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: 2017**

Instructions

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

2. Answer all questions.

1. Multiple-Choice Questions

(i) Which of the following sets of elements is arranged in order of increasing electronegativity?
A. Chlorine, fluorine, nitrogen, oxygen, carbon
B. Fluorine, chlorine, oxygen, nitrogen, carbon
C. Carbon, nitrogen, oxygen, chlorine, fluorine
D. Nitrogen, oxygen, carbon, fluorine, chlorine
E. Fluorine, nitrogen, oxygen, chlorine, carbon

Solution: Electronegativity increases across a period from left to right and decreases down a group in the periodic table. Carbon has the lowest electronegativity, followed by nitrogen, oxygen, fluorine, and chlorine. The correct order should be nitrogen, oxygen, carbon, fluorine, chlorine.

Correct answer: D

(ii) Which type of a fire is associated with electrical equipment?
A. Class E
B. Class C
C. Class F
D. Class B
E. Class A

Solution:
- Class A fires involve ordinary combustibles like wood and paper.
- Class B fires involve flammable liquids.
- Class C fires are associated with electrical equipment.
- Class D fires involve metal fires.
- Class F fires involve cooking oils.
Electrical fires fall under class C.

Correct answer: B

(iii) Which of the following is the electronic configuration of an element Y found in period 3 and group II of the periodic table?
A. 2:8
B. 2:8:2
C. 2:6
D. 2:8:8:2
E. 2:8:4

Solution: Group II elements have two valence electrons. An element in period 3 must have three shells. Magnesium (Mg) is in group II and period 3, and its electronic configuration is 2:8:2.

Correct answer: B

(iv) Technicians prefer to use blue flame in welding because
A. it is bright and non-sooty
B. it is light and non-sooty
C. it is very hot and large
D. it is very hot and non-sooty
E. it is not expensive

Solution: Blue flames burn with complete combustion, producing high temperatures and little to no soot, which is ideal for welding.

Correct answer: D

(v) Which method could be used to separate the products in the following equation?
$Pb(NO_3)_2(aq) + 2KI(aq) \rightarrow PbI_2(s) + 2KNO_3(aq)$
A. Chromatography
B. Crystallisation
C. Distillation
D. Filtration
E. Condensation

Solution: Lead iodide (PbI_2) is a precipitate (solid), which can be separated from the liquid solution using filtration.

Correct answer: D

(vi) The metal nitrate which will NOT give a metal oxide on heating is
A. calcium nitrate
B. silver nitrate
C. lead nitrate
D. copper nitrate
E. zinc nitrate

Solution: Most metal nitrates decompose on heating to give metal oxides. However, silver nitrate decomposes to give silver metal instead of silver oxide.

Correct answer: B

(vii) Which of the following compounds does NOT belong to the alkane homologous series?
A. C_2H_6
B. CH_4
C. C_4H_{10}

D. C_3H_8
E. C_4H_{12}

Solution: The general formula of alkanes is C_nH_{2n+2}. Checking the molecular formulas:
- C_2H_6 (ethane)
- CH_4 (methane)
- C_4H_{10} (butane)
- C_3H_8 (propane)
- C_4H_{12} does not follow the C_nH_{2n+2} rule, making it incorrect.

Correct answer: E

(viii) Which of the following is NOT among the composition of air?
A. Noble gases
B. Carbon dioxide
C. Nitrogen
D. Hydrogen
E. Water vapour

Solution: The main components of air are nitrogen, oxygen, noble gases, carbon dioxide, and water vapour. Hydrogen is not a significant component of air.

Correct answer: D

(ix) Chlorine ion, Cl^- differs from chlorine atom because it has
A. more protons
B. less protons
C. more electrons
D. less electrons
E. more neutrons

Solution: A chlorine ion (Cl^-) has gained one electron compared to a neutral chlorine atom. The number of protons and neutrons remains the same, but it has more electrons.

Correct answer: C

(x) Which of the following pairs of compounds can be used in the preparation of calcium sulphate?
A. Calcium carbonate and sodium sulphate
B. Calcium chloride and ammonium sulphate
C. Calcium hydroxide and barium sulphate
D. Calcium nitrate and lead (II) sulphate
E. Calcium chloride and barium sulphate

Solution: Calcium sulphate can be prepared by reacting calcium chloride with barium sulphate in a double displacement reaction.
Correct answer: E

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) An element with electronic configuration of 2:8
(ii) An element in which its oxide can be prepared by the action of nitric acid and heat
(iii) An element which acts as an oxidant or reductant
(iv) A gas that explodes when a flame is applied in the presence of air
(v) A gas which is prepared in the laboratory by isolation from air
(vi) An element with atomic mass of 40
(vii) An element which reacts with water to produce hydroxide and hydrogen gas
(viii) An element which is used in making jewellers
(ix) An element which is an allotrope of sulphur
(x) The most electronegative element

LIST B
A. Fluorine
B. Rhombic
C. Amorphous
D. Diamond
E. Argon
F. Zinc
G. Phosphorus
H. Nitrogen
I. Hydrogen
J. Mercury
K. Neon
L. Sulphur
M. Oxygen
N. Potassium
O. Chlorine

Answers
(i) M
(ii) F
(iii) G
(iv) I
(v) E
(vi) N

(vii) N
(viii) J
(ix) C
(x) A

3. (a) Define the following terms:

(i) Soil
Soil is the uppermost layer of the Earth's crust composed of minerals, organic matter, water, and air, which supports plant growth.

(ii) Leaching
Leaching is the process by which water dissolves and carries away nutrients and minerals from the soil, reducing its fertility.

(iii) Denitrification
Denitrification is a microbial process in which nitrates (NO_3^-) are converted into nitrogen gas (N_2) or nitrous oxide (N_2O), releasing them into the atmosphere and reducing soil nitrogen content.

(b) With the aid of a chemical equation, briefly explain how

(i) temporary hardness of water can be removed by boiling
Temporary hardness is caused by dissolved calcium and magnesium bicarbonates. Boiling converts them into insoluble carbonates, which can be removed as precipitate.

$Ca(HCO_3)_2$ ----------> $CaCO_3(s) + CO_2 + H_2O$

(ii) permanent hardness of water can be removed by chemical means
Permanent hardness is caused by calcium and magnesium sulphates or chlorides. It can be removed using washing soda (sodium carbonate) or ion exchange resins.

$CaSO_4 + Na_2CO_3$ ----------> $CaCO_3(s) + Na_2SO_4$

4. (a) State four steps employed in the extraction of moderate reactive metals.

(i) Concentration of the ore
(ii) Reduction of the ore
(iii) Purification of the extracted metal
(iv) Electrolysis (if necessary)

(b) Write balanced chemical equations to show how chlorine reacts with the following:

(i) water

$Cl_2 + H_2O$ --------> $HCl + HOCl$

(ii) aqueous iron (II) chloride solution
$Cl_2 + 2FeCl_2$ ----------> $2FeCl_3$

(iii) hydrogen sulphide
$Cl_2 + H_2S$ ----------> $2HCl + S$

5. (a) Copper can be obtained from the ore, copper pyrites ($CuFeS_2$). The ore is heated in a limited amount of air giving the following reaction:

$4CuFeS_2 + 11O_2$ ---------> $4Cu + 2Fe_2O_3 + 8SO_2$

(i) calculate the maximum mass of copper that can be obtained from 367 kg of copper pyrites.

Step 1: Calculate molar mass of $CuFeS_2$
Cu = 63.5, Fe = 55.8, S = 32 × 2 = 64
Molar mass = 63.5 + 55.8 + 64 = 183.3 g/mol

Step 2: Find moles in 367 kg = 367000 g
Moles of $CuFeS_2$ = 367000 / 183.3 = 2002.7 moles

Step 3: Use mole ratio
From the equation, 4 moles of $CuFeS_2$ produce 4 moles of Cu.
So, 2002.7 moles of $CuFeS_2$ will produce 2002.7 moles of Cu.

Step 4: Find mass of Cu
Mass = moles × atomic mass of Cu
Mass = 2002.7 × 63.5 = 127228 g = 127.23 kg

(ii) state why the gaseous product from this reaction must not be allowed to escape into the atmosphere.
Sulphur dioxide (SO_2) is a pollutant that causes acid rain, leading to environmental damage and respiratory problems.

(b) find the oxidation state of sulphur in the sulphate ion, SO_4^{2-}.
Let the oxidation state of sulphur be x:
x + 4(-2) = -2
x - 8 = -2
x = +6

6. (a) List two classes of oxides. Give one example in each case.

(i) Basic oxides - Example: Na_2O
(ii) Acidic oxides - Example: CO_2

(b) write the chemical formula of tetrachloromethane and state the type of bond that exists.
Formula: CCl_4
Bond type: Covalent bond

7. (a) state three main physical properties of water and show the usefulness of each property.

(i) High specific heat capacity – Helps regulate temperature in the environment and living organisms.
(ii) High surface tension – Enables capillary action in plants.
(iii) Universal solvent – Dissolves many substances, aiding chemical reactions and transport in living organisms.

(b) state three industrial applications of electrolysis.

(i) Electroplating of metals
(ii) Extraction of reactive metals like aluminium
(iii) Production of hydrogen and chlorine gases

8. (a) You are provided with CH_3CH_2OH, $CH_3CH_2CH_3$, CH_3COOH, and $CH_2=CH_2$.

(i) which compounds are gases at room temperature?
$CH_3CH_2CH_3$ (propane) and $CH_2=CH_2$ (ethene)

(ii) how can you distinguish compound $CH_3CH_2CH_3$ and $CH_2=CH_2$?
Ethene ($CH_2=CH_2$) decolorizes bromine water, while propane ($CH_3CH_2CH_3$) does not.

(iii) which compound would react with sodium carbonate? Write the balanced chemical equation for the reaction.
CH_3COOH (ethanoic acid) reacts with sodium carbonate.

$2CH_3COOH + Na_2CO_3$ ----------> $2CH_3COONa + CO_2 + H_2O$

(b) hydrogen peroxide breaks down slowly to form water and oxygen; the reaction can be sped up by using a catalyst.

(i) how does the catalyst speed up the rate of reaction?
It provides an alternative pathway with lower activation energy.

(ii) name a possible catalyst that can be used to speed up the reaction.

Manganese dioxide (MnO_2)

(iii) show that the catalyst always remains unchanged at the end of the reaction.
A catalyst does not get consumed; it remains chemically unchanged and can be recovered at the end of the reaction.

9. (a) an atom M has an atomic number 14 and mass number 28.

(i) what is the number of protons and neutrons?
Protons = Atomic number = 14
Neutrons = Mass number - Atomic number = 28 - 14 = 14

(ii) write the electronic configuration of atom M.
2:8:4

(b) calculate the volume of water produced when 1,120 cm^3 of oxygen at s.t.p. was liberated during the decomposition of hydrogen peroxide.

$2H_2O_2$ ----------> $2H_2O + O_2$

From the equation, 1 mole of O_2 (22.4 L) produces 2 moles of H_2O.
1120 cm^3 = 1.12 L
Water produced = (2 × 1.12 L) / 1 = 2.24 L
Density of water = 1 g/cm^3, so mass = 2.24 kg

10. (a) complete the following equations and determine the type of reaction.

(i) $Zn(s) + H_2SO_4(aq)$ ---------> $ZnSO_4(aq) + H_2(g)$
Type: Single displacement

(ii) $AgNO_3(aq) + NaCl(aq)$ -------> $AgCl(s) + NaNO_3(aq)$
Type: Precipitation reaction

(iii) $N_2(g) + H_2(g)$ -----> $2NH_3(g)$
Type: Combination reaction

(b) how long should a current of 5A be passed through a solution of silver chloride to deposit 3.24 g of silver?

Using Faraday's law:
t = (m × F) / (z × I)
Where F = 96500 C, z = 1, Ag = 108 g/mol
t = (3.24 × 96500) / (108 × 5) = 578.5 s

11. (a) why can't a mixture with equal boiling points be separated by simple fractional distillation?
The components vaporize together, making separation impossible.

(b) write a balanced chemical equation for the preparation of ammonia gas.
$NH_4Cl + NaOH$ ------> $NH_3 + NaCl + H_2O$

(ii) state two uses of ammonia.
- Fertilizer production
- Manufacture of explosives

12. (a) Explain three ways in which the rate of formation of hydrogen gas could be increased.

The rate of reaction between zinc and dilute sulphuric acid can be increased by applying the following methods:

i. Increasing the surface area of zinc metal
When the zinc metal granules are in large pieces, the reaction occurs only on the surface exposed to the acid. By using powdered zinc instead of granules, the surface area increases, allowing more acid to come into contact with the zinc at the same time. This leads to a faster reaction and a higher rate of hydrogen gas formation.

ii. Increasing the concentration of sulphuric acid
A more concentrated acid contains more hydrogen ions per unit volume, which increases the number of collisions between acid molecules and zinc atoms. This results in a faster rate of reaction and speeds up the production of hydrogen gas.

iii. Increasing the temperature of the reaction mixture
Raising the temperature of the acid increases the kinetic energy of the acid molecules. This leads to more frequent and energetic collisions between the zinc and acid molecules, thus increasing the rate of reaction and producing hydrogen gas at a faster rate.

(b) If the student wanted 36 cm^3 of hydrogen gas at s.t.p, what amount of the acid would be required?

The balanced chemical equation for the reaction is:

$Zn + H_2SO_4$ -------> $ZnSO_4 + H_2$

From the equation, 1 mole of zinc reacts with 1 mole of sulphuric acid to produce 1 mole of hydrogen gas.

At standard temperature and pressure (s.t.p), 1 mole of gas occupies 22.4 dm^3 (22400 cm^3).

Step 1: Determine the number of moles of hydrogen gas required
Moles of H_2 = Volume of H_2 / Molar volume at s.t.p

= 36 cm^3 / 22400 cm^3
= 0.00161 moles

Step 2: Since the reaction shows a 1:1 molar ratio between H_2SO_4 and H_2, the moles of H_2SO_4 required is also 0.00161 moles.

Thus, the amount of acid required is 0.00161 moles.

13. Using four examples, explain how the process of neutralization is important in day-to-day life.

Neutralization is a chemical reaction in which an acid reacts with a base to form salt and water. This reaction plays a crucial role in many practical applications in daily life, including medical, industrial, and environmental aspects.

i. Treatment of indigestion
The human stomach produces hydrochloric acid to aid digestion. However, excessive acid production can cause heartburn or indigestion. To relieve this condition, antacids containing bases such as magnesium hydroxide or calcium carbonate are taken. These antacids neutralize the excess stomach acid, forming water and a neutral salt, thereby reducing discomfort.

Example reaction:
$HCl + Mg(OH)_2$ -------> $MgCl_2 + H_2O$

ii. Agricultural applications - neutralizing acidic soil
Soil acidity can reduce crop yield by affecting nutrient availability and plant growth. Farmers use substances like lime (calcium carbonate) or slaked lime (calcium hydroxide) to neutralize acidic soil. This reaction raises the soil pH, making essential nutrients more accessible to plants and improving agricultural productivity.

Example reaction:
$CaCO_3 + 2H^+$ -------> $Ca^{2+} + CO_2 + H_2O$

iii. Treatment of acidic industrial waste
Industries such as mining and chemical manufacturing produce acidic waste, which can be harmful to the environment if released untreated. Neutralization is used to treat this waste by adding a base like sodium hydroxide or calcium hydroxide to neutralize the acid before disposal. This helps prevent water pollution and protects aquatic life.

Example reaction:
$H_2SO_4 + Ca(OH)_2$ -----> $CaSO_4 + 2H_2O$

iv. Relief from insect stings and bites

Many insect stings, such as bee stings, inject acidic venom into the skin, causing pain and inflammation. A weak base like sodium bicarbonate (baking soda) is applied to the affected area to neutralize the acid and relieve pain. Similarly, wasp stings are alkaline and can be neutralized using vinegar (acetic acid).

Example reaction for bee sting neutralization:
$HCO_3^- + H^+$ -----> $CO_2 + H_2O$

These examples highlight how neutralization is a fundamental chemical process with vital applications in health, agriculture, industry, and environmental protection.