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: 2010**

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 among the alternatives provided, and write its letter beside the item number in the answer booklet(s).

(i) Isotopes of the same element have

A. different atomic number
B. different atomic masses
C. the same number of neutrons
D. different number of electrons
E. different number of protons

Isotopes of an element have the same number of protons but different numbers of neutrons, which means they have different atomic masses.

The correct answer is B. different atomic masses.

(ii) A colourless gas is soluble in water. Its aqueous solution is acidic and gives white precipitate with aqueous silver nitrate acidified with dilute nitric acid. What is the name of the gas?

A. Carbon dioxide
B. Sulphur dioxide
C. Hydrogen chloride
D. Carbon monoxide
E. Nitrogen dioxide

Hydrogen chloride gas (HCl) dissolves in water to form hydrochloric acid, which is acidic. It also reacts with silver nitrate to form a white precipitate of silver chloride.

The correct answer is C. Hydrogen chloride.

(iii) Choose the set of elements that 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. Oxygen, carbon, fluorine, chlorine, nitrogen

Electronegativity increases from left to right in a period and decreases down a group in the periodic table. The correct increasing order is carbon < nitrogen < oxygen < chlorine < fluorine.

The correct answer is C. Carbon, nitrogen, oxygen, chlorine, fluorine.

(iv) The preparation of charcoal by local or modern methods is an example of

A. destructive distillation
B. fractional distillation
C. simple distillation
D. a process of cracking

Charcoal is prepared by the heating of wood in the absence of air, which is an example of destructive distillation.

The correct answer is A. destructive distillation.

(v) Example of a weak acid in the following list is

A. dilute sulphuric acid
B. dilute acetic acid
C. dilute nitric acid
D. dilute hydrochloric acid
E. saturated nitric acid

Acetic acid (CH_3COOH) is a weak acid because it partially ionizes in solution, unlike strong acids such as sulphuric acid or hydrochloric acid.

The correct answer is B. dilute acetic acid.

(vi) The chemical equation

$$CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$$
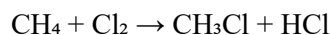
represents an example of

A. substitution reaction
B. addition reaction
C. esterification
D. polymerization
E. oxidation reaction

In this reaction, one hydrogen atom in methane is replaced by a chlorine atom, making it a substitution reaction.

The correct answer is A. substitution reaction.

(vii) The weight of oxygen in 90 g of water is

Find this and other free resources at: http://maktaba.tetea.org

Prepared by: Maria Marco for TETEA

A. 60 g
B. 70 g
C. 80 g
D. 90 g
E. 85 g

Water (H_2O) has a molar mass of 18 g/mol, where oxygen contributes 16 g and hydrogen contributes 2 g.
The proportion of oxygen in water = 16/18
Mass of oxygen in 90 g of water = (16/18) × 90 = 80 g

The correct answer is C. 80 g.

(viii) Consider the following reaction at equilibrium:
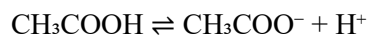
$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$

In order to produce more acetic acid we need to

A. increase the concentration of CH_3COO^- ions
B. increase the concentration of H^+ ions
C. decrease the concentration of H^+ ions
D. increase the initial concentration of CH_3COOH
E. decrease the concentration of CH_3COO^- ions

According to Le Chatelier's principle, to shift the equilibrium towards the production of more acetic acid (CH_3COOH), we need to increase the concentration of H^+ ions, making the reaction favor the backward direction.

The correct answer is B. increase the concentration of H^+ ions.

(ix) An example of an alkene that decolourises potassium permanganate solution is

A. methane
B. ethyne
C. ethene
D. ethane
E. butyne

Alkenes undergo an oxidation reaction with potassium permanganate, leading to decolourization. Ethene (C_2H_4) is an alkene and will react in this way.

The correct answer is C. ethene.

Find this and other free resources at: http://maktaba.tetea.org

Prepared by: Maria Marco for TETEA

(x) The empirical formula of a certain organic compound is CH_3. If its vapour density is 15, then its molecular formula is

A. C_2H_6
B. C_2H_4
C. CH_4
D. C_4H_{12}
E. C_3H_8

Step 1: Molecular mass = 2 × Vapour density = 2 × 15 = 30 g/mol
Step 2: Empirical formula mass of CH_3 = 12 + (3 × 1) = 15
Step 3: Molecular formula = (30 / 15) × CH_3 = C_2H_6

The correct answer is A. C_2H_6.

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) Milk souring
(ii) Air
(iii) Decomposition reaction
(iv) Precipitation reaction
(v) Oxidation reaction
(vi) Reversible reaction
(vii) Water and ethanol
(viii) Solid phase ⇌ vapour phase
(ix) Solution and filtration
(x) Water

List B

A. Two miscible liquids
B. Gaining hydrogen
C. Suspension
D. Sublimation
E. Physical change
F. Two liquids with very close boiling points
G. $CaCO_3$ (heat) → $CaO + CO_2$
H. $AgNO_3(aq) + NaCl(aq) → AgCl(s) + NaNO_3(aq)$
I. $CH_4(g) + 2O_2(g) → CO_2(g) + 2H_2O(g)$

J. $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

K. Compound

L. Element

M. Decantation

N. Fractional distillation

O. Soluble in water

P. Mixture

Q. Chemical change

R. Separating an insoluble substance from a soluble one

S. Evaporation

T. Incomplete combustion of hydrocarbon

Answers:

(i) Q – Chemical change

(ii) P – Mixture

(iii) G – $CaCO_3$ (heat) -------> $CaO + CO_2$

(iv) H – $AgNO_3(aq) + NaCl(aq)$ ------> $AgCl(s) + NaNO_3(aq)$

(v) I – $CH_4(g) + 2O_2(g)$ ------> $CO_2(g) + 2H_2O(g)$

(vi) J – $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

(vii) F – Two liquids with very close boiling points

(viii) S – Evaporation

(ix) R – Separating an insoluble substance from a soluble one

(x) K – Compound

3. (a) Define the following terms:

(i) Anode – The electrode at which oxidation occurs during electrolysis, where electrons are lost.

(ii) Cathode – The electrode at which reduction occurs during electrolysis, where electrons are gained.

(b) State Faraday's second law of electrolysis.

Faraday's second law states that the mass of a substance deposited or liberated at an electrode during electrolysis is directly proportional to its equivalent weight.

(c) A steady current of 2.5A was passed for 15 minutes through two different types of solutions namely copper sulphate and silver nitrate.

(i) Calculate the masses of copper and silver liberated.

(ii) From the masses in (i) what were the number of moles of each substance liberated?

(iii) What is the ratio in moles of Cu and Ag liberated in whole numbers?

Solution:

Step 1: Find the charge passed
Q = I × t
= 2.5 A × (15 × 60 s)
= 2250 C

Step 2: Find the mass of Cu and Ag using Faraday's law
Mass (m) = (Q × M) / (F × n)

For Cu: M = 63.5 g/mol, n = 2
m = (2250 × 63.5) / (96500 × 2)
m = 0.74 g

For Ag: M = 108 g/mol, n = 1
m = (2250 × 108) / (96500 × 1)
m = 2.52 g

Step 3: Calculate moles of Cu and Ag

Moles of Cu = 0.74 / 63.5 = 0.0117
Moles of Ag = 2.52 / 108 = 0.0233

Step 4: Find the ratio of moles of Cu and Ag in whole numbers

0.0117 : 0.0233
Dividing by the smallest value, we get approximately 1:2.

Thus, the ratio is 1:2

4. (a) What do you understand by the following terms?

(i) Proton – A positively charged subatomic particle found in the nucleus of an atom.
(ii) Neutron – A neutral subatomic particle found in the nucleus of an atom.
(iii) Electron – A negatively charged subatomic particle that orbits the nucleus of an atom.

(b) Sodium has a relative atomic mass of 23 and its atomic number is 11. Draw simple diagrams to show the particles which make up

(i) Sodium atom – Contains 11 protons, 12 neutrons in the nucleus, and 11 electrons arranged in shells (2,8,1).
(ii) Sodium ion – Contains 11 protons, 12 neutrons, and 10 electrons (2,8) after losing one electron.

(c) A and B represent atoms of two isotopes of silver, A is $^{107}_{47}Ag$ and B is $^{109}_{47}Ag$. State the number of

(i) Protons in atom A – 47
(ii) Electrons in atom B – 47
(iii) Neutrons in atom A – 107 - 47 = 60
(iv) Protons in atom B – 47

5. (a)(i) What is meant by the term reduction?

Reduction is the gain of electrons or the decrease in oxidation state of a substance in a chemical reaction.

(ii) What is the oxidation number of $FeSO_4$? Justify your answer.

Oxidation number of Fe in $FeSO_4$:
Let the oxidation number of Fe be x.
Oxidation number of SO_4^{2-} = -2
Since $FeSO_4$ is neutral:
x + (-2) = 0
x = +2

The oxidation number of Fe in $FeSO_4$ is **+2**.

(iii) Name the compound mentioned in (ii) above.

Iron(II) sulphate.

(b) Write the symbols and the valences of the following radicals.

(i) Nitrate – NO_3^- (Valency = 1)
(ii) Hydrogen carbonate – HCO_3^- (Valency = 1)
(iii) Sulphate – SO_4^{2-} (Valency = 2)

(c) Write the names and chemical formulae of the two oxides of iron where the metal has variable valences.

(i) Iron(II) oxide – FeO
(ii) Iron(III) oxide – Fe_2O_3

6. (a) Name at least two examples of each of the following:

(i) Mineral acid – Hydrochloric acid (HCl), Sulphuric acid (H_2SO_4)
(ii) Organic acid – Acetic acid (CH_3COOH), Citric acid ($C_6H_8O_7$)

(b)(i) Why do we use indicators in titrations?

Indicators help to determine the endpoint of a titration by changing color when the reaction is complete.

(ii) Name two common indicators and give their colours in acidic solution.

1. Methyl orange – Red in acid
2. Phenolphthalein – Colourless in acid

(c)(i) Which elements are contained in a table salt (common salt)?

Sodium (Na) and Chlorine (Cl).

(ii) Why common salt is classified as a normal salt?

Common salt (NaCl) is a normal salt because it is formed by the neutralization reaction between a strong acid (HCl) and a strong base (NaOH), and it does not contain any replaceable hydrogen or hydroxyl ions.

7. The elements magnesium, aluminium, sulphur, and argon are in the second period of the periodic table. For the listed elements, write

(a) Electronic structure of each element

Magnesium (Mg) – 2, 8, 2
Aluminium (Al) – 2, 8, 3
Sulphur (S) – 2, 8, 6
Argon (Ar) – 2, 8, 8

(b) Formulae for the hydride of magnesium, aluminium, and sulphur

Magnesium hydride – MgH_2
Aluminium hydride – AlH_3
Sulphur hydride – H_2S

(c) Formulae for the oxides of magnesium, aluminium, and sulphur and classify them into acidic, basic, amphoteric, and neutral oxides

Magnesium oxide – MgO (Basic oxide)
Aluminium oxide – Al_2O_3 (Amphoteric oxide)
Sulphur dioxide – SO_2 (Acidic oxide)
Sulphur trioxide – SO_3 (Acidic oxide)

8. (a) Define the following:

(i) Cracking – The process of breaking down large hydrocarbon molecules into smaller, more useful molecules, often using heat and catalysts.

(ii) Combustion – A chemical reaction where a substance reacts with oxygen to release energy in the form of heat and light.

(b)

(i) What is a reason for heating coal in the absence of air before using it in homes or factories?

Heating coal in the absence of air is known as destructive distillation, which removes volatile components such as water, tar, and gases, leaving behind coke, which is a more efficient fuel for combustion.

(ii) Explain how solar panels can help to save energy in homes.

Solar panels convert sunlight into electricity, reducing the dependence on non-renewable energy sources like coal and oil. They provide a sustainable and cost-effective way to generate electricity, reducing energy costs in homes.

(c) State at least four factors that determine the choice of a good fuel.

1. High calorific value – The fuel should release a large amount of energy per unit mass.
2. Availability – It should be easily accessible and abundant.
3. Environmental impact – It should produce minimal pollution and greenhouse gases.
4. Cost-effectiveness – The fuel should be affordable for widespread use.

9. Bauxite is an important raw material. It is the hydrated oxide of a certain metal. The metal is extracted from the oxide by electrolysis.

(a)(i) Which metal is extracted from bauxite?

Aluminium.

(ii) Why bauxite is dissolved in molten cryolite?

Bauxite is dissolved in molten cryolite (Na_3AlF_6) to lower its melting point, making the electrolysis process more energy-efficient and reducing costs.

(b) (i) Which types of electrodes are recommended for the extraction of the metal from bauxite?
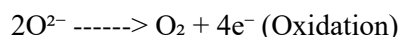
Graphite electrodes are used because they are good conductors of electricity and do not react with aluminium during the electrolysis process.

(ii) Write equations for the reactions taking place at the electrodes.

At the cathode:
$Al^{3+} + 3e^- -----> Al$ (Reduction)
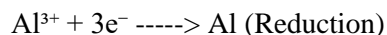
At the anode:
$2O^{2-} ------> O_2 + 4e^-$ (Oxidation)

(c)(i) Name the three alloys of the metal.

1. Duralumin
2. Magnalium
3. Alnico

(ii) What are the three properties which have made the metal popular in cooking utensils?

1. High thermal conductivity – It allows heat to be distributed evenly.
2. Non-toxic – It is safe for cooking food.
3. Corrosion resistance – It does not react easily with food or water.

10. (a) Why is the preparation of metallic oxides by direct combination not intensively used?

Some metallic oxides require extremely high temperatures to form directly, making the process inefficient and energy-intensive. Also, some metals form protective oxide layers that prevent further oxidation.

(b) The following results were obtained in an experiment to find the molecular formula of magnesium oxide when magnesium was burnt in the air.

Mass of crucible = 12.5 g
Mass of crucible + magnesium = 14.9 g
Mass of crucible + magnesium oxide = 16.5 g

(i) What mass of magnesium was used in the experiment?

Mass of magnesium = (Mass of crucible + magnesium) - (Mass of crucible)
= 14.9 g - 12.5 g
= 2.4 g

(ii) How many moles of magnesium atoms were used in the experiment?
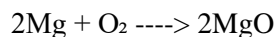
Moles of Mg = Mass / Molar mass
= 2.4 g / 24 g/mol
= 0.1 moles

(iii) What mass of oxygen combined with magnesium?

Mass of oxygen = (Mass of crucible + magnesium oxide) - (Mass of crucible + magnesium)
= 16.5 g - 14.9 g
= 1.6 g

(iv) How many moles of oxygen combined with magnesium?

Moles of O = Mass / Molar mass
= 1.6 g / 16 g/mol
= 0.1 moles

(c) Use the answers from part (b) to write the equation of the reaction.

$2Mg + O_2$ ----> $2MgO$

11. (a) Complete the following reactions:

(i) $Cu_2O + HCl$ -----> $2CuCl + H_2O$
(ii) $PbCO_3 + HCl$ ----> $PbCl_2 + CO_2 + H_2O$
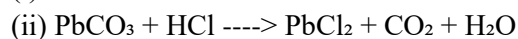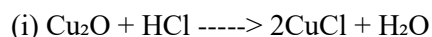
(b) Given copper(II) oxide, aqueous solutions of sodium hydroxide and sulphuric acid, and a suitable indicator, describe how you would prepare reasonably pure samples of:

(i) Sodium sulphate – React sodium hydroxide with sulphuric acid in a neutralization reaction. Evaporate the water to obtain sodium sulphate crystals.

(ii) Copper(II) sulphate – React copper(II) oxide with sulphuric acid to form copper(II) sulphate. Filter to remove excess CuO, then evaporate the water to crystallize $CuSO_4$.

(c) Give reasons for the use of nitrates in:

(i) Fertilizer industry – Nitrates provide essential nitrogen for plant growth.
(ii) Food preservative – Nitrates prevent bacterial growth in processed meats.
(iii) Antiseptics and photography – Silver nitrate is used in wound treatment and in developing photographic films.

12. (a) Give reasons for the following:

(i) Alkanes have the lowest melting and boiling points when compared to other classes of organic compounds.

Find this and other free resources at: http://maktaba.tetea.org

Prepared by: Maria Marco for TETEA

Alkanes have weak van der Waals forces between molecules, requiring less energy to break, resulting in low melting and boiling points.

(ii) Alkenes are more reactive than alkanes.

Alkenes contain a double bond, which is more reactive than the single bonds in alkanes due to the presence of a π-bond that is weaker and more easily broken.

(b) (i) Why is it dangerous to burn hydrocarbons in too little air?

Incomplete combustion occurs, producing carbon monoxide (CO), which is toxic and can cause suffocation.

(ii) Why is methane used as fuel? Write a balanced chemical equation for its combustion.

Methane is used as fuel because it has a high energy content, burns cleanly, and produces only carbon dioxide and water.

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$
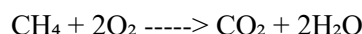
(c)(i) From which factors does the isomerism of alcohols arise?

Isomerism in alcohols arises from the position of the hydroxyl group (-OH) and the branching of the carbon chain.

(ii) Write and name all the isomers of the following alcohol: $CH_3CH_2CH_2CH_2OH$

1. Butan-1-ol ($CH_3CH_2CH_2CH_2OH$)
2. Butan-2-ol ($CH_3CH(OH)CH_2CH_3$)
3. 2-Methylpropan-1-ol ($CH_3CH(CH_3)CH_2OH$)
4. 2-Methylpropan-2-ol ($CH_3C(OH)(CH_3)_2$)

Find this and other free resources at: http://maktaba.tetea.org

Prepared by: Maria Marco for TETEA