

SHIVAJI UNIVERSITY, KOLHAPUR.



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CHOICE BASED CREDIT SYSTEM

Syllabus For

B.Sc. Part - I

Chemistry

SEMESTER I AND II

(Syllabus to be implemented from June, 2018 onwards.)

B. Sc. I Semester I**DSC-3A- Chemistry paper I (Inorganic Chemistry)
(Theory Credits: 02 : 30 Lectures)****Unit I: Atomic Structure and Periodicity of Elements (09)**

- 1.1 Bohr's theory of hydrogen atom and its limitations
- 1.2 Wave particle duality
- 1.3 Heisenberg uncertainty principle
- 1.4 Quantum numbers and their significance
- 1.5 Shapes of *s*, *p* and *d* atomic orbitals
- 1.6 Electrons filling rules in various orbitals: a) Aufbau's principle b) Hund's rule of maximum multiplicity c) Pauli's exclusion principle
- 1.7 Electronic configuration of elements. Stability of empty, half-filled and completely filled orbitals
- 1.8 Periodicity of the elements: General discussion of the following properties of the elements with reference to s block elements: a) electronic configuration b) atomic radii c) ionic radii d) ionization energy e) electron affinity f) electronegativity g) metallic characters h) reactivity i) oxidation state j) melting and boiling points k) chemical properties

Unit II: Chemical Bonding and Molecular structure (A) Ionic Bonding (07)

- 2:1 Definition and formation of ionic bond. General characteristics of ionic bonding
- 2:2 Energetic in Ionic bond formation
- 2:3 Born-Haber cycle for NaCl and its applications
- 2:4 Fajan's Rule, Applications of Fajan's rule for,
 - Polarizing power and polarizability
 - Ionic character in covalent compounds
 - Bond moment, dipole moment and percentage ionic character

Unit III: Chemical Bonding and Molecular structure (B) Valence bond theory (VBT). (07)

- 3.1 Concept of hybridization, different types of hybridization and geometry of following molecules,
 - Linear geometry- BeCl_2 (*sp* hybridization)

- Planer trigonal geometry- BF_3 (sp^2 hybridization)
- Tetrahedral geometry- SiCl_4 (sp^3 hybridization)
- Trigonal bipyramidal geometry- PCl_5 (sp^3d hybridization)
- Octahedral geometry- SF_6 (sp^3d^2 hybridization)
- Pentagonal bipyramidal geometry - IF_7 (sp^3d^3 hybridization)

Unit IV: Chemical Bonding and Molecular structure (C) Molecular orbital theory (MOT)

(07)

- 4.1 LCAO method, formation of bonding , anti bonding and nonbonding molecular orbitals.
- 4.2 Conditions for successful overlap, Types of overlaps - S-S ,S-px, Px-Px, Py-Py and Pz-Pz overlaps.
- 4.3 Bond order and its significance.
- 4.4 Energy level sequence for molecular orbital when $n=1$ & 2 .
- 4.5 MO diagrams for homonuclear diatomic molecule of 1st & 2nd period Elements (He_2 , Li_2 , B_2 , N_2 , O_2).
- 4.6 Molecular orbital diagrams for heteroatomic diatomic molecules. (CO, NO)

Reference Books:

- 1) Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
- 2) Cotton, F.A., Wilkinson, G. & Gaus, P.L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.
- 3) Douglas, B.E., McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry*, John Wiley & Sons.
- 4) Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. *Inorganic Chemistry*:
- 5) Principles of Structure and Reactivity, Pearson Education India, 2006.
- 6) Puri, Sharma, Kalia. *Principles of Inorganic Chemistry*
- 7) Madan R. L. Chemistry for Degree Students(B. Sc. First year), S. Chand Publications

B. Sc. I Semester I**DSC-4A- Chemistry paper II (Organic Chemistry)
(Credits: 02 : 30 Lectures)****Unit I: Fundamentals of Organic Chemistry (08)**

Introduction, Curved arrow notations, Cleavage of Bonds: Homolysis and Heterolysis. Organic molecular species: Nucleophiles and electrophiles. Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation effect, Reactive Intermediates: Generation, Structure, Stability and Reactions of Carbocations, Carbanions and carbon free radicals.

Unit II: Stereochemistry (09)**Hrs**

Introduction, Types of Stereoisomerism, Optical Isomerism: Concept of Chirality, Elements of Symmetry, Optical Isomerism in tartaric acid, 2, 3 Dihydroxybutanoic acid, Enantiomerism, Diastereomerism and Meso compounds, Geometrical isomerism in C=C, C=N and alicyclic compounds. Nomenclature of stereoisomers: D and L, erythro and threo, R and S, E and Z.

Unit III: Aromaticity (07)

Introduction, Characteristics properties of organic compounds, Meaning of terms: Aromatic, Non aromatic, Antiaromatic, Pseudoaromatic, Structure of Benzene: Kekule structure, Resonance structure, M.O. picture, Modern theory of Aromaticity, Mechanism of Electrophilic substitution reactions: Nitration, Sulphonation, Halogenation and Friedel craft reaction.

Unit IV: Cycloalkanes, cycloalkenes and alkadienes (06)

Cycloalkanes: - Introduction. Method of formation - a) By addition of carbene to alkene b) Action of metallic sodium on dihaloalkane c) Diels - Alder reaction d) By reduction of aromatic compounds, Chemical properties- a) Photohalogenation b) Catalytic halogenations c) Catalytic hydrogenation d) Effect of heat e) Reaction with hydrogen halide

Cycloalkenes : Introduction, Method of formation from cyclic compounds, Chemical Properties - a) Hydrogenation b) Addition of Halogens and halogen acids, c) Allylic halogenations

Alkadienes : Introduction, Classification, Buta-1,3-diene - a) Structure b) Methods of formation - from cyclohexane, From Butane by dehydrogenation, From acetylene, From Butane-1,3 - diol, From ethanol and acetaldehyde (Industrial method), Chemical Properties - a) Reaction with hydrogen halide b) Reaction with halogens -With one molar equivalent of halogens (Cl_2 or Br_2) c) Diels- Alder reaction d) Reduction – hydrogenation e) Oxidation – Ozonolysis f) Polymerization

Reference Books:

- 1) Graham Solomon, T.W., Fryhle, C.B. & Snyder, S.A. *Organic Chemistry*, John Wiley & Sons (2014).
- 2) McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
- 3) Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, New Delhi (1988).
- 4) Eliel, E.L. *Stereochemistry of Carbon Compounds*, Tata McGraw Hill education, 2000.
- 5) Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
- 6) Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
- 7) Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010.
- 8) D.Nasipuri :Stereochemistry of Organic compounds
- 9) R. L. Madan, Chemistry for Degree Students (B. Sc. First Year), S. Chand.Publication

CHEMISTRY-DSC 3B: Chemistry Paper-III (Physical Chemistry)**(Credits :02 , Lectures-30)****Unit -I Chemical Energetics (06)****A) Thermodynamics**

Introduction, Basic concepts of thermodynamics, First law of thermodynamics Spontaneous and non-spontaneous process with examples, Statements of second law of thermodynamics, Carnot's cycle and its efficiency. Entropy, Physical Significance of entropy, Statement of Third Law of thermodynamics and calculation of absolute entropies of substances

B) Thermochemistry (04)

Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation.

Unit II . Chemical Equilibrium: (06)

Chemical Equilibrium: Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG° , Le Chatelier's principle. Relationships between K_p , K_c and K_x for reactions involving ideal gases.

Unit- III. Kinetic Theory of Gases (07)

Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Ideal and Non ideal gases, Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. Van der Waals equation of state for real gases. Explanation of real gas behaviour by Van der Waal's equation, Boyle temperature (derivation not required). Critical Phenomena: PV-isotherms of real gases (Andrew's isotherms), Continuity of state, Critical constants and their calculation from vander Waals equation. Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance. Temperature dependence

of these distributions. Most probable, average and root mean square velocities (no derivation).
Numerical Problems.

Unit- IV. Chemical Kinetics

(07)

Introduction, Rate of reaction, Definition and units of rate constant, Factors affecting rate of reaction. (Nature of reactant, Concentration, pressure, temperature and catalyst.) Order and Molecularity of reaction, Zero order reaction, First order reaction, Characteristics of first order reaction.examples, Pseudo-unimolecular reactions,examples. Second order reaction: Derivation of rate constant for equal and unequal concentration of the reactants. Characteristics of Second order reaction., Determination of order of reaction by i) integration method ii) graphical method iii) Half life method, Effect of temperature on rate of reaction, Arrhenius equation, Concept of energy of activation.

Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only). Numerical problems.

Reference Books:

1. Principles of Physical Chemistry Puri, Sharma and Pathania, Vishal Publishing House, 44th Edition
2. Advanced Physical Chemistry Gurdeep Raj GOEL Publishing House, 36th Edition
3. Essentials of Physical Chemistry, Bahl, Tuli and Bahl
4. Text Book of Physical Chemistry, Soni and Dharmarha
5. Essentials of Nuclear Chemistry by H J Arnikar, New Age, 4th edition.
6. Mathematical preparation of Physical Chemistry : F. Daniel, Mc-Graw Hill Book Company Ltd.
7. Elements of Physical Chemistry : S. Glasstone and D.Lewis
(D.Van Nostrand Co.Inc)
8. Physical Chemistry : W. J. Moore (Orient Longman)
9. Principles of Physical Chemistry : Maron Prutton
10. University Chemistry : B. H. Mahan (Addision - Weseley Publ. Co.)
11. Chemistry for Degree students(B. Sc. First Year): R L Madan (S. Chand and Company)

B.Sc. I Semester II
DSC-4B-Chemistry Paper IV (Analytical Chemistry)
(Theory Credits:02, Lectures-30)

- 1. Introduction to analytical Chemistry (06)**
 - 1.1 Introduction
 - 1.2 Importance of analysis
 - 1.3 Analytical processes (Qualitative and Quantitative)
 - 1.4 Methods of analysis (Only classification)
 - 1.5 Sampling of solids, liquids and gases
 - 1.6 Errors, types of errors (determinate and indeterminate), methods of expressing accuracy (Absolute and relative error)
 - 1.7 Significant figures, mean, median, standard deviation (Numerical problems expected)

- 2. Chromatography (06)**
 - 2.1 Introduction, Basic Principle of Chromatography, Basic terms, Classification of Chromatography
 - 2.2 Paper Chromatography- Principle, Methodology-types of papers and treatment, sample loading, choice of solvent, development-ascending, descending, circular, location of spots, determination of R_f value, Applications, advantages and disadvantages
 - 2.3 Thin layer chromatography; Principle, Solvent system, stationary phases, preparation of TLC plate, Detecting reagents, methodology-sample loading, development, detection of spot, R_f value, Applications, advantages and disadvantages
 - 2.4 Comparison of paper chromatography and TLC

- 3. Theory of titrimetric Analysis (06)**
 - 3.1 Introduction
 - 3.2 Acid-base indicators
 - 3.3 Theory of indicators w.r.t. Ostwald's ionization theory and quinoid theory
 - 3.4 Neutralization curves and choice of indicators for
 - a. Strong acid-strong base
 - b. Strong acid-weak base
 - c. Strong base-weak acid
 - 3.5 Complexometric titrations
 - a. Introduction
 - b. Types EDTA titrations
 - c. Metallochromic indicators-Eriochrome black- T
 - d. Indicator Action of Eriochrome black- T

- 4. Water Analysis** (06)
- 4.1 Physical analysis of water – pH, Conductance, Colour, odour, Turbidity and taste
 - 4.2 Chemical Analysis – Total Dissolved solids , Hardness, Salinity, Alkalinity, Acidity, Sulphates, Nitrates, Dissolved Oxygen, Chemical Oxygen Demand, Biological Oxygen Demand
- 5. Analysis of Fertilizers** (06)
- 5.1 Introduction
 - 5.2 Types of fertilizers
 - 5.3 Necessity and requirements of good fertilizers
 - 5.4 Sampling and sample preparation
 - 5.5 Analysis of Nitrogen by Kjeldahl's method
 - 5.6 Analysis of Phosphorus by phosphomolybdate method
 - 5.7 Analysis of Potassium by sodium tetraphenyl borate method

References:

1. Textbook of quantitative Inorganic analysis-A.I. Vogel
2. Instrumental methods of Chemical analysis-H. Kaur
3. Instrumental methods of Chemical analysis-B.K. Sharma
4. Instrumental methods of Chemical analysis-Chatwal Anand
5. Fundamental of analytical Chemistry-Skoog and West
6. Basic Concepts of analytical Chemistry-S.M. Khopkar
7. Analytical Chemistry-Alka Gupta (Pragati Prakashan)
8. Indian Pharmacopoeia
9. Chromatography-H. Kaur
10. Chemistry for Degree students(B.Sc. First Year): R. L. Madan (S. Chand and Company)

**B.Sc. I Semester I and II
Practical Course**

(Credits 02: Lectures-04per week)

A) Inorganic Chemistry (Any Six)

1. To prepare standard 0.1 N KMnO_4 solution and to determine the strength of given oxalic acid solution.
2. To determine quantity of Fe(II) ions from the given solutions by titrating it with 0.1 N $\text{K}_2\text{Cr}_2\text{O}_7$ solution by using internal indicator
3. To estimate amount of Cu(II) ions by iodometric titration by using $\text{Na}_2\text{S}_2\text{O}_3$ solution.
4. To standardize supplied EDTA solution by titrating with 0.01 M ZnSO_4 solution and to estimate amount of calcium from given solution by using Erio-T as an indicator.
5. Quality control-To determines percentage purity of the given sample of soda ash Na_2CO_3 by titrimetric method.
6. Estimation of amount of Acetic acid from the given vinegar sample by titrimetric method
7. Chromatography : Separation and identification of cations by Paper Chromatographic technique from the following mixtures :
 - a) $\text{Ni}^{2+} + \text{Cu}^{2+}$
 - b) $\text{Ni}^{2+} + \text{Co}^{2+}$

B) Organic Chemistry

1. **Estimations** (any two) :
 1. Estimation of aniline. (by bromination method)
 2. Estimation of acetamide.
 3. Estimation of Aspirin.
2. Organic Qualitative Analysis: Detection of physical constant, type, functional group, elements, and Confirmatory test.

Identification of Organic Compounds (at least eight) (four containing at least one extra element- N, S, Cl, Br, I)

 - a) Acids: Oxalic acid, Benzoic acid, cinnamic acid
 - b) Phenols: Beta-Naphthol, Resorcinol
 - c) Base: Aniline, p-Nitroaniline

d) Neutral: Acetone, Acetanilide, Chloroform, m-Dinitrobenzene, Thiourea, Bromobenzene

3. Purification of organic compounds by crystallization (from water and alcohol) and distillation.

References:

- 1) Vogel's Text Book of Quantitative Chemical Analysis. (Longmann) ELBS Edition.
- 2) Vogel's Text Book of Qualitative Chemical Analysis. (Longmann) ELBS Edition.
- 3) Hand book of Organic Qualitative Analysis : Clarke.
- 4) Comprehensive Practical Organic Chemistry – Qualitative Analysis by V. K. Ahluwalia, Sunita Dhingra. University Press. Distributor – Orient Longman Ltd.
- 5) Comprehensive Practical Organic Chemistry preparation and Quantitative Analysis : V. K. Ahluwalia, Renu Aggarwal. University Press. Distributor – Orient Longman Ltd.
- 6) A Laboratory Hand - Book of Organic Qualitative Analysis and Separation : V. S. Kulkarni. Dastane Ramchandra & Co. Pune

C) Physical Chemistry

Physical Chemistry (Any Six)

1. Determination of equivalent weight of Mg by Eudiometer.
2. Study of specific reaction rate of hydrolysis of methyl acetate in presence of HCl.
3. Determination of heat of ionization of weak acid by using polythene bottle.
4. Determination of heat capacity of calorimeter for different volumes.
5. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
6. Determination of integral enthalpy of solution of salts (KNO_3 , NH_4Cl).
7. Determination of enthalpy of hydration of copper sulphate.
8. Study of the solubility of benzoic acid in water and determination of ΔH .

References:

- 1) Practical book of Physical Chemistry: Nadkarni, Kothari & Lawande.

- 2) Experimental Physical Chemistry: A. Findlay.
- 3) Systematic Experimental Physical Chemistry: S. W. Rajbhoj, Chondhekar.
(Anjali Publication.)
- 4) Experiments in Physical Chemistry: R. C. Das and B. Behra. (Tata Mc Graw Hill)
- 5) Advanced Practical Physical Chemistry: J. B. Yadav (Goel Publishing House.)
- 6) Practical Physical Chemistry: B. D. Khosala. (R. Chand & Sons)
- 7) Experiments in Chemistry: D. V. Jahagirdar.
- 8) A Text Book of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis: A.I. Vogel (Third Ed.) (ELBS)