



UNIVERSITY OF RUHUNA
FACULTY OF FISHERIES AND MARINE SCIENCES &
TECHNOLOGY

Bachelor of Science Honors in Fisheries and Marine Sciences Degree/
Bachelor of Science Honors in Marine and Freshwater Sciences Degree

Level I, Semester-I Examination – 2023/2024

November/December- 2024

CHM 1111: Principles in Chemistry

Time: 1 hour and 15 minutes

Answer only Two (02) questions

1)

A) i) Explain the dual nature of electron.

ii) Write down the two sets of quantum numbers that can describe an electron in 2s atomic orbital.

(20 marks)

B) i) Based on valance bond theory, predict the **molecular shape and hybridization** of the following molecules

- a) IF_5
- b) CH_3^+
- c) BrO_3^-

ii) Even though all three molecules are having tetrahedral geometry, bond angles of CH_4 , NH_3 , and H_2O are 109.5° , 107° , and 104.5° respectively. Briefly explain this variation.

(35 marks)

C) The following questions are based on transition element **Mn**. ($Z=25$)

i) Write down the ground state electron configuration of Mn.

ii) How many unpaired electrons does a ground-state Mn atom possess?

iii) Calculate the value of the shielding constant/screening constant (σ) for a,

- a) 4s electron
- b) 3d electron of Mn atom.

iv) Calculate the effective nuclear charge (Z_{eff}) for a,

- a) 4s electron
- b) 3d electron of Mn atom.

v) When transition metals are converting into cations, it is **ns electrons** and not **(n-1) d electrons** which are removed from the isolated gaseous atom. Explain this statement by comparing Z_{eff} values which you obtained in part (iv).

(45 marks)

2)

A) i) Define the term “**Ionization Energy**” of an element?

ii) State four factors that affect ionization Energy.

iii) First, second and third ionization energies of Al is found to be 578, 1820, 2750 kJ mol^{-1} respectively. Explain the trend.

(30 marks)

B) i) Define the following terms

- Isotopes
- Pauli exclusion principle
- Polarizing power

ii) Elements X, Y and Z have 4, 5, and 7 valence electrons respectively.

- Write the molecular formula of the compounds formed by these elements individually **with hydrogen**.
- Which of these compounds will have the highest dipole moment?

(35 marks)

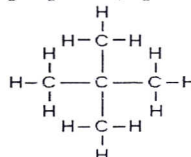
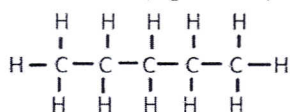
C) i) What are the four different types of intermolecular forces?

ii) Determine what type of intermolecular forces exist in the following molecules in their natural form.

- H_2O
- HCl
- CO_2

iii) Give reasons for the changes in boiling point (b.p) of the following molecules.

- Methane (M.W. 16 g mol^{-1} , b.p. -161.5°C) < Ethane (M.W. 30 g mol^{-1} , b.p. -88.6°C)
- Pentane (b.p. 36°C) > 2, 2-dimethylpropane (b.p. 9°C)



(35 marks)

t (n-1) d
ent by

(45 marks)

kJmol⁻¹

(30 marks)

ividually

(35 marks)

heir natural

38.6 °C)

(35 marks)

3)

A) i) How would you distinguish a covalent bond and an ionic bond in terms of size of the ions?

ii) From following two pairs of salts which salt is more covalent in each pair? Briefly explain your answer.

a) AlCl₃, NaCl

b) ZnO, ZnS

(25 marks)

B) Lattice energy is a measure of the strength of the ionic bonds in an ionic compound.

i) Write two factors that determine the Lattice energy.

ii) Calculated lattice energy for NaF is 910 kJmol⁻¹, whereas it is 3795 kJmol⁻¹ for MgO.

What could be the reason for this? Internuclear distances for NaF and MgO are 235 pm & 212 pm respectively.

iii) Briefly explain the following variation.

Compound	Melting point (°C)
NaF	988
NaCl	801
NaBr	790
NaI	660

(30 marks)

C) i) Ionic radius of Li⁺, Na⁺, K⁺ are given as 76 pm, 102 pm, and 232 pm respectively.

a) Find the values of ionic potential for each cation.

b) Arrange them according to the increasing order of ;

I. Hydration enthalpy

II. Size in the aqueous solution

III. Electrical conductivity (Ionic conductance)

ii) Briefly Explain

a) Alkaline earth metal ions form a large number of hydrated salts than alkaline metal ions.

b) Ionic solids are insoluble in non-polar solvents.

iii) The solubility of an ionic solid depends on the relative contribution of both the energy of hydration and the lattice energy. Justify the statement.

(45 marks)



4)

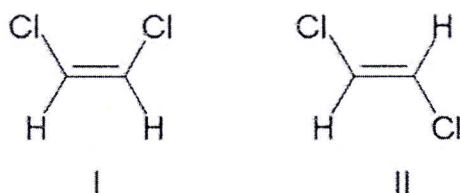
A) i) State two drawbacks of Rutherford's nuclear model.

ii) What's the significance of Bohr's atomic model?

(20 marks)

B) i) Why water is a polar molecule?

ii) Which of the following molecule (I or II) possessed a net dipole moment. Write reasons for your answer.



iii) How can dipole moment be used to predict whether a molecule is symmetric or not?

(35 marks)

C) i) List two assumptions for the Linear Combination of Atomic Orbitals in molecular orbital theory.

ii) Using a suitable molecular orbital diagrams rationalize why He_2^+ exists while He_2 is not?

iii) **Just because some chemical species show integral value of bond order, doesn't mean that they should necessarily exist at room temperature.** Justify this statement using C_2 molecular orbital diagram.

iv) Compare the stability and magnetic behavior of NO and NO^+ using their MO diagrams.

(45 marks)