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Hindi Vidya Prachar Samiti's

R. J. College of Arts, Science & Commerce

(RAMNIRANJAN JHUNJHUNWALA COLLEGE)

Ghatkopar (West), Mumbai 400086, Maharashtra, INDIA.

Website: rjcollege@rjcollege.edu.in ***Email : rjcollege@rjcollege.edu.in***

Affiliated to UNIVERSITY OF MUMBAI

AUTONOMOUS COLLEGE

Revised Syllabus of

FYBSc - Chemistry

SEM I & II

(Choice Based Credit System with effect from the Academic year 2018-19)

Hindi Vidya Prachar Samiti's
Ramniranjan Jhunjhunwala College (Autonomous)
Department of Chemistry

Proposed draft syllabus for
B.Sc. (Chemistry)
Semester – I
Paper – I
Course code: RJSCHE101
Total No. of Lectures (45 L)

Unit I (Physical Chemistry)

Learning Objectives:

1. To learn the terminologies involved in chemical thermodynamics.
2. To study the first law and zeroth law of thermodynamics.
3. To learn the various ways of expressing the concentration of solutions.
4. To learn how to plot graphs.

1.1 Chemical Thermodynamics - I: (7 L)

Thermodynamic terms: System, surroundings, boundaries, open, closed and isolated system, intensive and extensive properties, state functions and path functions, zeroth law of thermodynamics

First law of thermodynamics: concept of heat (q), work (w), internal energy (U),statement of first law, enthalpy, relation between heat capacities, sign conventions, calculations of heat (q), work (w), internal energy (U), and enthalpy (H) (Numericals expected)

1.2 Chemical Calculations: (5 L)

Expressing concentration of solutions: Normality, molality, molarity, formality, mole fractions, weight ratio, volume ratio, ppm, ppb, millimoles, milliequivalents (Numericals expected), Stoichiometry.

1.3 Graphical Representation of Experimnetal Data: (3 L)

Rules for drawing graph, Co-ordinates, equation of straight line, slope and intercept, plotting the graph from the data of chemical properties and problems.

Unit II (Inorganic Chemistry)

Learning Objectives:

1. To study the model, theory and principles associated with atomic structure.
2. To learn quantum numbers & atomic spectra of hydrogen.
3. To study the classification of elements according to long form of periodic table.
4. To learn the periodicity of properties of elements.

2.1 Atomic Structure **(7 L)**

Rutherford's Atomic model & its drawbacks, Bohr's theory and its limitations, Dual nature of electron, Heisenburg's principle of uncertainity, Quantum numbers, Filling of orbitals in atoms (Aufbau principle, Pauli's exclusion principle and Hund's rule), Atomic spectrum of hydrogen.

2.2 Periodic table & periodicity of properties **(8 L)**

Long form of Periodic Table;
Classification of elements
(a) main group, transition and inner transition elements.
(b) electronic configuration of s, p, d & f block.

Periodicity in the following properties:
Atomic and ionic size: electron gain enthalpy; ionization enthalpy, effective nuclear charge (Slater's rule): electronegativity; Pauling, Mulliken and Alfred Rochow electronegativities (Numerical problems expected, wherever applicable)

Unit-III (Organic Chemistry)

Learning Objectives:

1. To apply IUPAC rule in naming aliphatic compounds.
2. To understand the importance of electronic effects in organic reactions.
3. To learn basic concept of stereochemistry & their importance.

3.0 Basics of Organic Chemistry:

3.1 IUPAC nomenclature of organic compounds: **(5 L)**

Nomenclature of mono and bi-functional aliphatic compounds (up to six carbon atoms) on the basis of priority order of the following classes of compounds:
Alkanes, Alkenes, Alkynes, Haloalkanes, Alcohols, Ethers, Aldehydes, Ketones, Carboxylic acids, Acid Derivatives (Acid halides, Esters, Anhydrides, Amides), Nitro compounds, Nitriles and Amines.

3.2 Fundamentals of organic reactions. **(5 L)**

3.2.1 Electronic effects: Inductive effect, Electromeric effect, Resonance and Hyper conjugation effects with examples.

3.2.2 Organic acids and bases:
Comparison of relative strengths of aliphatic carboxylic acids and amines on the basis of inductive and resonance effects.

3.2.3 Electrophiles and Nucleophiles.

3.3 Stereochemistry I. **(5 L)**

3.3.1 Basic Concepts: Configurational isomerism, stereogenic centre, molecular chirality.

3.3.2 Fischer and Wedge dot projection formulae.

3.3.3 2^n rule in optical isomerism (up to two stereogenic centers), molecules with similar and dissimilar chiral center.

3.3.4 Enantiomers, diastereomers, meso compounds and racemic mixtures

Semester – I

Paper – II

Course code: RJSCHE102

Total No. of Lectures (45 L)

Unit I (Physical Chemistry)

Learning Objectives:

1. To learn the basics of chemical kinetics.
2. To study the integrated rate expression for first and second order reactions.
3. To know how to determine the order of a reaction.
4. To study the characteristic properties of liquids as well as the methods used to determine the surface tension and viscosity of liquids.

1.1 Chemical Kinetics: (8 L)

Rate of reaction, rate constant, measurement of reaction rates, order and molecularity of reaction, integrated rate equation (specific reaction rate) of first and second order reactions (with equal initial concentration of reactants) (Numericals expected)

Determination of order of reaction by (a) Integration method (b) Graphical method (c) Ostwald's isolation method (d) Half time method (Numericals expected)

1.2 Liquid State: (7 L)

Characteristic properties of liquid state.

Surface tension: Introduction, methods of determination of surface tension by drop number method (Numericals expected)

Viscosity: Introduction, coefficient of viscosity, relative viscosity, specific viscosity, reduced viscosity, determination of viscosity by Ostwald viscometer (Numericals expected).

Parachor (Numericals expected), Liquid crystals and its application.

Unit II (Inorganic Chemistry)

Learning Objectives:

1. To study the comparative chemistry of main group elements with respect to electronegativity, metallic and non-metallic characters.
2. To study the comparative chemistry of carbides, nitrides, oxides and hydrides of alkali and alkaline earth metals.
3. To learn about oxidation states, allotropes and catenation ability of main group elements.
4. To study in detail about some compounds of sodium and calcium.
5. To understand the effects of oxides of C, N and S on the environment.

2.0 Comparative chemistry of Main group elements: (10 L)

2.1 a) Metallic and non-metallic character, oxidation states, electronegativity, anomalous behavior, allotropy, catenation, diagonal relationship.

b) Comparative chemistry of carbides, nitrides, oxides and hydrides of Group 1 & Group 2 elements.

c) Study of compounds: Na_2CO_3, $NaHCO_3$, NaOH, CaO, $CaCO_3$.

2.2 Oxides of C,N,S w.r.t. environmental aspects which includes sources, health hazards and control techniques, green house effect, photochemical smog, acid rain and ozone layer depletion. **(5 L)**

Unit III (Organic chemistry)

Learning Objectives:

1. Help students to understand the reactivity of different functional groups in reaction mechanisms depending on the hybridization.
2. Types of bond fission, importance of transition state and intermediates in determining the course of reaction.
3. General mechanism & of the stereochemical aspects, factors affecting formation of specific products pertaining to Substitution, Elimination reaction.

3.0 Basics of Organic Chemistry:

3.1 Understanding bonding in organic compounds: **(4 L)**

a) Formation of sigma/ π bonds in aliphatic compounds containing C-C, C=C, C≡C,>C=O, R_3(C-N), -C≡N with representative examples.

b) Hydrogen bonding and its application.

3.2 Reactive Intermediates **(6 L)**

Homolytic and heterolytic bond fission, transition state and intermediates formation, structure and stability of carbocations, carbanions, carbon radicals and carbenes.

3.3 General mechanism of the following types of reaction. **(5 L)**

3.3.1 Substitution reaction: SN^1 and SN^2 mechanisms, factors affecting these reactions, Energy profile diagrams.

3.3.2 Elimination reaction: E_1,E_2,E_1 CB mechanism, Saytzeff and Hoffmann elimination.

Chemistry Practicals

Course code: RJSCHEPR1

Learning Objectives:

1. Students will understand the structure, properties & reactions of organic compounds, this will also help to understand the functional group inter-conversions.
2. To understand the quantitative methods along with the principle behind.
3. To understand how to determine the rate constant of a first order reaction.

Paper-I

1) Characterization of organic compounds containing C,H,O,N,S,X (minimum six compounds)

Paper-II

1) **Gravimetric Analysis:**

1.1 To determine the percent purity of sample of $BaSO_4$ containing NH_4Cl gravimetrically.
1.2 To determine the percent purity of ZnO containing $ZnCO_3$ gravimetrically.

2) To determine the rate constant for the hydrolysis of ester using HCl as catalyst.

Semester – II

Paper – I

Course code: RJSCHE201

Total No. of lectures: (45 L)

Unit I (Physical Chemistry)

Learning Objectives:

1. To learn about ideal gases, ideal gas laws and deviations from the same.
2. To study about real gases, van der Waals equation of state and Joule-Thomson effect.
3. To learn about the equilibrium constants, Le Chatelier's principle and entropy.

1.1 Gaseous State: (8 L)

Ideal gas laws, kinetic theory of gases, Maxwell-Boltzmann's distribution of velocities (qualitative discussion), ideal gases, real gases, compressibility factor, Boyle's temperature (Numericals expected).

Deviation from ideal gas laws, reasons for deviation from ideal gas laws, Van der Waals equation of state, Joule-Thomson effect: qualitative discussion and experimentation, inversion temperature.

1.2 Chemical Equilibria and Thermodynamic Parameters: (7 L)

Reversible and irreversible reactions, law of mass action, dynamic equilibria, equilibrium constants, (Kc and Kp), relationship between Kc and Kp, Le Chatelier's principle, factors affecting chemical equilibrium (Numericals expected)

Statements of second law of thermodynamics, concepts of entropy, thermodynamic derivation of equilibrium constant (Numericals expected).

Unit II (Inorganic Chemistry)

Learning Objectives:

1. To learn about types of qualitative analysis.
2. To know the use of reagent papers in the qualitative analysis.
3. To understand how the ions get precipitated from the solution and the factors affecting the precipitation process.
4. To study about acid-base theories and their applications.

2.1 Concept of Qualitative Analysis: (8 L)

i. Types of qualitative analysis – Macro, semi micro, micro and ultra micro technique.

ii. Testing of gaseous Evolutes, Role of papers impregnated with reagents in qualitative analysis (with reference to starch iodide, potassium dichromate, lead acetate, dimethylglyoxime and oxine reagents).

iii. Precipitation equilibria, solubility product, ionic product, effect of common ions, uncommon ions, oxidation states, buffer action, complexing agents on precipitation of ionic compounds.(Balanced chemical equations and numerical problems expected)

2.2 Acid –Base Theories: **(7 L)**

Arrhenius, Lowry-Bronsted, Lewis, Solvent-Solute concept of acids and bases. Hard and Soft acids and bases. Application of HSAB applications of acid base chemistry in:

i. Understanding organic reactions like Friedel Crafts (acylation/alkylation) reaction.
ii. Volumetric analysis with special reference to calculation of titration curve involving strong acid and strong base.

Unit III (Organic Chemistry)

Learning Objectives:

1. To learn methods of preparation of alkanes, alkenes & alkynes & to discuss addition reaction of
2. Introduction of pericyclic reaction.
3. To learn the concept of Aromaticity & Electrophilic substitution reaction of aromatic compound.

3.1 Chemistry of Alkanes, alkenes and alkynes (up to 6 carbons) **(8 L)**

3.1.1 Alkanes : Preparation of alkanes, Wurtz reaction, reaction – halogenation (mechanism) relative reactivity and selectivity.

3.1.2 Alkenes : Preparation : Cracking of alkanes, Dehydrologeration of alkyl halides.
Reactions : Markownikoff and anti-Markownikoff addition (mechanism).
Epoxidation (using per acid) and hydrolysis to glycols,
Ozonolysis of alkenes.

3.1.3 Alkynes : Preparation : From vicinal dihalides.
Reaction: Reduction to form cis / trans alkenes, Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

3.1.4 Alkadienes : Types of alkadienes, Diels Alder reaction.

3.2 Aromaticity: **(7 L)**

3.2.1 Characteristics of aromatic compounds, Huckel's rule, Aromatic character of arenes, Cyclic carbocations, carbanions with suitable examples. Anti aromaticity.

3.2.2 Arene electrophilic substitution: Mechanism of nitration, sulphonation, halogenation, Friedel Crafts alkylation & acylation in benzene.

Semester – II

Paper – II

Course code: RJSCHE202

Total no. of lectures: (45 L)

Unit I (Physical Chemistry)

Learning Objectives:

1. To learn the basics of ionic equilibria.
2. To learn about pH, buffers, buffer capacity and Henderson equation.
3. To learn the terminologies involved in molecular spectroscopy.
4. To learn the terminologies involved in solid state chemistry.

1.1 Ionic Equilibria: (7 L)

Strong 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 & pOH, common ion effect, dissociation constants of mono- and di-basic acid
Numericals based on pH & pOH.
Buffers: Introduction, types of buffers, derivation of Henderson equation for acidic and basic buffers, buffer action, buffer capacity (Numericals expected)

1.2 Molecular Spectroscopy -I: (4 L)

Electromagnetic radiation, electromagnetic spectrum, Planck's equation, interaction of electromagnetic radiation with matter: Absorption, emission, scattering, flourescence, electronic, vibrational and rotational transitions (Numericals expected).
Definitions of wave length, frequency, wave number (Numericals expected).

1.3 Solid State Chemistry: (4 L)

Types of solids, crystal lattice, lattice points, unit cell, space lattice and lattice plane, laws of crystallography: Law of constancy of interfacial angle, law of symmetry and law of rational indices (Numericals expected).

Unit II (Inorganic Chemistry)

Learning Objectives:

1. To study about the bonding and characteristics of ionic and covalent compounds.
2. To learn how to predict the shape of molecules by applying VSEPR theory.
3. To study about isoelectronic principle, Lewis dot structure and limitations of VSEPR theory.
4. To learn how to balance redox reactions.
5. To study the applications of redox chemistry with respect to extraction of elements and reagents used in volumetric analysis.
6. To learn about reduction potential, Latimer diagram and titration curve for single electron redox system.

2.0 Chemical bonding and Reactivity: (9 L)

2.1 Types of Chemical Bonds, Comparison between Ionic and covalent bonds, Polarizability (Fajans rule), Lewis dot structures, shapes of molecules, Sidgwick Powell theory,VSEPR theory for AB_n type

molecules with and without lone pair, isoelectronic principle & applications and limitations of VSEPR theory.

2.2 Oxidation-Reduction Chemistry: (6 L)

Reduction potential, Redox half reactions, Balancing redox equations, Latimer diagram and its applications, Applications of redox Chemistry:

a) Extraction of elements (Isolation of Cu by auto reduction) b) Redox reagents in volumetric analysis (I_2 & $KMnO_4$) c) Titration curves for single electron system e.g. Ce (IV) against Fe(II).

Unit III (Organic chemistry)

Learning Objectives:

1. Representation of 3-dimension structure on papers.
2. Idea of cis trans isomerisum in cycloalkanes & energy of various conformations of simple molecules.
3. Illustrative examples involving functional group interconversions.

3.1 Stereochemistry II (7 L)

3.1.1 D/L and Erythro- Threo system.

3.1.2 Fischer, Newmann and Sawhorse Projection formulae of Erythro- Threo isomers of tartaric acid and 2,3 –dichlorobutane & their interconversion.

3.1.3 Geometrical isomerism in alkenes and cycloalkanes (cis- trans nomenclature only)

3.1.4 Conformation of ethane & propane, Relative stability with energy diagram.

3.2 Functional group interconversion (8 L)

Functional group interconversion of aliphatic compounds for classes - alkyl halide, alcohols, aldehydes & ketones, acids, esters, amides and amines.

Their interconversion involving one or two steps. (up to 6 carbons) Illustrative examples expected for all types (mechanism not expected).

Chemistry Practicals
Course code: RJSCHEPR2

Learning Objectives:

1. Students will understand how different group cations can be separated as their insoluble salts at different pH using specific reagents.
2. Students will know the choice of solvent and technique for purification.
3. Technique to know the strength of common industrial reagents.

Paper-I

1) Qualitative analysis: (Minimum 4 mixtures to be analyzed)
Semi-micro qualitative analysis of water soluble mixtures containing two cations and two anions.
Cations: Ba^{2+}, Cu^{2+}, Fe^{2+}, Ni^{2+}, K^{+},NH^{4+}
Anions: CO_3^{2-}, NO_3^{-}, Cl^{-}, SO_4^{2-},
(Scheme of analysis should avoid use of sulphide ion in any form for precipitation / separation of cations.)

Paper-II

1) Purification of solid organic compounds by recrystallization using water as solvent.
(Any two compounds like benzoic acid and salicylic acid can be used)
2) Commercial analysis of mineral acid.
3) To standardize commercial sample of HCl using borax.

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