

UNIVERSITY OF NORTH BENGAL



Accredited by NAAC with grade A
Raja Rammohunpur, Dist: Darjeeling, Pin: 734013.

CHOICE BASED CREDIT SYSTEM

CORE COURSE (HONOURS IN CHEMISTRY)

Truncated Syllabus
(First Semester)

CHEMISTRY
SYLLABUS (CBCS)
(B.Sc. HONOURS)
FIRST SEMESTER -2020

SCHEME for B.Sc. (HONOURS) 1st SEMESTER -2020

YEAR	SEMESTER	CORE COURSE [CC]
1 st	1 st	CC-I : INORGANIC CHEMISTRY-I
		CC-II : PHYSICAL CHEMISTRY- I

SCHEME for B.Sc Students of Honours with other Disciplines (GENERIC ELECTIVE)

YEAR	SEMESTER	GENERIC ELECTIVE	
1 st	1st	GE-I PAPER-1	Section-A : Inorganic Chemistry Section-B : Organic chemistry

CORE COURSE (HONOURS IN CHEMISTRY)

UNIVERSITY OF NORTH BENGAL

SEMESTER I

CHEMISTRY-C I: INORGANIC CHEMISTRY-I

(Credits: Theory-04, Practicals-02)

Theory: 30 Lectures

UNIT I:

Atomic Structure:

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.

Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations. **(6 Lectures)**

UNIT II:

Periodicity of Elements:

s, p, d, f block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to *s* and *p*-block.

(a) Effective nuclear charge, shielding or screening effect, Slater rules.

(b) Atomic radii (van der Waals)

(c) Ionic radii

(d) Covalent radii (octahedral and tetrahedral)

(e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy.

(f) Electron gain enthalpy, trends of electron gain enthalpy.

(g) Electronegativity, Pauling's/Mulliken's and Allred Rachow's electronegativity scales.

Variation of electronegativity with bond order, partial charge and hybridization. **(8 Lectures)**

UNIT III:

Chemical Bonding:

(i) *Ionic bond*: General characteristics, Radius ratio rule. Packing of ions in crystals. Born-Landé equation with derivation. 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, Molecular orbital theory. Molecular orbital diagrams of diatomic molecules N₂, O₂, C₂, B₂, F₂, CO, NO, and their ions. Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons.

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) *Weak Chemical Forces*: Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points. **(14 Lectures)**

UNIT IV:

Oxidation-Reduction:

Principles involved in volumetric analysis to be carried out in class. **(2 Lectures)**

Reference Books:

- Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
 - Douglas, B.E. and McDaniel, D.H. *Concepts & Models of Inorganic Chemistry* Oxford, 1970
 - Atkins, P.W. & Paula, J. *Physical Chemistry*, 10th Ed., Oxford University Press, 2014.
 - Day, M.C. and Selbin, J. *Theoretical Inorganic Chemistry*, ACS Publications, 1962.
 - Rodger, G.E. *Inorganic and Solid State Chemistry*, Cengage Learning India Edition, 2002.
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CHEMISTRY LAB- C I LAB:

30 Lectures

[A theoretical background, with chemical reactions, of the following experiments is required]

(A) Titrimetric Analysis

- (i) Calibration and use of apparatus

(B) Acid-Base Titrations

- (i) Estimation of carbonate and hydroxide present together in mixture.

(C) Oxidation-Reduction Titrimetry

- (i) Estimation of Fe(II) and oxalic acid using standardized KMnO_4 solution.
- (ii) Estimation of Fe(II) with $\text{K}_2\text{Cr}_2\text{O}_7$ using an external indicator.

Reference text:

- Mendham, J., A. I. Vogel's *Quantitative Chemical Analysis 6th Ed.*, Pearson, 2009.
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CHEMISTRY-C II: PHYSICAL CHEMISTRY-I

(Credits: Theory-04, Practicals-02)

Theory: 30 Lectures

UNIT I:

Gaseous State:

Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity; variation of viscosity with temperature and pressure.

Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.

Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z , and its variation with pressure for different gases. Causes of deviation from ideal behaviour. Van der Waals equation of state, its derivation and application in explaining real gas behavior. Continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states. **(9 Lectures)**

UNIT II:

Liquid State:

Physical properties of liquids; surface tension and coefficient of viscosity, and their determination. Temperature variation of viscosity of liquids and comparison with that of gases. **(2 Lectures)**

UNIT III:

Solid State:

Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. **(9 Lectures)**

UNIT IV:

Ionic Equilibria:

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect;

Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action.

Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations.

(10 Lectures)

Reference Books:

- Atkins, P. W. & Paula, J. de *Atkin's Physical Chemistry* 10th Ed., Oxford University Press (2014).
 - Ball, D. W. *Physical Chemistry* Thomson Press, India (2007).
 - Castellan, G. W. *Physical Chemistry* 4th Ed. Narosa (2004).
 - Mortimer, R. G. *Physical Chemistry* 3rd Ed. Elsevier: NOIDA, UP (2009).
 - Engel, T. & Reid, P. *Physical Chemistry* 3rd Ed. Pearson (2013).
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CHEMISTRY LAB- C II LAB:

30 Lectures

[A theoretical background of the following experiments is required]

1. Surface tension measurements

Determine the surface tension by drop number method.

2. Viscosity measurement using Ostwald's viscometer

Determination of viscosity of aqueous solutions of polymer/ethanol/sugar at room temperature.

3. pH measurements

(a) Preparation of buffer solutions of different pH, of Sodium acetate-acetic acid

(b) pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base

Reference Books

- Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).
 - Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry* 8th Ed.; McGraw-Hill: New York (2003).
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GENERIC ELECTIVE

SEMESTER-I

Generic Elective Papers (GE)

Chemistry for other Departments/ Disciplines: (Credit: 06 each)

GE-1: PAPER-I ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS (Credits: Theory-04, Practicals-02)

Section A: Inorganic Chemistry-1

Atomic Structure:

Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.

What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it.

Significance of Quantum numbers.

(7 Lectures)

Chemical Bonding and Molecular Structure:

Ionic Bonding:

General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent Bonding:

VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. Concept of resonance and resonating structures in various inorganic and organic compounds.

MO Approach: MO treatment of Homonuclear molecules

(8 Lectures)

Section B: Organic Chemistry-1

Fundamentals of Organic Chemistry:

Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles.

Reactive Intermediates: Carbocations, Carbanions and free radicals.

(4 Lectures)

Stereochemistry:

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis - trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

(7 Lectures)

Aliphatic Hydrocarbons:

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkanes: (Upto 5 Carbons). Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent.

Alkenes: (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule). Addition of HX (Markownikoff's and anti-Markownikoff's addition).

(4 lectures)

Reference Books:

- Lee, J.D. Concise Inorganic Chemistry ELBS, 1991
 - Cotton, F.A., Wilkinson, G & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley.
 - Douglas, B.E., McDaniel, D.H & Alexander, J.J. Concepts and Models in Inorganic Chemistry, John Wiley & Sons.
 - Huheey, J.E., Keiter, E.A., Keiter, R.L & Medhi, O.K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006.
 - Graham Solomon, T.W., Fryhle, C.B & Snyder, S.A. Organic Chemistry, John Wiley & Sons (2014). McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
 - Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
 - Eliel, E.L. Stereochemistry of Carbon Compounds, Tata McGraw Hill education, 2000
 - Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.
 - Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
 - Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
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GE LAB: GE -I PAPER -I

ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

Section A: Inorganic Chemistry - Volumetric Analysis (ANY ONE)

1. Estimation of oxalic acid by titrating it with KMnO_4 .
2. Estimation of water of crystallization in Mohr's salt by titrating with KMnO_4 .

Section B: Organic Chemistry (ANY ONE)

1. Detection of extra elements (N, S, Cl, Br) in organic compounds (containing upto two extra elements)
2. Separation of mixtures by Chromatography: Measure the R_f value in each case (combination of two compounds to be given)

Reference Books:

- Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012
 - Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009
 - Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J & Smith, P.W.G.,
 - Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
 - Mann, F.G & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
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