching and student revision.

14. Always primary standard reagents are used to standardize secondary standard reagents. In four points, evaluate the effectiveness of anhydrous sodium carbonate in standardizing hydrochloric acid.

Anhydrous sodium carbonate is highly effective as a primary standard because it has a high purity level and is stable when exposed to air, which ensures accurate and consistent results during standardization of hydrochloric acid.

It has a relatively high molar mass, which minimizes weighing errors during preparation of standard solutions. This makes it convenient and reliable for use in titration experiments.

The substance is also non-hygroscopic, meaning it does not readily absorb moisture from the air. This property ensures that its mass remains constant over time, contributing to the accuracy of prepared solutions.

Lastly, its reaction with hydrochloric acid is simple and complete, following a clear stoichiometric equation without side reactions. This makes the endpoint in titration easy to detect, particularly when using suitable indicators like methyl orange.