ARSD College, University of Delhi

Model Course Handout/Lesson Plan

Course Name : B.Sc. (Hons) chemistry						
Semester	**Course Code**	**Course Title**	**Lecture (L)**	**Tutorial (T)**	**Practical (P)**	**Credit (C)**
I	32171101 CHEMISTRY –C I-: Inorganic Chemistry I	Atomic Structure and **Covalent Bonding**	**4**			**4**
Teacher/Instructor(s)		Dr. Neha Bhardwaj				
Session		2020-2021				

Course Objective: The course reviews the structure of the atom, which is a necessary pre-requisite in understanding the nature of chemical bonding in compounds. It provides basic knowledge about ionic, covalent and metallic bonding and explains that chemical bonding is best regarded as a continuum between the three cases. It discusses the periodicity in properties with reference to the s and p block, which is necessary in understanding their group chemistry.

Course Learning Outcomes: By the end of this course, students will be able to:

• Solve the conceptual questions using the knowledge gained by studying the quantum mechanical model of the atom, quantum numbers, electronic configuration, radial and angular distribution curves, shapes of s, p, and d orbitals, and periodicity in atomic radii, ionic radii, ionization energy and electron affinity of elements.
• Draw the plausible structures and geometries of molecules using Radius Ratio Rules, VSEPR theory and MO diagrams (homo- & hetero-nuclear diatomic molecules).
• Understand the concept of lattice energy using Born-Landé and Kapustinskii expression.
• Rationalize the conductivity of metals, semiconductors and insulators based on the Band theory.
• Understand the importance and application of chemical bonds, inter-molecular and intramolecular weak chemical forces and their effect on melting points, boiling points, solubility and energetics of dissolution.

Lesson Plan:

Unit No.	Learning Objective	Lecture No.	Topics to be covered
1.	Atomic Structure	1-2	Recapitulation of Bohr's theory, its limitations and

			atomic spectrum of hydrogen atom.
		3-4	Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance.
		5-6	Schrödinger's wave equation, significance of ψ and ψ2 .
		7-8	Quantum mechanical treatment of H- atom, Quantum numbers and their significance.
		9-10	Normalized and orthogonal wave functions. Sign of wave functions.
		11-12	Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, and d orbitals, Relative energies of orbitals.
		13-14	Pauli's Exclusion Principle, Hund's rule of maximum spin multiplicity, Aufbau principle and its limitations.
	Periodicity of Elements	15-16	Brief discussion of the following properties of the elements
		17-18	with reference to s- & p-block and the trends shown: (a) Effective nuclear charge, shielding or screening effect
		19-20	Slater rules, variation of effective nuclear charge in periodic table
		21-22	(b) Atomic and ionic radii
2		23-24	(c) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization enthalpy and trends in groups and periods
		25-26	(d) Electron gain enthalpy and trends in groups and periods.
		27-28	(e) Electronegativity, Pauling's/ Allred Rochow's scales.
		29-30	Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity.
3	Chemical Bonding	31-32	Ionic bond: General characteristics, types of ions, size effects
		33-34	radius ratio rule and its limitations.
		35-36	Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy.
		37-38	Madelung constant, Born-Haber cycle and its application, Solvation energy. Covalent character in ionic compounds,
		39-40	polarizing power and polarizability. Fajan's rules and consequences of polarization.

4	Covalent bond	41-42	Covalent bond: Valence Bond theory (Heitler-London approach).
		43-44	Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule
		45-46	Resonance and resonance energy. Ionic character in covalent compounds: Bond moment and dipole moment.
		47-48	Percentage ionic character from dipole moment and electronegativity difference. Molecular orbital theory.
		49-50	Molecular orbital diagrams of diatomic and simple polyatomic molecules N2, O2, C2, B2, F2, CO, NO, and their ions; HCl (idea of s-p mixing and orbital interaction to be given).
5	VSEPR Theory	51-52	VSEPR Theory: Lewis structure, Valence shell electron pair repulsion theory (VSEPR)
		53-54	shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons: H2O, NH3, PCl3, PCl5, SF6, ClF3, I3 - , BrF2 + , PCl6 - ,ICl2 - ICl4 - , and SO4 2-
		55	Multiple bonding (σ and π bond approach) and bond lengths.
6	Metallic Bond	56-57	Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.
		58-59	Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interaction, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment).
		60	Effects of weak chemical forces, melting and boiling points, solubility, energetics of dissolution process.

Evaluation Scheme:

No.	Component	Duration	Marks
1.	Internal Assessment • Quiz • Class Test • Attendance • Assignment		25
2.	End Semester Examination	3 hr	75

Details of the Course		
Unit	**Contents**	**Contact Hours**

1 **Covalent Bonding**	(i) I onic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy. (ii) Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2 , O_2 , C_2 , B_2 , F_2 , CO, NO, and their ions; HCl (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons: H_2O, NH_3, PCl_3, PCl_5, SF_6, ClF_3, I^{3-} , BrF_2^+, PCl^{6-} , ICl^{2-} ICl^{4-} and SO_4^{2-} . Multiple bonding (ζ 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. (iii) Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids. (iv) Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interaction. Hydrogen bonding (theories of hydrogen bonding, valence bond treatment). Effects of weak chemical forces, melting and boiling points, solubility, energetics of dissolution process.	16
	Total	**16**

Suggested Books:

Sl. No.	**Name of Authors/Books/Publishers**	**Year of Publication/Reprint**
-1	Lee, J.D. Concise Inorganic Chemistry, Pearson Education	2010
2	Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K. Inorganic Chemistry, Principles of Structure and Reactivity, Pearson Education	2006
3	Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford	1970
4	Shriver, D.D. & P. Atkins, Inorganic Chemistry 2 nd Ed., Oxford University Press	1994
5	Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications	1962

Mode of Evaluation:	Internal Assessment / End Semester Exam