Pabna University of Science & Technology

Department of

INFORMATION AND COMMUNICATION ENGINEERING

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ASSIGNMENT

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Question Number :5

(a)Give the defects of Rutherford's model of atom. What suggestions were given by Bohr to remove these defects?

(b)What do you understand by the term, "Quantum number". How many quantum numbers has an electron in an orbital? Explain the significance of each quantum number.

5 (a) Defects of Rutherford's Atomic Model and Bohr's Modifications

Defects of Rutherford's Model:

- - Atomic Instability: Moving electrons should radiate energy causing atomic collapse, contradicting observed stability.
- - Failure to Explain Line Spectra: Could not explain discrete atomic spectra.
- - No Concept of Energy Quantization: Did not propose specific energy levels.

Bohr's Modifications:

- - Electrons move in fixed orbits without radiation.
- - Energy is absorbed or emitted during orbital transitions.
- - Quantization of Angular Momentum: $mvr = nh/2\pi$
- - Electron Energy in nth orbit (Hydrogen): $E_n = -13.6/n^2$ eV

5 (b) Quantum Numbers and Their Significance

Quantum numbers describe electron properties in an atom.

Quantum Number	Symbol	Range of Values	Significance
Principal	n	1,2,3,...	Main energy level and orbital size

Azimuthal	l	0 to n-1	Shape of the orbital (s,p,d,f)
Magnetic	m	-l to +l	Orientation in space
Spin	s	+1/2 or -1/2	Direction of spin

Example for a 2p electron: n=2, l=1, m=-1/0/+1, s=±1/2

Question Number :6

(a)Compare the properties of ionic and covalent compounds. Give two examples of each type of compounds.

(b)What is a co-ordinate covalent bond? How does it differ from a normal covalent bond?

6 (a) Comparison Between Ionic and Covalent Compounds

Property	**Ionic Compounds**	**Covalent Compounds**
Nature	Hard and brittle	Soft and flexible
Melting/Boiling Points	High (NaCl: 801°C)	Low to moderate (CO_2: -78°C)
Electrical Conductivity	Conducts in molten/solution	Generally non-conductive
Solubility	Soluble in polar	Soluble in non-polar

	solvents	solvents
Examples	NaCl, CaF_2	CO_2, NH_3

6 (b) Co-ordinate Covalent Bond vs. Normal Covalent Bond

Aspect	Normal Covalent Bond	Coordinate Covalent Bond
Electron Sharing	Each atom donates one electron	One atom donates both electrons
Formation Example	H_2 molecule	NH_4^+ ion
Example Reaction	N/A	$NH_3 + H^+ \rightarrow NH_4^+$

Question Number: 7

(a)What do you understand by hydrogen bonds? Classify them with examples. Explain why water has abnormally high boiling point.

(b)Why bond angles of H2O and NH3 are 104.5° and 107° respectively although central atoms are sp3 hybridized.

7 (a) Hydrogen Bonds and Water's High Boiling Point

Hydrogen bond: Strong dipole-dipole attraction between H and F, O, or N atoms.

Types: Intermolecular (e.g., H_2O-H_2O), Intramolecular (e.g., o-nitrophenol).

Strong hydrogen bonding in water results in a high boiling point (~100°C).

7 (b) Explanation of Bond Angles in H_2O and NH_3

Both H_2O and NH_3 are sp^3 hybridized.

- - NH_3 (1 lone pair): bond angle ≈ 107°
- - H_2O (2 lone pairs): bond angle ≈ 104.5°

Lone pairs cause greater repulsion, reducing bond angles from the ideal 109.5°.

Question Number:8

(a)What do you mean by the „ionization potential" of an element? Why the first ionization potential of an element is less than the second ionization potential? How does the ionization potential of an element vary with atomic volume?

(b)What do you mean by f-block elements? Why f-block elements are called inner transition elements?

8 (a) Ionization Potential and Its Variation

Ionization potential: Energy required to remove the most loosely bound electron from an isolated gaseous atom.

- - First ionization: Atom neutral → Easier.
- - Second ionization: Atom becomes positive → Harder.

Trend:

- - Down a group: Atomic size ↑ → Ionization potential ↓
- - Across a period: Atomic size ↓ → Ionization potential ↑

Example: Li (520 kJ/mol) < Be (900 kJ/mol)

8 (b) f-block Elements and Inner Transition Elements

f-block elements: Electrons enter f-orbitals.

Called Inner Transition Elements because f-orbitals fill after (n-1)d but before ns orbitals.

Examples:

- - Lanthanides: Ce (58) to Lu (71)
- - Actinides: Th (90) to Lr (103)