

Inorganic Chemistry - I

Assam University

FYUG · Semester 1 · Credits 3

CHMDSC101T

OBJECTIVES

- To introduce fundamental concepts of atomic structure and periodic properties of elements
- To develop an understanding of chemical bonding theories and intermolecular forces
- To acquaint students with basic principles of redox reactions and metallurgy

COURSE CONTENT

Unit 1: Atomic Structure (9 Hours)

- □ Bohr's theory, its limitations and atomic spectrum of hydrogen atom
- □ Wave mechanics: de Broglie equation, Heisenberg's uncertainty principle and its significance
- □ Schrödinger's wave equation, significance of ψ and ψ^2
- □ Quantum numbers and their significance
- □ Normalized and orthogonal wave functions
- □ Sign of wave functions
- □ Radial and angular wave functions for hydrogen atom
- □ Radial and angular distribution curves
- □ Shapes of s, p, d and f orbitals
- □ Contour boundary and probability diagrams
- □ Pauli's exclusion principle
- □ Hund's rule of maximum multiplicity
- □ Aufbau's principle and its limitations

Unit 2: Periodicity of Elements (9 Hours)

- □ s-, p-, d- and f-block elements
- □ Long form of periodic table
- □ Effective nuclear charge and shielding or screening effect
- □ Slater rules and variation of effective nuclear charge in periodic table
- □ Atomic radii (van der Waals)
- □ Ionic and crystal radii
- □ Covalent radii (octahedral and tetrahedral)
- □ Ionization enthalpy
- □ Successive ionization enthalpies and factors affecting ionization energy
- □ Applications of ionization enthalpy
- □ Electron gain enthalpy and its trends
- □ Electronegativity
- □ Pauling's, Mulliken's and Allred–Rochow's electronegativity scales
- □ Variation of electronegativity with bond order, partial charge, hybridization and group electronegativity

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Unit 3: Chemical Bonding - I (9 Hours)

ExamArchive

- Ionic bond: general characteristics
- Types of ions and size effects
- Radius ratio rule and its limitations
- Packing of ions in crystals
- Madelung constant
- Born–Haber cycle and its applications
- Solvation energy
- Covalent bond: Lewis structure
- Valence Bond theory (Heitler–London approach)
- Energetics of hybridization
- Equivalent and non-equivalent hybrid orbitals
- Resonance and resonance energy
- Molecular orbital theory
- MO diagrams of diatomic and simple polyatomic molecules (N_2 , O_2 , C_2 , B_2 , F_2 , CO , NO and their ions)
- MO theory of HCl , BeF_2 and CO_2 (idea of s–p mixing and orbital interaction)
- Formal charge
- VSEPR theory
- Shapes of simple molecules and ions containing lone pairs and bond pairs
- Multiple bonding (σ and π bond approach) and bond lengths
- Covalent character in ionic compounds
- Polarizing power and polarizability
- Fajan’s rules and consequences of polarization
- Ionic character in covalent compounds
- Bond moment and dipole moment
- Percentage ionic character from dipole moment and electronegativity difference

Unit 4: Chemical Bonding - II (9 Hours)

- Metallic bond
- Qualitative idea of valence bond and band theories
- Semiconductors and insulators
- Defects in solids
- Weak chemical forces
- van der Waals forces
- Ion–dipole forces
- Dipole–dipole interactions
- Induced dipole interactions
- Instantaneous dipole–induced dipole interactions
- Hydrogen bonding
- Theories of hydrogen bonding
- Valence bond treatment of hydrogen bonding

Unit 5: Oxidation–Reduction and Principles of Metallurgy (9 Hours)

- Redox equations
- Standard electrode potential and its application to inorganic reactions

- Principles involved in volumetric analysis
- Fe(II) and oxalic acid using standardized KMnO₄ solution
- Fe(II) with K₂Cr₂O₇ solution
- General principles of metallurgy
- Chief modes of occurrence of metals based on standard electrode potentials
- Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agents
- Electrolytic reduction
- Hydrometallurgy
- Methods of purification of metals
- Electrolytic processes
- Mond's process
- Zone refining

LEARNING OUTCOMES

- Explain atomic structure using quantum mechanical principles
- Analyse periodic trends and their applications
- Apply theories of chemical bonding to molecular structure and properties
- Understand redox processes and basic metallurgical principles

REFERENCES

- Principles of Inorganic Chemistry – Puri, Sharma and Kalia
- Concise Inorganic Chemistry – J. D. Lee
- Concepts and Models of Inorganic Chemistry – B. E. Douglas and D. H. McDaniel
- Theoretical Inorganic Chemistry – M. C. Day and J. Selbin