TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF APPLIED AND HEALTH SCIENCES
DEPARTMENT OF PURE & APPLIED SCIENCES
UNIVERSITY EXAMINATION FOR:
BACHELOR OF SCIENCE IN MARINE RESOURCE MANAGEMENT
ACH 4102: FUNDAMENTALS OF CHEMISTRY
END OF SEMESTER EXAMINATION
SERIES: DECEMBER 2024
TIME: 2 HOURS
DATE: Pick DateSelect MonthPick Year

Instructions to Candidates
You should have the following for this examination
Answer Booklet, examination pass and student ID
This paper consists of **FIVE** questions. Attempt question ONE (Compulsory) and any other TWO questions.
Do not write on the question paper.

Some useful information
Speed of light c = 3.0 x 10^{8} ms^{-1}, Plank's Constant h = 6.6262 x 10^{-34} J s, 1nm = 1 x 10^{-9} m, R = -2.18 x 10^{-18}, 1 eV = 1.60218 x 10^{-19} J.

Question One (Compulsory)

a) Define or explain each of the following terms:
   i. Atom
   ii. Element
   iii. Mixture
   iv. Molecule
   v. Compound
   vi. Matter
   vii. Emission spectrum
   viii. Solute
   ix. Saturation point
   x. Electromagnetic radiation

(1 mark each, 10 marks total)

b) The photoelectric equation is given as:

$E = hv_0 + w$

i) State the meaning of each term in the above equation. (2 marks)

ii) Calculate the kinetic energy of an electron emitted from a surface of potassium metal (work function = 3.62 × 10^{-12} erg) by light of wavelength 5.5 × 10^{-8} cm. (c = 3.0 × 10^{8} m/s) (4 marks)

c) Classify the bonds in the following compounds as ionic, covalent or polar covalent:
   i. HCl
   ii. NaCl
   iii. NCl_3
   iv. KI

(4 marks)

d) Iodine molecule dissociates after absorbing light of 4500Å. If one quantum radiation is absorbed by each molecule, calculate the kinetic energy of iodine atom. (Bond energy of I_2 = 240×10^3 kJ/mol, A = 6.023×10^{23}). (6 marks)

e) What is the molarity of a solution prepared by dissolving 75.5 g of KOH (100 % pure) in 540 mL of solution. (K = 39.1 g/mol, O = 16.0 g/mol, H = 1.0 g/mol). (4 marks)

Question Two

a) Distinguish between each of the following
   i. Atomic number and mass number
   ii. Cathode rays and positive rays
   iii. Valence and oxidation number

(6 marks)

b) The molecules of CH_4, H_2O and NH_3 all involve sp^3 hybridization of the central atom but the bond angles in these molecules are 109° 28´, 104° 30´, and 107° 18´, respectively.
   i. Draw the structure of each of the molecules. (3 marks)
   ii. Explain why the bond angles are different. (3 marks)

c) 2.82 g of glucose (molar mass 180 g/mol) are dissolved in 30 g of water (molar mass is 18 g/mol). Calculate:
   i. The molality of the solution. (4 marks)

   ii. The mole fraction of glucose and water. (4 marks)

Question Three

a) Distinguish between each of the following parts of a wave:
   i. Crest and trough (2 marks)
   ii. Amplitude and frequency (2 marks)

b) The wavelength of a violet light is 400 nm. Calculate its frequency and wave number (4 marks)

c) A mixture is known to contain four compounds indicated in Table 1 below

Table 1: Properties of individual components of a mixture

Mixture component	**Dissolution or reaction**			
	Cold water	**Hot water**	**3 M HCl**	**3 M NaOH**
Benzoic acid	No	Yes	No	Yes
Magnesium II hydroxide	No	No	Yes	No
Sodium sulphate	Yes	Yes	Yes	Yes
Zinc II hydroxide	No	No	Yes	Yes

Use a flow chart to describe the steps that can be applied in separation of the compounds into their pure forms.

(12 marks)

Question Four

a) Indicate what ions are present in each of the following compounds
   i. $CaCl_2$
   ii. $Fe(OH)_3$
   iii. NH_4NO_3

(3 marks)

b) For each of the compounds in (a), indicate whether each compound is water soluble. (3 marks)

c) Explain your answer in (b) above. (3 marks)

d) Write the net ionic equation that occurs when aqueous solutions of $Pb(NO_3)_2$ and KI are mixed. (5 marks)

e) Potassium permanganate ($KMnO_4$, molar mass = 158.03 g/mol) is a strong oxidising agent whose solutions are often used in laboratory experiments.

i. If 0.433 g $KMnO_4$ is added to a 500 mL volumetric flask and water is added to the 500 mL mark. What is the molarity of the resulting solution? (4 marks)

ii. You need to prepare 0.025 M solution of $KMnO_4$ for an experiment. How many grams of $KMnO_4$ should be added with sufficient water to a 1 L volumetric flask to give the desired solution? (2 marks)

Question Five

a) Indicate the properties of α-rays, β-rays, and γ-rays by completing Table 2 below.

Table 2: Properties of α-rays, β-rays, and γ-rays

Property	**α-rays**	**β-rays**	**γ-rays**
Nature	Helium nuclei	Fast electrons	Electromagnetic radiation
Velocity	One-tenth velocity of light	Velocity of light	Velocity of light
Penetrating power	Low	Moderate	High
Stopped by	Paper or 0.01 mm thick aluminium sheet	1 cm sheet of aluminium	Several cm of thick lead or concrete layer

(12 marks)

b) Write electronic configuration of the atoms of each of the following elements:

i. C (Atomic number = 6)
ii. Al (Atomic number = 13)
iii. Ca (Atomic number = 20)
iv. Ge (Atomic number = 32)

(8 marks)