THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

032/1 **CHEMISTRY 1**

(For Private Candidates Only)

Time: 3 Hours **ANSWERS** **Year: 2015**

Instructions

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

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

(i) Which of the following transforms a mechanical energy to an electric energy?

A. Hydroelectric power plant
B. An electric motor
C. Solar panels
D. An electric cooker
E. A motor cycle wheel

A hydroelectric power plant converts the mechanical energy of flowing water into electrical energy using turbines and generators.

The correct answer is A. Hydroelectric power plant.

(ii) Organic compounds with general formula RCOOH is known as

A. Aldehydes
B. Carboxylic acid
C. Hydrocarbons
D. Esters
E. Alcohols

Carboxylic acids have the general formula RCOOH and contain the carboxyl (-COOH) functional group.

The correct answer is B. Carboxylic acid.

(iii) Which of the following will increase the equilibrium yield of hydrogen in the equation,

$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g) - \Delta H$

A. Decrease the temperature
B. Increase the pressure
C. Decrease the surface area of methane
D. Decrease the methane concentration
E. Addition of catalyst

Increasing the pressure shifts the equilibrium towards the side with fewer moles of gas, increasing hydrogen yield.

The correct answer is B. Increase the pressure.

(iv) Sodium atom and sodium ion have the same

A. electronic configuration
B. number of electrons
C. chemical properties
D. number of protons
E. charge

Sodium atoms and sodium ions have the same number of protons but differ in their number of electrons.

The correct answer is D. number of protons.

(v) The three basic components of an atom are

A. protons, neutrons, and electrons
B. protons, neutrons, and ions
C. protons, neutrons, and nucleus
D. protons, neutrinos, and ions
E. protons, nucleons, and tritium

Atoms consist of protons and neutrons in the nucleus and electrons orbiting around them.

The correct answer is A. protons, neutrons, and electrons.

(vi) Which of the following is an example of oxide of metal used in liming?

A. Al_2O_3
B. Na_2O
C. CO_2
D. CaO
E. CuO

Calcium oxide (CaO) is used in agriculture to neutralize acidic soils, a process known as liming.

The correct answer is D. CaO.

(vii) The quantity of electricity needed to deposit 0.5 moles of aluminium in the electrolysis of aluminium chloride is

A. 144750 Coulombs
B. 289500 Coulombs
C. 386000 Coulombs
D. 96500 Coulombs

E. 193000 Coulombs

Using Faraday's law:
Charge (Q) = moles × Faraday constant × charge number
Q = 0.5 × 96500 × 3
Q = 144750 Coulombs

The correct answer is A. 144750 Coulombs.

(viii) Which of the following represents a redox reaction?

A. $Br_2 + 2Na \rightarrow 2NaBr$
B. $K \rightarrow K^+ + e^-$
C. $NaOH + HCl \rightarrow NaCl + H_2O$
D. $Cl_2 + 2e^- \rightarrow 2Cl^-$
E. $AgNO_3 + KBr \rightarrow AgBr + KNO_3$

A redox reaction involves both oxidation (loss of electrons) and reduction (gain of electrons). The reaction $Br_2 + 2Na \rightarrow 2NaBr$ involves oxidation of sodium and reduction of bromine.

The correct answer is A. $Br_2 + 2Na \rightarrow 2NaBr$.

(ix) Which process does not result in the formation of both carbon dioxide and water?

A. Addition of dilute acid to a carbonate
B. Burning of ethanol
C. Burning of methane
D. Heating $Na_2CO_3.10H_2O$
E. Burning of ethane

Heating $Na_2CO_3.10H_2O$ removes water but does not produce carbon dioxide.

The correct answer is D. Heating $Na_2CO_3.10H_2O$.

(x) Which two reagents could be used to prepare an insoluble salt of copper (II) carbonate?

A. CuO and Na_2CO_3
B. CuO and $MgCO_3$
C. $CuSO_4(aq)$ and $Na_2CO_3(aq)$
D. $CuSO_4(aq)$ and $MgCO_3(s)$
E. $CuCl_2(aq)$ and $CaCO_3(s)$

An insoluble salt like $CuCO_3$ is prepared using a precipitation reaction, where a soluble copper salt reacts with a soluble carbonate.

The correct answer is C. $CuSO_4(aq)$ and $Na_2CO_3(aq)$.

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 in the answer booklet provided.

List A

(i) It burns in air to produce carbon dioxide and water.
(ii) It is used to identify the presence of nitrate ions.
(iii) It is used to identify the presence of calcium ions.
(iv) It is a yellow crystalline.
(v) It is an insoluble powder in water, but soluble in organic solvent.
(vi) It is used to identify sulphate ions.
(vii) It is used to identify carbonate ions.
(viii) It forms white fumes with hydrogen chloride.
(ix) It blackens lead acetate paper.
(x) It is used to identify halide ions.

List B

A. Ammonia
B. Iron (II) sulphate
C. Sulphuric acid
D. Calcium hydroxide
E. Hydrogen sulphide
F. Silver nitrate
G. Rhombic sulphur
H. Ammonium oxalate
I. Nitrogen dioxide
J. Methane
K. Sulphur
L. Nitrogen
M. Carbon dioxide
N. Barium chloride
O. Ammonium chloride

Answers

(i) J. Methane
(ii) F. Silver nitrate

(iii) D. Calcium hydroxide
(iv) G. Rhombic sulphur
(v) E. Hydrogen sulphide
(vi) N. Barium chloride
(vii) D. Calcium hydroxide
(viii) O. Ammonium chloride
(ix) I. Nitrogen dioxide
(x) F. Silver nitrate

3. (a) Identify the types of bonds found in each of the following compounds:

(i) NaCl
Sodium chloride (NaCl) is an ionic compound, meaning it is formed by the transfer of electrons from sodium (Na) to chlorine (Cl). Sodium loses one electron to become Na^+, while chlorine gains one electron to become Cl^-, resulting in a strong electrostatic attraction between the oppositely charged ions.

(ii) O_2
Oxygen (O_2) is a covalent molecule, meaning it is formed by the sharing of electrons between two oxygen atoms. Each oxygen atom shares two electrons to achieve a stable octet configuration, forming a double covalent bond (O=O).

(iii) Cl_2
Chlorine (Cl_2) is also a covalent molecule, meaning it is formed by the sharing of one pair of electrons between two chlorine atoms. Each chlorine atom needs one more electron to complete its octet, so they share one electron each, forming a single covalent bond (Cl–Cl).

(b) Briefly explain how sulphur dioxide causes pollution and how this harms trees.

Sulphur dioxide (SO_2) is a major air pollutant released primarily from the burning of fossil fuels and industrial processes. It reacts with moisture in the atmosphere to form sulphuric acid (H_2SO_4), leading to acid rain.

Effects on trees:
1. Acidification of soil – Acid rain lowers soil pH, leading to the loss of essential nutrients such as calcium and magnesium. This weakens trees and makes them more susceptible to diseases.
2. Damage to leaves – Sulphur dioxide directly damages the stomata of leaves, reducing photosynthesis and leading to poor growth and defoliation.
3. Toxicity to roots – Acidic soil increases the solubility of toxic metals like aluminum, which damages tree roots and affects nutrient uptake.

4. (a) In a certain experiment, the following results were obtained: 69.58% Ba, 6.09% C, 24.32% O. Calculate the empirical formula for the compound.

Step 1: Convert percentages to moles
Ba = 69.58 / 137 = 0.508
C = 6.09 / 12 = 0.508
O = 24.32 / 16 = 1.52

Step 2: Divide by the smallest number
Ba = 0.508 / 0.508 = 1
C = 0.508 / 0.508 = 1
O = 1.52 / 0.508 = 3

Empirical formula = $BaCO_3$

(b) List two environmental problems that are associated with the disposal of plastics.

1. Non-biodegradability – Plastics do not decompose naturally, leading to long-term pollution in landfills and water bodies.
2. Microplastic pollution – Plastics break down into small particles that contaminate soil and water, harming aquatic life and entering the food chain.

5. (a) Calculate the number of moles of sodium chloride present in 22 cm^3 of 2 M solution.

Number of moles = concentration × volume (in dm^3)
= 2 × (22 / 1000)
= 0.044 moles

(b) 2.5 g of calcium carbonate was dropped into a beaker containing dilute hydrochloric acid. Write the ionic equation for the reaction and calculate the loss in mass of calcium carbonate.

Reaction:
$CaCO_3 + 2HCl$ ---------> $CaCl_2 + CO_2 + H_2O$

Ionic equation:
$CO_3^{2-} + 2H^+$ --------> $CO_2 + H_2O$

Loss in mass = mass of CO_2 released
Molar mass of $CaCO_3$ = 100 g/mol
Moles of $CaCO_3$ = 2.5 / 100 = 0.025
Mass of CO_2 = 0.025 × 44 = 1.1 g

Loss in mass = 1.1 g

6. (a) Briefly explain how the following lead to soil erosion and destruction of soil structure:

(i) Overgrazing – When animals feed excessively on vegetation, plant roots that hold the soil together are removed, leading to increased erosion by wind and water.
(ii) Overstocking – Too many animals in a small area compact the soil, reducing water infiltration and increasing surface runoff, which erodes the topsoil.
(iii) Deforestation – Cutting down trees removes the protective canopy and roots, exposing the soil to direct rainfall, increasing the likelihood of erosion.
(b) The electronic arrangement of ions of x^{3+} and y^{2-} are 2.8 and 2.8.8 respectively. Write the

(i) Electronic arrangement of their atoms
x (before losing electrons) = 2.8.3
y (before gaining electrons) = 2.8.6

(ii) Formula of the compound formed between x and y
Since x has a charge of +3 and y has a charge of -2, the ratio in the compound will be x_2y_3 to balance the charges.

7. (a) Briefly explain three effects of using charcoal as a source of energy to the environment.

1. Deforestation – Large-scale charcoal production leads to the destruction of forests, affecting biodiversity and reducing carbon absorption.
2. Air pollution – Burning charcoal releases carbon monoxide (CO) and particulate matter, which contribute to respiratory diseases and air pollution.
3. Soil degradation – Tree removal for charcoal production exposes the soil to erosion, reducing its fertility.

(b) Describe what would be observed in each of the following experiments and write equations for the reactions that occur.

(i) Aqueous sodium hydroxide is added to aqueous copper (II) sulphate.

Observation: A blue precipitate of copper (II) hydroxide forms.
Equation: $CuSO_4 + 2NaOH$ ------> $Cu(OH)_2 + Na_2SO_4$
(ii) Copper (II) nitrate crystals are heated strongly.

Observation: A brown gas (NO_2) is released, and a black residue of CuO remains.
Equation: $2Cu(NO_3)_2$ --------> $2CuO + 4NO_2 + O_2$

8. (a) Briefly explain the meaning of the following and give an example in each case.

(i) Addition reaction – A reaction where atoms or groups are added to a molecule without the removal of any atom. Example: $C_2H_4 + Br_2$ -------> $C_2H_4Br_2$

(ii) Substitution reaction – A reaction where an atom or group in a molecule is replaced by another atom or group. Example: $CH_4 + Cl_2$ ------> $CH_3Cl + HCl$

9. (a) The Frasch process in the extraction of sulphur is essentially a physical process. Justify this statement.

The Frasch process extracts sulphur by melting it with superheated steam and forcing it to the surface using compressed air. No chemical change occurs; only the physical state of sulphur changes from solid to liquid.

(b) Briefly explain what will happen when the following salts are heated strongly.

(i) Hydrated iron (II) sulphate – It decomposes to form iron (III) oxide, sulphur dioxide, and sulphur trioxide.
$FeSO_4 \cdot 7H_2O$ ------> $Fe_2O_3 + SO_2 + SO_3 + H_2O$

(ii) Iron (III) sulphate – It decomposes to form iron (III) oxide and sulphur trioxide.
$2Fe_2(SO_4)_3$ ------> $2Fe_2O_3 + 6SO_3$

(iii) Ammonium carbonate – It decomposes to form ammonia, water, and carbon dioxide.
$(NH_4)_2CO_3$ -----> $2NH_3 + H_2O + CO_2$

10. (a) State two uses for each of the following:

(i) Graphite – Used as a lubricant and in making electrodes for batteries.
(ii) Diamond – Used in cutting tools and in jewelry.

(b) Indicate whether a chemical or physical change is involved in the following process:

(i) Addition of sodium metal to water – Chemical change, as hydrogen gas is produced, and NaOH is formed.
(ii) Heating magnesium in air – Chemical change, as magnesium reacts with oxygen to form magnesium oxide.

12. Soil fertility plays a vital role in agricultural activities. Based on this statement, explain three ways of maintaining soil fertility and four ways in which soil can lose its fertility.

Ways of maintaining soil fertility:

1. Crop rotation – Growing different crops in succession on the same piece of land helps prevent soil depletion by balancing nutrient usage. Leguminous plants, for example, help fix nitrogen in the soil.
2. Use of organic manure – Adding compost or animal manure enriches the soil with essential nutrients, improving its structure and microbial activity.
3. Proper irrigation practices – Ensuring sufficient water supply without over-irrigating prevents salinization and maintains soil health for plant growth.

Ways in which soil can lose its fertility:
1. Soil erosion – The removal of the top layer of fertile soil by wind or water leads to a loss of nutrients, making the land less productive.
2. Overgrazing – Allowing too many animals to feed on vegetation reduces plant cover, leading to soil compaction and nutrient depletion.
3. Continuous monocropping – Growing the same crop repeatedly on the same land exhausts specific nutrients, leading to imbalanced soil fertility.
4. Excessive use of chemical fertilizers – Overuse of synthetic fertilizers can degrade soil structure and reduce beneficial microbial activity, leading to long-term infertility.

13. The following diagram represents an experiment whose aim was to electroplate an iron rod with silver metal. The solution contained K^+, Ag^+, and CN^- ions.

(a) Which electrode was used as anode?
The pure silver electrode was used as the anode. During electroplating, the metal to be deposited (silver) is placed at the anode so that it dissolves into the electrolyte before being deposited on the cathode.

(b) Which process took place at the anode?
At the anode, oxidation occurred, where silver atoms lost electrons to form Ag^+ ions, which then dissolved into the electrolyte. The reaction at the anode is:
$Ag(s) \rightarrow Ag^+(aq) + e^-$

(c) State three importance of this experiment.

1. Prevents corrosion – Electroplating iron with silver creates a protective layer that prevents rusting and oxidation.
2. Enhances appearance – The process improves the aesthetic value of objects by giving them a shiny, decorative silver coating.
3. Improves conductivity – Silver-plated objects have better electrical conductivity, making the process useful in electrical components.

(d) If after passing a constant current for 400 minutes, the iron rod gained 2.16 g of silver, calculate the number of coulombs and the current which passed during the experiment.

Step 1: Determine the number of moles of silver deposited
Molar mass of Ag = 108 g/mol
Moles of Ag = 2.16 / 108 = 0.02 moles

Step 2: Find charge using Faraday's law
Charge (Q) = n × F × z
Q = 0.02 × 96500 × 1
Q = 1930 C

Step 3: Calculate current
$I = Q / t$
$I = 1930\ C / (400 \times 60)$
$I = 0.0804\ A$

Thus, the charge is 1930 C, and the current is 0.0804 A.