PABNA UNIVERSITY OF SCIENCE AND TECHNOLOGY

Faculty of Engineering and Technology
Department of Information and Communication Engineering

ASSIGNMENT

CHEM-2201: Chemistry

Date : 27-04-2025

Submitted To :

Abrar Yasir Abir
Lecturer
Department of Chemistry, PUST

Submitted By :

Apurbo Sharma
Roll : 220604
Student of 2021-22 session
Department of ICE, PUST

5. (a) Defects of Rutherford’s Model and Bohr’s Suggestions

Rutherford's Model Defects:

1. **Instability Problem**:
   According to electromagnetic theory, an electron revolving around the nucleus should continuously lose energy and spiral into the nucleus. Hence, atoms should be unstable — but they are stable.
2. **No Energy Levels**:
   Rutherford’s model did not explain how electrons are arranged in the atom (no concept of energy levels).
3. **No Spectrum Explanation**:
   It could not explain the atomic spectra of elements (why only specific wavelengths are emitted).

Bohr’s Suggestions:

1. **Quantized Orbits**:
   Electrons revolve only in certain fixed orbits (energy levels) without losing energy.
2. **Energy Absorption/Emission**:
   Electrons can move between orbits by absorbing or releasing a fixed amount of energy (quantum).
3. **Stability of Atom**:
   As long as the electron stays in its orbit, the atom remains stable.

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5. (b) Quantum Numbers & Their Significance

Quantum Numbers:

There are **four quantum numbers** that describe the state of an electron in an atom:

Quantum Number	Symbol	Significance
Principal	n	Size and energy of orbital
Azimuthal (Angular Momentum)	l	Shape of orbital (s, p, d, f)
Magnetic	m	Orientation of orbital in space
Spin	s	Direction of electron spin (+½ or –½)

- Each electron in an atom has a unique set of these four numbers.
- **Total: 4 Quantum numbers per electron.**

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6. (a) Compare Properties of Ionic and Covalent Compounds

Property	Ionic Compound	Covalent Compound
Nature	Forms between metals and nonmetals	Forms between nonmetals
Bond Type	Transfer of electrons	Sharing of electrons
Melting/Boiling Point	High	Low
Solubility	Soluble in water	Soluble in organic solvents
Electrical Conductivity	Conducts in molten or aqueous form	Poor conductor

Examples:

- Ionic: NaCl, KBr
- Covalent: H_2O, CH_4

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6. (b) Co-ordinate Covalent Bond

Definition:

A **coordinate covalent bond** (also called a dative bond) is a type of covalent bond where **both electrons** come from the **same atom**.

Difference from Normal Covalent Bond:

- In a **normal covalent bond**, each atom contributes one electron.
- In a **coordinate bond**, one atom donates both electrons for the shared pair.

Example:

- Formation of **NH_4^+** (Ammonium ion)

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7. (a) Hydrogen Bonds

Definition:

A **hydrogen bond** is an electrostatic attraction between a hydrogen atom bonded to a highly electronegative atom (like N, O, F) and another electronegative atom.

Types:

- **Intermolecular Hydrogen Bonding**: Between molecules (e.g., water molecules)
- **Intramolecular Hydrogen Bonding**: Within the same molecule (e.g., o-nitrophenol)

Why Water Has High Boiling Point:

- Strong hydrogen bonding between H_2O molecules requires more energy to break bonds, resulting in **high boiling point**.

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7. (b) Bond Angles of H_2O and NH_3

- **H_2O bond angle = 104.5°**
- **NH_3 bond angle = 107°**

Reason:
Although both O and N atoms are **sp^3 hybridized**,

- In **NH_3**, there is **one lone pair** → slightly reduces bond angle.
- In **H_2O**, there are **two lone pairs**, causing **more repulsion** → bond angle decreases further.

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8. (a) Ionization Potential

Definition:

Ionization potential is the amount of energy needed to remove an electron from a gaseous atom.

Why First Ionization Potential < Second:

- After removing one electron, the atom becomes **positively charged**.
- More energy is required to remove the next electron due to **greater attraction** towards the nucleus.

Variation with Atomic Volume:

- **Larger atomic volume** → outer electrons farther → less attraction → **lower ionization energy**.
- **Smaller atomic volume** → outer electrons closer → **higher ionization energy**.

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8. (b) f-block Elements

Definition:

f-block elements are those elements in which the last electron enters the **f-orbital**.

- **Lanthanides** (Atomic No. 58–71) and **Actinides** (Atomic No. 90–103).

Why Called Inner Transition Elements:

- Because they are located between **s-** and **d-block** elements.
- Their f-orbitals are filling **internally**, beneath outer shells.