THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

032/1 **CHEMISTRY 1**

(For Both School and Private Candidates)

Time: 3 Hours **ANSWERS** **Year: 2011**

Instructions

1. This paper consists of sections A, B and C with total of thirteen questions

1. For each of the items (i) - (x), choose the correct answer from the given alternatives and write its letter beside the item number.

(i) The volume of 0.2 M H_2SO_4 acid required to neutralize completely 25.00 cm^3 of 0.05 M KOH is

A 6.26 cm^3
B 6.125 cm^3
C 6.315 cm^3
D 3.125 cm^3
E 12.500 cm^3

Using the formula $M_1V_1 = M_2V_2$:
$(0.05 \times 25) = (0.2 \times V_2)$
$V_2 = (0.05 \times 25) / 0.2 = 6.25\ cm^3$

Correct answer: B

(ii) The Brownian movement is taken to be an evidence of the:

A newton theory
B theory of colloidal suspension
C theory of association of water molecules
D kinetic theory of behavior of substances
E theory of ionization

Brownian motion supports the kinetic theory of matter, which states that particles are always in motion.

Correct answer: D

(iii) A mixture of ammonium chloride salt and sand can be separated by using a method known as

A evaporation
B sorting
C fractional distillation
D sublimation
E decantation

Ammonium chloride sublimes when heated, leaving the sand behind.

Correct answer: D

(iv) Which of the following statements is not true about hydrogen gas?

A Is a neutral gas, almost insoluble in water.
B Is a reducing agent.
C Burns in air to form steam.
D Diffuses more rapidly than carbon dioxide.
E Is prepared by the action of dilute nitric acid on zinc metal.

Hydrogen gas is not prepared using dilute nitric acid because nitric acid acts as an oxidizing agent, converting hydrogen into water instead of releasing it as a gas.

Correct answer: E

(v) An electric current was passed through a concentrated solution of hydrochloric acid using carbon electrodes. The substance liberated at the anode was

A copper
B hydrogen
C oxygen
D sodium
E chlorine

At the anode, chlorine gas is liberated because chloride ions (Cl^-) are discharged preferentially over oxygen ions.

Correct answer: E

(vi) When an atom gains an electron it becomes

A an anion
B a cation
C a molecule
D an isotope
E a proton

An atom that gains an electron becomes negatively charged, forming an anion.

Correct answer: A

(vii) The magnesium salt responsible for permanent hardness of water is

A hydrogen carbonate
B sulphate
C nitrate
D carbonate

E chloride

Permanent hardness in water is mainly caused by calcium and magnesium sulfates.

Correct answer: B

(viii) The biochemical oxidation of ammonia salts to nitrate compounds in the soil is known as

A nitrogen assimilation
B nitrification
C nitration
D denitrification
E decomposition

Nitrification is the process where ammonia is converted into nitrates by bacteria.

Correct answer: B

(ix) An example of a homologous series is

A ethene, ethyne, and propene
B propane, butane, and pentyne
C ethene, propane, and butyne
D ethane, propene, and butane
E methane, ethane, and propane

A homologous series consists of compounds with the same functional group and general formula.

Correct answer: E

(x) A Bunsen burner flame will produce a luminous flame when

A the air hole of the Bunsen burner is fully closed
B sufficient gas is supplied to the Bunsen burner
C the air hole of the Bunsen burner is fully opened
D the gas tap is partially opened
E the gas tap is fully opened

A luminous flame is produced when the air hole is fully closed, resulting in incomplete combustion.

Correct answer: A

2. Match the items in List A with the responses in List B by writing the letter of the correct response beside the item number.

List A

(i) Methyl orange indicator
(ii) Calcium hydroxide
(iii) pH 2
(iv) Neutralization reaction
(v) Molar solution
(vi) Sodium hydrogen sulfate
(vii) An acid found in certain fruits
(viii) Sodium sulfate
(ix) Precipitation reaction
(x) 0.01M sodium hydroxide

List B

A Citric acid
B Dilute base
C Normal salt
D Acidic salt
E $H^+ + OH^- \rightarrow H_2O$
F Slaked lime
G Strong base + weak acid
H Strong acid
I Concentrated base
J 36.5 g of HCl in 1000 cm^3 of solution
K Composition reaction
L Basic salts
M Caustic potash
N Strong acid + weak base
O Concentrated acid
P Decolorization
Q 36.6 g of HCl in 1000 cm^3 of water
R $Ag^+(aq) + Cl^-(aq)$ -----> AgCl(s)
S Ethanoic acid
T Neutral salt

(i) P
(ii) F
(iii) H
(iv) E

(v) J
(vi) D
(vii) A
(viii) C
(ix) R
(x) B

3. (a) Iron reacts with sulfur to form iron (II) sulfide. Write the reaction equation and calculate the mass of iron that would combine with 80 g of sulfur.

Reaction equation:
$Fe(s) + S(s) \rightarrow FeS(s)$

Step 1: Molar masses
Molar mass of Fe = 56 g/mol
Molar mass of S = 32 g/mol
Total molar mass of FeS = 56 + 32 = 88 g/mol

Step 2: Mass proportion
56 g of iron reacts with 32 g of sulfur.
Mass of iron needed for 80 g of sulfur:

(56 g Fe / 32 g S) × 80 g S = 140 g Fe

Mass of iron required = 140 g

(b) Briefly explain why calcium carbonate is used in the blast furnace and suggest what would happen if calcium carbonate was not there.

Calcium carbonate ($CaCO_3$) is used in the blast furnace as a flux to remove impurities by forming slag. It decomposes into calcium oxide (CaO) and carbon dioxide (CO_2). The calcium oxide reacts with silicon dioxide (SiO_2) impurities, forming calcium silicate (slag), which floats on molten iron.

If calcium carbonate were not used, impurities like silicon dioxide would not be removed, leading to impure iron, which is brittle and of low quality.

4. (a) Organic chemistry deals with carbon elements and its compounds. Name one carbon-hydrogen compound and write the equation for its combustion.

A common carbon-hydrogen compound is methane (CH_4).

Combustion equation:

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ + energy

(b)

Write all the structural isomers of alcohols whose molecular formula is $C_4H_{10}O$ and give their IUPAC names.

1. Butan-1-ol: CH_3-CH_2-CH_2-CH_2OH
2. Butan-2-ol: CH_3-$CH(OH)$-CH_2-CH_3
3. 2-Methylpropan-1-ol: CH_3-$CH(CH_3)$-CH_2OH
4. 2-Methylpropan-2-ol: CH_3-$C(OH)(CH_3)$-CH_3

(c) Briefly explain why carbon dioxide is very important for making life on land and sea possible.

Carbon dioxide is essential for life because:
- It is used in photosynthesis by plants to produce oxygen and glucose, forming the base of the food chain.
- It helps regulate Earth's temperature by trapping heat in the atmosphere, preventing extreme cooling.
- It dissolves in seawater and is used by marine organisms to form calcium carbonate shells and skeletons.

5. (b) The thermal decomposition of calcium carbonate can be represented by the following equation:
$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$
Calculate the volume of carbon dioxide (measured at standard temperature and pressure) liberated when 150 g of calcium carbonate are completely decomposed.

Step 1: Molar mass of $CaCO_3$
Ca = 40, C = 12, O = 3 × 16 = 48
Molar mass of $CaCO_3$ = 40 + 12 + 48 = 100 g/mol

Step 2: Moles of $CaCO_3$ in 150 g
150 g / 100 g/mol = 1.5 moles

Step 3: Using mole ratio
From the equation, 1 mole of $CaCO_3$ produces 1 mole of CO_2.
So, 1.5 moles of $CaCO_3$ produce 1.5 moles of CO_2.

Step 4: Volume at STP
1 mole of gas at STP = 22.4 L
1.5 × 22.4 = 33.6 L of CO_2

6. (a)

Element Y with atomic number 5 has isotopes A and B whose atomic masses are 10.010 and 11.013 respectively. The proportion in nature of A is 20% and that of B is 80%. Calculate the relative atomic mass of Y and write its electronic configuration.

Relative atomic mass:
$(10.010 \times 0.2) + (11.013 \times 0.8)$
$= 2.002 + 8.8104$
$= 10.8124 \approx 10.81$

Electronic configuration of Y (Boron):
2, 3

(b) Explain why solid $CaCl_2$ does not conduct electricity while its aqueous solution does.

In solid state, calcium chloride ($CaCl_2$) has ions held in a rigid lattice structure and cannot move freely to conduct electricity. However, when dissolved in water, it dissociates into Ca^{2+} and Cl^- ions, which move freely and conduct electricity.

7. Study the portion of the periodic table given in the following table and answer the questions that follow.

Group	I	II	III	IV	V	VI	VII	0
Period 2	Li	Be	B	C	N	O	F	Ne
Period 3	Na	Mg	Al	Si	P	S	Cl	Ar

(a) Explain how the ionization energy of elements varies from Be to Mg and from B to O.

- Ionization energy decreases from Be to Mg because Mg has a larger atomic radius and more shielding, making it easier to remove an electron.
- Ionization energy increases from B to O because nuclear charge increases, attracting electrons more strongly and requiring more energy to remove them.

(b) Name the types of bonds formed when S combines with O. Give two properties of compounds of such a bond.

Sulfur and oxygen form covalent bonds.

Properties:
1. Covalent compounds have low melting and boiling points.
2. They do not conduct electricity in solid or liquid state.

8. (a) Briefly describe how sodium is extracted in Down's cell. Write all the necessary equations.

Sodium is extracted from molten sodium chloride (NaCl) by electrolysis in Down's cell.

Reactions:
At cathode: $Na^+ + e^- \text{------> } Na(l)$
At anode: $2Cl^- \text{-----> } Cl_2(g) + 2e^-$

Overall reaction: $2NaCl \text{------> } 2Na(l) + Cl_2(g)$

9. (a)

Briefly explain how soil fertility can be maintained by adopting good farming methods.

1. Crop rotation helps prevent nutrient depletion.
2. Use of organic manure improves soil nutrients.
3. Planting nitrogen-fixing crops like legumes enhances nitrogen levels.
4. Avoiding excessive use of chemical fertilizers prevents soil degradation.

(b) With reasons, suggest suitable indicators for the titrations of sodium hydroxide against sulfuric acid and ammonia solution against hydrochloric acid.

- Sodium hydroxide vs sulfuric acid: Methyl orange, because it changes color in strong acid and weak base titrations.
- Ammonia vs hydrochloric acid: Phenolphthalein, as it is suitable for weak base and strong acid titrations.

10. (a)

Name the particles that form the nucleus part of an atom. What is the difference between them?

The nucleus consists of protons and neutrons.

- Protons have a positive charge (+1) while neutrons are neutral.
- Protons determine the atomic number, while neutrons contribute to mass but do not affect charge.

11. (a)

289500 coulombs were required to deposit one mole of a metallic element Q from its aqueous salt solution. Calculate the valence of Q.

Using Faraday's law:
Charge = n × F × z
289500 C = (1 × 96500 × z)
z = 289500 / 96500 = 3

Valency of Q = 3

(b) The following experiment was used to electroplate a metallic neck chain.
Explain what happened to the anode and the cathode and the right ionic question for that reaction which occurred at the electrodes

- At the anode, copper dissolves as Cu^{2+} ions: Cu ------> $Cu^{2+} + 2e^-$
- At the cathode, Cu^{2+} ions are reduced and deposit on the metallic chain: $Cu^{2+} + 2e^-$ -------> Cu

12.

Consider the following equation:

$A(g) + B(g) \rightleftharpoons D(g) \quad \Delta H = -X\ kJ$

Use Le Chatelier's principle to describe how the rate of production of D can be altered.

Le Chatelier's principle states that if a system at equilibrium is subjected to a change in conditions, the equilibrium position will shift to counteract that change. The rate of production of D can be altered by adjusting temperature, pressure, or reactant concentration.

i. Effect of Temperature
- Since the reaction is exothermic ($\Delta H = -X$ kJ), heat is released when D is formed.
- Increasing temperature adds heat, causing the equilibrium to shift towards the reactants (A and B), reducing the production of D.
- Decreasing temperature removes heat, shifting the equilibrium towards the formation of D.
- Conclusion: Lowering temperature increases the rate of production of D.

ii. Effect of Pressure
- If there is a difference in the number of gas molecules on the reactant and product sides, changing pressure will affect equilibrium.
- If fewer moles of gas exist on the product side than the reactant side, increasing pressure will favor the production of D.
- If both sides have an equal number of gas molecules, changing pressure will have no effect on the equilibrium position.

iii. Effect of Concentration
- Increasing the concentration of A or B will shift equilibrium to the right, increasing the production of D.
- Decreasing the concentration of A or B will shift equilibrium to the left, reducing the production of D.

- Removing D from the system as it forms will shift the reaction forward, leading to continuous production of D.

iv. Effect of a Catalyst
- A catalyst speeds up both the forward and reverse reactions equally, reducing the time required to reach equilibrium.
- It does not affect the equilibrium position but increases the overall rate of reaction.

In conclusion, the production of D can be increased by lowering temperature, increasing pressure (if applicable), and increasing the concentration of reactants.

13.

Environment supports lives of all organisms. Its pollution has led to some major catastrophic effects. Describe water pollution by analyzing its causes, effects, and the protective and remedial measures to be taken.

Water pollution occurs when harmful substances such as chemicals, waste, and microorganisms contaminate water bodies, making them unsafe for use by humans and other organisms. The sources of pollution can be industrial, agricultural, or domestic.

i. Causes of Water Pollution

a. Industrial Waste
- Factories discharge toxic chemicals, heavy metals, and radioactive substances into rivers, lakes, and oceans.
- Pollutants such as lead, mercury, and arsenic poison aquatic life and pose serious health risks to humans.

b. Agricultural Runoff
- Excessive use of fertilizers and pesticides leads to runoff that contaminates nearby water bodies.
- Nitrogen and phosphorus from fertilizers cause algal blooms, which deplete oxygen levels in water and kill aquatic organisms.

c. Sewage and Wastewater
- Untreated sewage contains bacteria, viruses, and harmful chemicals.
- Poor sanitation and direct disposal of human and animal waste into water bodies cause waterborne diseases.

d. Oil Spills
- Accidental spills from oil tankers and offshore drilling contaminate oceans, affecting marine life and coastal ecosystems.

- Oil coats the feathers of birds, reducing their ability to fly, and blocks the breathing of aquatic organisms.

e. Plastics and Solid Waste
- Plastics and non-biodegradable waste accumulate in oceans and rivers.
- Marine animals mistakenly consume plastic, leading to choking, poisoning, and death.

f. Thermal Pollution
- Industries release hot water into rivers, increasing water temperature.
- Higher temperatures reduce oxygen levels in water, making it difficult for aquatic life to survive.

ii. Effects of Water Pollution

a. Harm to Aquatic Life
- Polluted water reduces oxygen levels, leading to the death of fish and other marine organisms.
- Toxic substances accumulate in food chains, affecting higher organisms, including humans.

b. Health Problems in Humans
- Contaminated water spreads diseases such as cholera, typhoid, dysentery, and hepatitis.
- Heavy metals in polluted water cause neurological disorders, kidney failure, and cancer.

c. Destruction of Ecosystems
- Pollution disrupts the balance of aquatic ecosystems, leading to loss of biodiversity.
- Algal blooms caused by fertilizers deplete oxygen, leading to "dead zones" where marine life cannot survive.

d. Economic Losses
- The fishing industry suffers due to fish deaths and contamination of seafood.
- Tourism declines as polluted beaches and rivers become unattractive.
- Water treatment costs increase as authorities spend more to purify polluted water.

iii. Protective and Remedial Measures

a. Proper Waste Disposal
- Industries should treat wastewater before discharging it into water bodies.
- Solid waste, especially plastics, should be recycled to prevent pollution.

b. Reduction of Chemical Usage
- Farmers should use organic fertilizers instead of chemical-based ones to prevent runoff.
- Pesticides should be applied responsibly to avoid contaminating nearby water sources.

c. Treatment of Sewage Water

- Cities should establish proper sewage treatment plants to prevent raw waste from entering rivers and lakes.
- Wastewater should be purified before being released into the environment.

d. Control of Oil Spills
- Oil transportation should be closely monitored to prevent spills from tankers.
- Special chemicals should be used to clean oil spills without harming marine life.

e. Public Awareness and Legislation
- Governments should enforce strict regulations on industries and waste disposal.
- Educational programs should teach people the importance of protecting water resources.

f. Afforestation and Soil Conservation
- Planting trees along riverbanks prevents soil erosion and runoff.
- Wetlands should be protected as they naturally filter pollutants from water.

In conclusion, water pollution is a serious threat to both human and aquatic life. By implementing strict pollution control measures, reducing waste, and adopting environmentally friendly practices, we can protect and restore water resources for future generations.