

B.Sc. Semester – III
BCH3T05: Physical Chemistry-2
(Thermodynamics, phase equilibria, electrochemistry and kinetics)
Theory 2 credits + Practical 1 credit

Course Outcomes

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

1. *Recollect the meanings of various thermodynamic terminology*
2. *Evaluate the thermodynamic quantities*
3. *Deduce and interpret the phase diagrams of binary and ternary systems*
4. *Analyze and elaborate the conductance properties of electrolytes*
5. *Evaluate the emf values and interpret the results in redox equilibria*
6. *Understand the mechanisms and kinetics of chemical reactions.*

Unit-I: 7.5h

Thermodynamics

A) Second law of thermodynamics: Need for second law of thermodynamics, statements of second law of thermodynamics, Carnot's cycle and its efficiency, thermodynamic scale of temperature, concept of entropy, entropy as a state function of V & T, P & T, entropy change in phase change for ideal gas, entropy as criteria of spontaneity & equilibrium.

B) Free energy functions and Systems of variable composition: Helmholtz free energy (A) & Gibb's free energy (G) and their properties, standard free energies, effect of temperature on free energy (Gibb's – Helmholtz equation) & its applications, A & G as criteria for thermodynamic equilibrium.

Partial molar quantities, chemical potential, Van't-Hoffs reaction isotherm, relation between standard free energy change & equilibrium constant (thermodynamic derivation of law of mass action), effect of temperature on equilibrium constant (reaction isochore).

Unit-II : 7.5h

Phase Equilibria

(A) Phase rule : Statement of phase rule, definition of phase, component and degree of freedom, Derivation of phase rule, Applications of phase rule to one component system i) water system, ii) Sulphur system, and two component system i) Pb-Ag system. ii) Bi-Cd system, Pattinson's process.

(B) Liquid-Liquid mixtures : Ideal liquid mixtures, Raoult's law of ideal solutions, Henry's law, non-ideal systems, azeotropes : HCl-H₂O & ethanol- water system. Partial miscible liquids : phenol-water system, trimethylamine- water, nicotine-water system, lower & upper con solute temperature, effect of impurity., Nernst distribution law, limitations, deviations & applications.

Unit-III : 7.5h

Electrochemistry

(A) Electrical transport : Conductance in metals (electronic) & in electrolyte solutions (ionic conductance), conductivity of electrodes, specific, equivalent & molar conductance, measurement of equivalent conductance, variation of equivalent & specific conductance with dilution, mobility of ions & Kohlrausch's law, Arrhenius theory of electrolyte dissociation & its limitation, Debye-Huckel theory (elementary treatment)

(B) Migration of ions, velocity of ions & change in concentration around electrode, transport number: definition & determination by Hittorf's method & moving boundary method, factors affecting transport



number of ions, relation between transport number & ionic conductance. Application of Kohlrausch's law & conductance for the determination of degree of dissociation, dissociation constant of acids, solubility of sparingly soluble salt, conductometric titrations (Acid-Base & precipitation) .

Unit-IV: 7.5h

Chemical Kinetics

(A) Concept of reaction rate, factors affecting the rate of a reaction – concentration., temperature, pressure, solvent, light, catalyst. Mathematical expression for rate constant of first and second order reactions, their characteristics. Pseudo order reactions. Half life and mean life of reactions with examples. Methods of determination of order of reaction –integration differential method, method of half life period and isolation method Experimental methods based on conductometry, polarimetry etc. Effect of temperature on rate of reaction. Arrhenius equation, activation energy.

(B) Collision theory of bimolecular reactions (hard sphere model). Transition state theory, expression for rate constant based on equilibrium constant and thermodynamic aspects. Lindmann's theory of unimolecular reactions

Reference books

1. Puri, Sharma, Pathania, Physical Chemistry, Vishal Publishing Co..
2. Castellan, G. W. (2004), Physical Chemistry, 4th Edition, Narosa.
3. Kapoor, K.L.(2015), A Textbook of Physical Chemistry, Vol 2, 6th Edition, McGraw Hill Education.
4. Kapoor, K.L.(2013), A Textbook of Physical Chemistry, Vol 3, 3rd Edition, McGraw Hill Education.
5. Kapoor, K.L. (2019),A Textbook of Physical Chemistry, Vol.7, 1st Edition, McGraw Hill Education.

BCH3P05: Physical Chemistry Practical (1 credits)

Practical I (Physical Chemistry)

1. To determine the heat of solution of calcium chloride and to determine lattice energy of calcium chloride using Born-Haber Cycle.
2. To determine heat of dilution of H_2SO_4 .
3. To construct the phase diagram of three component system (Acetic acid- Chloroform- water)
4. To determine critical solution temperature of partially miscible liquids (phenol-water systems).
5. 4 To study the distribution of Iodine between Water and Carbon tetrachloride/Kerosene
6. To determine the strength of HCl conductometrically using standard alkali solution.
7. To determine the strength of CH_3COOH conductometrically using standard alkali solution.
8. To determine the strength of HCl and CH_3COOH in a mixture conductometrically.
9. To determine the specific reaction rate of the hydrolysis of methyl acetate catalyzed by H^+ ions at room temperature.
10. To determine specific reaction rate of hydrolysis of ethyl acetate catalysed by bas (saponification)



B.Sc. Semester – III

BCH3T06: Inorganic Chemistry-2 (Bonding, transition elements and solutions)

Theory 2 credits + Practical 1 credit

Course Outcomes

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

1. Explain properties of diatomic molecules using MO theory
2. Deduce the structures of various inorganic molecules formed by noble gases
3. Explain the properties of f-block elements using electronic configuration concept
4. Explain various reactions in non-aqueous media
5. Discuss properties of compounds using HSAB principle
6. Elaborate the geometries of compounds formed by noble gases.

Unit – I: 7.5h

A) MO theory : LCAO approximation, wave equation for molecular orbitals. Difference between bonding and antibonding MO in terms of energy and electron density distribution curves, order of energy levels in MO. Molecular Orbital diagrams for homonuclear diatomic molecules of elements (with $Z = 1$ to 9) Concepts of nonbonding MO in HF molecule. Coulson's MO diagram of CO and NO diatomic molecule.

B) Noble gases: Chemical properties of the noble gases, Chemistry of Xenon and Krypton, Preparation, properties and structures of xenon fluorides (XeF_2 , XeF_4 and XeF_6), structure and bonding in XeOF_2 , XeOF_4 and XeO_2F_2 .

Unit - II: 7.5h

A) Chemistry of elements of first transition series: Characteristic properties of the elements of first transition series with reference to their: Electronic configuration, Atomic and ionic radii, Ionization potential, Variable oxidation states, Magnetic properties, Colour, Complex formation tendency and catalytic activity.

B) Chemistry of elements of second and third transition series: Electronic configuration of 4d and 5d transition series. Comparative treatment with their 3d-analogous (Group Cr-Mo-W, Co-Rh-Ir,) in respect of oxidation states and magnetic behaviour.

Unit - III: 7.5h

A) Chemistry of Lanthanides: Position in periodic table, electronic configuration, Oxidation states, Atomic and ionic radii, Lanthanide contraction and its consequences, Complex forming tendency. Occurrence and separation of lanthanides (ion exchange and solvent extraction).

B) Chemistry of Actinides: Position in periodic table, electronic configuration, Oxidation states, Atomic and ionic radii, actinide contraction.

Unit - IV: 7.5h

A) Non-aqueous solvents: Classification of solvents based on proton donor-acceptor properties and ionizing nature. Aqueous and non-aqueous solvents. Properties of liquid ammonia and liq. SO_2 as solvents, solubilities of various compounds in liquid ammonia and liquid SO_2 . Following reactions in liq. NH_3 and liq. SO_2 : (i) acid base (ii) redox (iii) precipitation (metathesis).

B) Hard and Soft Acids and Bases: Classification of Acids and Bases as Hard and Soft. Pearson's HSAB Concept and its applications. Acid-base strength versus hardness and softness. Theoretical basis for hardness. Symbiosis. Limitations of HSAB concept.



Reference books:

1. Lee, J.D. (2010), Concise Inorganic Chemistry, Wiley India.
2. Huheey, J.E.; Keiter, E.A.; Keiter, R. L.; Medhi, O.K. (2009), Inorganic Chemistry- Principles of Structure and Reactivity, Pearson Education.
3. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J.(1994), Concepts and Models of Inorganic Chemistry, John Wiley & Sons.
4. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), Shriver and Atkins Inorganic Chemistry, 5th Edition, Oxford University Press.
5. Wulfsberg, G (2002), Inorganic Chemistry, Viva Books Private Limited.
6. Miessler, G.L.; Fischer P.J.; Tarr, D. A. (2014), Inorganic Chemistry, 5th Edition, Pearson.
7. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), Vogel's Textbook of Quantitative Chemical Analysis, John Wiley and Sons.

BCH3P06: Inorganic Chemistry Practical-2 (1 credits)

- 1) Estimation of Fe(II) by dichromate using internal indicator.
- 2) Determination of acetic acid in commercial vinegar using NaOH
- 3) Determination of alkali content in antacid tablet using HCl
- 4) Determination of Zn by complexometric titration with EDTA
- 5) Determination of total Hardness of water (permanent and Temporary) by EDTA
- 6) Estimation of Fe(II) by KMnO_4 as a self-indicator.
- 7) Determination of molar concentration copper solution using iodometric titration.

Note: Preparation of standard solution by weighing is compulsory in each experiment.



B.Sc. Semester III
Generic Elective
BGO3T05: Chemistry in Everyday Life
Theory: 2 credits

Course Outcomes

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

1. *Explain chemicals involved in food products*
2. *Elaborate the structural basis of colour and constitution*
3. *Evaluate the properties of various organic molecules in biosystems*
4. *Understand the impact of toxicants on environment*
5. *Identify and remove toxicants from water and air bodies.*

UNIT-I: Chemistry of food products (7.5 h)

Dairy Products: Composition of milk and milk products. Analysis of fat content, minerals in milk and butter. Estimation of added water in milk.

Beverages: Analysis of caffeine in coffee and tea, detection of chicory in coffee, chloral hydrate in toddy, estimation of methyl alcohol in alcoholic beverages.

Food additives: Food preservatives like benzoates, propionates, sorbates, disulphites. Their action, significance and health effects.

UNIT-II: Chemistry of colours (7.5 h)

Dyes: Colour and constitution (electronic concept). Classification of dyes. Methods of applying dyes to the fabrics. A general study of azo dyes, Mordant brown, Congo red and methyl orange.

Paints & Pigments: White pigments (white lead, ZnO, lithopone, TiO₂). Blue, red, yellow and green pigments. Paints and distempers: Requirement of a good paint. Emulsion, latex; luminescent paints. Fire retardant paints and enamels, lacquers. Solvents and thinners for paints.

UNIT III: Chemistry of food ingredients (7.5h)

Carbohydrates: Structure, function and Chemistry of some important mono and disaccharides.

Proteins: Composition of proteins. Classification, denaturation and structure elucidation of protein.

Oils and fats: Composition of edible oils, detection of purity, rancidity of fats and oil. Tests for adulterants like aregemone oil and mineral oils.

Enzymes: Enzymes as catalysts, properties and mechanism of enzyme catalysis.

UNIT IV: Toxic chemicals around us (7.5 h)

Air toxicants: Causes and harmful effects of Greenhouse gases, CFCs, PAN. Heavy metals in particulate and aerosols.

Water toxicants: Soaps and detergents. Soaps and detergents in water bodies and their effects. Fertilizers and eutrophication. Pesticide pollution and remediation. Sewage water and industrial effluent treatment process.

Solid toxicants: Microplastics and their effects. Problems of plastic waste management. Strategies for the development of environment friendly polymers.



References

1. B. K. Sharma: introduction to Industiral Chemistry, Goel Publishing, Meerut (1998)
2. Medicinal Chemistry by Ashtoush Kar.
3. Drugs and Pharamaceutical Sciences Series, Marcel Dekker, Vol. II, INC, New York.
4. Analysis of Foods – H.E. Cox: 13. Chemical Analysis of Foods – H.E.Cox and pearson.
5. Foods: Facts and Principles. N. Shakuntala Many and S. Swamy, 4th ed. New Age International (1998)
6. Physical Chemistry – P I Atkins and J. de Paula – 7 th Ed. 2002, Oxford University Press.
7. Handbook on Ferilizer Technology by Swaminathan and Goswamy, 6th ed. 2001, FAI.
8. Organic Chemistry by I. L. Finar, Vol. 1 & 2.
9. Polymer Science and Technology, J. R. Fired (Prentice Hall).



B.Sc. Semester III
Vocational Skill Course (VSC)
BVS3P05: Soil sampling and analysis
Practical 2 credits

Course Outcomes

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

1. *Identify sampling locations for different types of soil samples.*
2. *Carry out sampling of soils from various locations.*
3. *Analyse spot parameters at sampling location.*
4. *Carry out complete analysis of soil using classical and instrumental methods.*
5. *Suggest remedial measures for soil quality improvement.*

List of Experiments

1. Sampling of soil from farms and roadsides.
2. Particle size distribution by sieving.
3. Determination of moisture content of soil.
4. Determination of bulk density of soil.
5. Determination of water holding capacity of soil.
6. Determination of alkalinity of water extract of soil.
7. Determination of soil pH.
8. Determination of exchangeable acidity of soil.
9. Determination of electrical conductivity of soil.
10. Determination of organic carbon in soil.
11. Determination of total nitrogen content of soil.
12. Determination of available phosphate in soil.
13. Determination of sodium and potassium in soil.

References:

1. Pansu, M., Gautheyrou, J (2006) Handbook of soil analysis, Springer.
2. Soil analysis manual (2014), Rokupr Agricultural Research Centre (RARC) and Japan International Cooperation Agency (JICA).
3. Patnaik, P. (2010) Handbook of Environmental analysis, CRC press.
4. Thakur, Baghel, Sharma, Amule, Chouhan (2014), Laboratory Manual Course Programme on Management of Soil Health: Challenges and Opportunities, Indian Council of Agricultural Research.
5. Hooda, S., Kaur, S. (1997) Laboratory Manual of Environmental Chemistry: S. Chand and Co. Ltd. New Delhi.



B.Sc. Semester – IV

BCH4T07: Inorganic Chemistry-3 (Coordination chemistry, Redox reactions and Inorganic polymers)

Theory 2 credits + Practical 1 credit

Course Outcomes

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

1. Understand various theories of coordination compounds
2. Discuss the structural aspects and isomerism in complexes
3. Explain the behaviour of various acids and bases using different theories
4. Draw various stability diagrams of redox systems under environmental conditions
5. Expertise in inorganic polymers structures and applications.

Unit-I (7.5 h)

Coordination compounds: Distinction among simple salts, double salts and coordination compounds. Terminology and nomenclature of Coordination compounds. Types of ligands on the basis of denticity. Werner's Coordination theory and its experimental verification. Sidgwick's electronic interpretation, EAN rule with examples. Valence Bond Theory of transition metal complexes. Determination of structures and magnetic properties of complexes on the basis of VBT. Chelates: Classification and their application.

Unit- II (7.5 h)

A) Isomerism in coordination compounds: Structural isomerism and Stereoisomerism (Geometrical and optical) in coordination compounds with four and six coordination numbers.

B) Acids and bases: Arrhenius theory and its limitations. Lowry-Bronsted concept, conjugate acid-base pair, relative strengths of acids and bases, mono and polyprotic acids and bases. Limitations of L-B concept. Solvent system concept and its limitations. Lux-Flood concept of metal oxides. Lewis theory, types of Lewis acids and bases, Strengths of Lewis acids and bases. Advantages and limitation of Lewis concept.

Unit- III (7.5 h)

Oxidation and reduction: Various definitions of oxidation and reduction, Single electrode potential, standard electrode potential, electrochemical series and its applications. Concept of overvoltage. Balancing of redox reaction by ion-electron method, Use of redox potential data: Analysis of Redox cycle, redox stability in water, Latimer diagram of Chlorine and Oxygen, Frost diagram of Nitrogen and Oxygen, and Pourbaix diagrams of Iron. Predicting disproportionation and comproportionation phenomena. Deriving Frost diagram from Latimer diagram.

Unit –IV (7.5 h)

A) Inorganic Polymers: Silicones: Introduction, Nomenclature, preparation, properties and uses, General introduction to Silicon oils, Silicone Elastomers and Silicon Resins

B) Phosphonitrilic halide polymers: Introduction, Preparation, properties and uses. Structure and bonding in $(\text{NPCl}_2)_3$ and $(\text{NPCl}_2)_4$

Reference books:

1. Wulfsberg, G (2002), Inorganic Chemistry, Viva Books Private Limited.
2. Miessler, G.L.; Fischer P.J.; Tarr, D. A. (2014), Inorganic Chemistry, 5th Edition, Pearson.



3. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), Vogel's Textbook of Quantitative Chemical Analysis, John Wiley and Sons.
4. Lee, J.D. (2010), Concise Inorganic Chemistry, Wiley India.
5. Huheey, J.E.; Keiter, E.A.; Keiter, R. L.; Medhi, O.K. (2009), Inorganic Chemistry- Principles of Structure and Reactivity, Pearson Education.
6. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J. (1994), Concepts and Models of Inorganic Chemistry, John Wiley & Sons.
7. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), Shriver and Atkins Inorganic Chemistry, 5th Edition, Oxford University Press.

BCH3P07: Inorganic Chemistry Practical (1 credits)

A) Preparation of following complexes and Comments on its VBT structure, magnetic properties and colors

- a) $[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]\text{SO}_4$ b) $[\text{Ni}(\text{NH}_3)_6]\text{SO}_4$ c) Trans $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]\text{Cl}$ d) $\text{K}_3[\text{Fe}(\text{C}_2\text{O}_4)_3] \cdot \text{H}_2\text{O}$
e) Ni-DMG f) $\text{Hg}[\text{Co}(\text{SCN})_4]$

B) Chromatographic separation of binary mixtures (at least Two) containing Cu(II), Co(II) and Ni(II) ions by paper chromatography and determination of R_f values.



B.Sc. Semester – IV

BCH3T08: Organic Chemistry-3 (Nitrogen compounds, Heterocyclics and organometallics)

Theory 2 credits + Practical 1 credit

Course Outcomes

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

1. Name various organic compounds containing nitrogen with their structures.
2. Explain structural features of heterocyclic compounds of N, S, and O.
3. Evaluate the percentage composition of organic compounds with their empirical formulae.
4. Explain the electromagnetic spectrum with their interaction with matter
5. Calculate the bond parameters using IR frequencies.

UNIT- I (7.5 h)

A) Organic compounds of Nitrogen: Preparation of nitroalkanes and nitrobenzene, chemical reactions of nitroalkanes. Mechanism of nucleophilic substitution in nitrobenzene and their reduction in acidic, neutral and alkaline media. Picric acid- preparation and uses,

B) Amines: Structure and nomenclature of amines, Physical properties, stereochemistry of amines, separation of mixture of 1°, 2° and 3° amines, structural features affecting basicity of amines, preparation of alkyl & aryl amines (reduction of nitro compounds and nitriles), reductive amination of aldehydic and ketonic compounds, Gabriel phthalimide reaction, Hofmann bromamide reaction, Reactions of amines, Preparation and synthetic transformations of aryl diazonium salts.

UNIT – II (7.5 h)

Heterocyclic Compounds: Molecular orbital picture and aromaticity of furan, thiophene, pyrrole and pyridine. Methods of synthesis of pyridine. Mechanism of electrophilic and nucleophilic substitution reaction of pyridine. Chemical reaction of pyridine. Structure of pyridine. Comparison of basicity of pyrrole and pyridine. Introduction to condensed five and six membered heterocycles. Preparation and reactions of Indole, Quinoline and Isoquinoline with special reference to Fischer Indole synthesis, Skraup synthesis and Bischler Napieralski synthesis.

UNIT-III (7.5 h)

A) Quantitative Analysis: Estimation of carbon, hydrogen, nitrogen, sulphur and halogens (only principles and calculations). Calculation of Empirical and molecular formula with Numericals

B) Organometallic compounds: Organomagnesium compound : Grignard reagent formation, chemical reactions and structure. Organozinc compounds : Formation and chemical reactions. Organolithium compounds: Formation and chemical reactions.

UNIT-IV (7.5 h)

A) Electromagnetic spectrum: Absorption spectra, Ultraviolet absorption spectroscopy, Absorption laws (Beer Lambert law), molar absorptivity, Presentation and analysis of UV spectra, Types of electronic transitions, Effect of conjugation, concept of chromophores and auxochromes, Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated dienes and enones.

B) Infrared (IR) spectroscopy: Molecular vibrations, Hook's law, Selection rules, Intensity and position of IR bands, measurement of IR spectrum. Fingerprint region, characteristic absorptions of various functional groups and application of IR spectra.

Reference books:

1. Mann, F. G.; Saunders, B. C. (2009), Practical Organic Chemistry, Pearson Education.



- Ahluwalia, V.K.; Dhingra, S. (2004), Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press.
- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012), Vogel's Textbook of Practical Organic Chemistry, Pearson.
- Leonard, J.; Lygo, B.; Procter, G. Advanced Practical Organic Chemistry, CRC Press.
- Morrison, R. N.; Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 1 & 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Chandra, R. ; Singh, S.; Singh, A. (2019), Basic Organic Chemistry, Arcler Press.
- Eliel, E. L.; Wilen, S. H. (1994), Stereochemistry of Organic Compounds; Wiley: London.
- Singh, S.P.; Prakash, O., (2017), Reaction Mechanism in organic chemistry, Laxmi

BCH3P08: Organic Chemistry Practical-3 (1 credit)

1. Estimation of Glucose
2. Estimation of Amide
3. Estimation of Nitro group
4. Estimation of Carboxylic group
5. Saponification of oil
6. Estimation of phenolic group
7. Estimation of keto group



B.Sc. Semester – IV
Generic Elective
BGO4T06: Molecules of Life
Theory: 2 credits

Course Outcomes: At the end of the course students would be able to

1. *Draw the structures of essential biomolecules*
2. *Understand the role of biomolecules in various life processes*
3. *Understand the structure and importance of proteins and nucleic acid.*
4. *Understand the general idea about the polymer and way of synthesis of synthetic drugs and dyes.*

Unit I: Oils and fats (7.5h)

Introduction, Structures of Fats and Oils, Physical properties of Fats and Oils. Hydrolysis, Hydrogenation, Saponification and Rancidity of oils, Drying oils. Analytical constants: Acid value, Saponification value, Iodine value, significance and principle involved in their determination.

Unit II: Sugars and detergents (7.5h)

Introduction, Classification, Properties and Biological importance. Natural and synthetic sugars, structures of glucose, reducing and non-reducing sugars, Introduction to structures of maltose, sucrose, lactose, starch, cellulose, ribose and deoxyribose without involving structure determination. Synthetic detergents, Alkyl and aryl sulfonate

Unit III: Amino acids, peptides, proteins (7.5h)

Classification, structure and stereochemistry of amino acids. Acids base behavior, isoelectric point and electrophoresis. Structure and nomenclature of peptides and protein. Classification of proteins. Protein denaturation. Structure determination of proteins (primary and secondary).

Unit IV (7.5h)

Polymers: Introduction, Definition, Types of polymer (Natural, synthetic and semi-synthetic polymers) types of polymerization processes, properties of polymers, Structure and applications of Polyethylene, Teflon, PVC, Polystyrene, etc.

Synthetic dyes: Classification of Dyes based on chemical constitution. Structure and uses of Congo red, Crystal violet, Phenolphthalein and Alizarin dye.

References

1. Polymer Science, V.R. Gowarikar, N.V. Vishwanathan, Jaydev Shridhar, New age International publisher.



2. Morrison, R. T.; Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Nelson, D. L.; Cox, M. M. Lehninger's Principles of Biochemistry 7th Ed., W. H. Freeman. Berg, J. M. Tymoczko, J.L. & Stryer, L. Biochemistry, W.H. Freeman, 2002.
6. A Textbook of organic chemistry, K. S. Tewari, N. K. Vishoi. Vikas Publishing House Pvt. Ltd.
7. Organic Chemistry, Robert Thomson Morrison, Robert Neilson Boyd. New York University.
8. A Textbook of Organic Chemistry, Arun Bahl, B. S. Bahl. S. Chand Publication.

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B.Sc. Semester – IV
Skill Enhancement Course (SEC)
BVS4P06: Phytochemistry
Practical 2 credits

Course Outcomes

At the end of the course student will be able to:

1. *To understand the medicinal properties in different medicinal plants.*
2. *To confirm medicinal values of plant by pharmacological activity.*
3. *To analyse various chemical molecules present in plant extract responsible for reduction and other activities.*
4. *To prepare plant extract by applying various techniques.*
5. *To isolate and identify the structures of the active ingredients.*
6. *To ascertain possible medicinal actions.*

List of Experiments

- A) Introduction to clavengers and Soxhlet apparatus.
- B) Preparation and separation-
 1. Preparation of plant extract by soxhlet using water solvent.
 2. Preparation of plant extract by soxhlet using alcohol solvent.
 3. Separation of colour pigments in flower by paper chromatography.
 4. Separation of colour pigments in leaves by paper chromatography.
- C) Identification of primary metabolites from plant extract (Root extract, Leaves extract, Flowers extract)-
 1. Identification of carbohydrate in plant extract (Fehling's test, Benedict's test, Molish's test)
 2. Identification of protein (Biuret test, Ninhydrin test)
 3. Identification test for amino acids (Ninhydrin test)
 4. Identification test for fixed oil and fats (saponification test)
- D) Identification of secondary metabolites from plant extract (Root extract, Leaves extract, Flowers extract)-
 1. Identification of glycosides in plant extract.
 2. Identification of flavonoids in plant extract (Lead acetate test)
 3. Identification of alkaloids in plant extract (Mayer's Reagent test)
 4. Identification of tannins in plant extract (Lead acetate test)
 5. Identification of terpenoids in plant extract.
 6. Identification of steroids in plant extract.
 7. Identification of phenols in plant extract.

References:

1. Harborne J B, Phytochemical Methods, Chapman And Hall, International Edition, London
2. Bruneton Jean, Pharmacognosy : Phytochemistry Medicinal Plants, Lavoisier Publishing.
3. Anasari, Pharmacognosy Textbook Of Natural Products, Latest Edition.
4. Ashutosh Kar, Pharmacognosy And Pharmacobiotechnology,
5. Rangari & Rangari, Text Book of Pharmacognosy Cultivation And Utilization of Medicinal Plants By C.K. Atal, R.R. L. Jammu.
6. Paridhavi, Herbal Drug Technology, Ayurvedic Pharmacopoeia Of India
7. Nadkarni and Satyavati, Indian Medicinal Plants



MINOR PAPERS

B.Sc. Semester – III

Minor 1: BCH1T01

Inorganic Chemistry-1 (Atomic structure, bonding and main group elements)

Theory 2 credits + Practical 1 credit

Course Outcomes

By the end of the course, the students will be able to:

1. 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 properties.
2. Draw the plausible structures and geometries of molecules using VSEPR theory.
3. Explain geometries and properties of molecules based on VBT.
4. Understand the concept of lattice energy using Born-Haber Cycle.
5. Rationalize the metallic properties based on various theories.
6. Elaborate structures and properties of common compounds formed by main group elements.
7. Identify acidic and basic radicals in simple inorganic salts.

Unit-I: 7.5 h

(A) Atomic structure: Bohr model, Idea of de-Broglie matter Waves, Heisenberg's uncertainty principle. Schrodinger wave equation, significance of ψ and ψ^2 , Quantum numbers, Concept of atomic orbital, Radial and angular wave functions and probability distribution curves for *1s*, *2s*, *2p*, *3s*, *3p* and *3d* orbitals, shapes of *s*, *p* and *d* orbitals, Aufbau principle, Bohr-Bury rule, Pauli's exclusion principle and Hund's rule of maximum multiplicity. Principle of extra stability. Electronic Configuration of elements and ions.

(B) Periodic Properties: Atomic and ionic radii, ionization energy, electron affinity and electronegativity- Definition, trends in periodic table. Factors affecting ionization potential. Pauling's, Mulliken's and Allred-Rochow scale of electronegativity. Effective nuclear charge and Slater's rule with some numericals.

Unit-II: 7.5 h

(A) Covalent Bond: Valency Bond Theory, Formation of Hydrogen molecule with potential energy diagram with all improvements, Limitations of VBT, Bond energy, bond length, Bond order, Bond angle. Various types of hybridization and shape of inorganic molecules [BeF_2 , BCl_3 , CH_4 , NH_3 , H_2O , PCl_5 , SF_6 and IF_7].

VSEPR Theory: Rules/postulates and their applications to various common molecules and ions (NH_3 , ClF_3 , H_2O , SF_4 , H_3O^+ , NH_4^+ , ICl_2^- etc)

(B) Ionic solids: Close packing in ionic solids [Square, Hexagonal, Cubic, BCC and FCC], Radius ratio rule and its limitations, Ionic structures with respect to NaCl and CsCl , Lattice energy and Born- Haber cycle. Solvation energy and solubility of ionic solids, polarizing power and polarizability of ions, Fajan's rules.

Unit -III: 7.5 h

(A) s- block elements: Electronic configuration, atomic and ionic radii, Ionisation potential, Reducing properties and Metallic Properties. Diagonal Relationships (Li-Mg).



Metallic Bond – Free electron, Valence Bond and Band theory of metallic bond. Properties of conductors, insulators and semiconductors based on Band theory.

Hydrogen bonding - Classification and effect of Hydrogen bonding on viscosity, solubility, melting point and boiling point.

(B) p-block elements: Introduction to p-block elements, comparative study of groups 15, 16 and 17 with respect to atomic and ionic radii, ionisation potential, electron affinity, electronegativity, redox properties, oxidation state. Diagonal relationship (B-Si).

Unit- IV:7.5 h

Hydrides: Comparative study with respect to structure of NH_3 , PH_3 , AsH_3 and SbH_3 . Structure and bonding of diborane, structure of borazine.

Allotropes of Carbon [Graphite, Diamond and Fullerene], **Carbides:** Classification and uses, **Silicates:** classification, **Nitrides of sulphur:** Structure of S_4N_4 , **Fluorocarbon** and its uses.

Oxides of Phosphorus: Structure and bonding in P_2O_3 and P_2O_5 .

Oxyacids of Phosphorous: Structures of H_3PO_2 , H_3PO_3 , H_3PO_4 , $\text{H}_4\text{P}_2\text{O}_6$ and $\text{H}_4\text{P}_2\text{O}_7$

Peroxyacids of Sulphur: Preparation and structure of Caro's and Marshall's acids.

Interhalogens and Polyhalides: Preparation, properties and structure of Interhalogen compounds. Polyhalides- Classification, Structure of I_3^- , I_5^- , ICl_4^- .

Inorganic Chemistry Practical (1 credit): BCH1P01

A) Introduction to Chemistry Laboratory:

1. Safety rules in laboratory
2. Introduction to nomenclature of glassware and instruments
3. Demonstration of handling pipette, burette, volumetric flask and other common glassware.
4. Pipettable and non-pipettable liquids (aqueous, organic, volatile, viscous, carcinogenic etc)
5. Common mistakes in chemistry laboratory

B) Semimicro Qualitative Analysis: Qualitative analysis of inorganic salt mixture containing two acidic radicals of different group and two basic radicals of same groups.

Note: At least eight mixtures should be analyzed.

Reference books

8. Lee, J.D. (2010), Concise Inorganic Chemistry, Wiley India.
9. Huheey, J.E.; Keiter, E.A.; Keiter, R. L.; Medhi, O.K. (2009), Inorganic Chemistry- Principles of Structure and Reactivity, Pearson Education.
10. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J.(1994), Concepts and Models of Inorganic Chemistry, John Wiley & Sons.
11. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), Shriver and Atkins Inorganic Chemistry, 5th Edition, Oxford University Press.
12. Wulfsberg, G (2002), Inorganic Chemistry, Viva Books Private Limited.
13. Miessler, G.L.; Fischer P.J.; Tarr, D. A. (2014), Inorganic Chemistry, 5th Edition, Pearson.
14. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), Vogel's Textbook of Quantitative Chemical Analysis, John Wiley and Sons.
15. Svehla, G. (1996), Vogel's Qualitative Inorganic Analysis, Prentice Hall.



B.Sc. Semester – III
Minor 2: BCH1T02
Organic Chemistry-1 (Fundamentals, stereochemistry and hydrocarbons)
Theory 2 credits + Practical 1 credit

Course Outcomes

On completion of the course, the student will be able to:

1. Understand and explain the different nature and behaviour of organic compounds based on fundamental concepts learnt.
2. Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.
3. Learn and identify many organic reaction mechanisms including Free Radical Substitution, Electrophilic Addition and Electrophilic Aromatic Substitution.
4. Understand the fundamental concepts of stereochemistry.
5. Elaborate various properties of aliphatic and aromatic hydrocarbons.
6. Experimentally identify extra element and functional group in the given organic compound.
7. Synthesize various organic compounds making use of selective reagents.

Unit – I: 7.5h

A) Structure and Bonding : Hybridization in case of Methane, Ethane, Ethylene and acetylene, Bond lengths, bond angles and bond energies. Inductive effect, Electromeric effect. Resonance effect. Hyperconjugation definition, examples and application of these effects. Hydrogen bonding in organic compounds (with reference to alcohol, phenols, amines, acids) and consequences.

B) Mechanism of Organic Reactions : Homolytic and heterolytic bond breaking examples and factors favouring the bond fission. Electrophiles and nucleophiles definition and example both neutral and charged. Types of organic reactions addition, substitution, elimination, rearrangement. Energy consideration. Reactive intermediates carbocations, carbanions, free radicals, carbenes, formation, geometry, stability and reactions given by these intermediates.

Unit - II: 7.5h

A) Stereochemistry of Organic Compounds : Concept of isomerism. Types of isomerism with suitable examples. Optical isomerism-elements of symmetry, molecular chirality, enantiomers, stereogenic centre(lactic acid as example). Optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centres (Tartaric acid) diastereomers, mesocompound. Resolution of enantiomers biological and chemical methods. Inversion retention and racemisation. Asymmetric synthesis. Relative and absolute configuration, sequence rules, D and L and R and S system of nomenclature.

B) Geometrical isomerism : E and Z system of nomenclature, geometric isomerism in alkenes with examples, maleic acid and fumaric acid, 2-butene.

Conformational isomerism : Conformational analysis of ethane, n-butane and substituted n-butane, conformations of Cyclohexane, axial and equatorial bonds. Newman's projection and sawhorse formulae. Difference between configuration and conformation.

Unit - III: 7.5h

A) Alkanes: IUPAC nomenclature of branched and unbranched alkanes. Alkyl group, Isomerism in alkanes. Methods of formation (Ethane)– Wurtz reaction, Kolbe reaction, decarboxylation of carboxylic acid. Physical properties and chemical reactions of alkanes-halogenation, nitration, sulphonation, isomerization, cyclization, aromatization, pyrolysis and cracking oxidation, L.P.G., Octane number. Mechanism of free radical halogenation of alkane.



B) Cycloalkanes : Nomenclature, methods of formation of cyclohexane from dihalides, benzene and cyclohexanone, chemical reactions of cyclohexane oxidation, aromatization, chlorination, Baeyer's strain theory and its limitations. Ring strain in small rings cyclopropane and cyclobutane. Theory of strainless rings.

C) Alkenes : Nomenclature of alkenes, methods of formation- dehydrogenation, dehydrohalogenation of alkyl halides, dehydration of alcohol dehalogenation of dihalides. Mechanism of dehydration of alcohol and dehydrohalogenation of Alkyl halides. Saytzeff rule, Hofmann elimination reaction. Chemical reactions of alkenes- hydroboration, oxidation KMnO_4 , HIO_4 , Epoxidation, Ozonolysis, Hydroxylation, Polymerization Substitution in allylic and vinylic position of alkenes. Industrial applications of ethylene and propylene. Markownikoff Rule and peroxide effect. Ionic Mechanism of addition of Br_2 to ethene and HBr to propene. Free radical mechanism of addition of HBr to propene. Stereochemistry of bromine and KMnO_4 addition to alkene.

Unit - IV: 7.5h

A) Dienes: Nomenclature and classification of dienes Methods of formation of 1, 3 - butadiene. 1,2 and 1,4 addition reactions of substituted 1,3-butadiene, Diels-Alder reaction.

B) Alkynes: Nomenclature, structure and bonding in Alkynes. Methods of formation of acetylene from - calcium carbide, dehydrohalogenation of dihalides Chemical reaction - hydroboration, oxidation metal ammonia reduction and polymerization. Oxyacetylene flame. Acidity of alkynes.

C) Aromatic Compounds and Aromaticity: Nomenclature of Benzene derivatives, structure of benzene, Molecular formula and Kekule structure. Resonance structure, MO picture, Huckel rule, aromatic ions (cyclopentadienyl anion and cycloheptatrienyl cation). Aromatic electrophilic substitution mechanism with energy profile diagram (eg. nitration and sulphonation).

Organic Chemistry Practical (1 credit): BCH1P02

A) Qualitative Analysis:

1. Element detection (N, S and halogens)
2. Identification of functional groups ($-\text{COOH}$, Phenolic $-\text{OH}$, $-\text{CHO}$, $-\text{NH}_2$, $-\text{NO}_2$, $-\text{CONH}_2$)
3. Melting and Boiling Points

B) Preparations and determination of yield (%) and melting points of products:

1. Hydrolysis : Preparation of Benzoic acid from Benzamide
2. Oxidation: Preparation of Benzoic acid from Benzaldehyde
3. Bromination of Phenol

Reference books

10. Morrison, R. N.; Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
11. Finar, I. L. Organic Chemistry (Volume 1& 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
12. Chandra, R. ; Singh, S.; Singh, A. (2019), Basic Organic Chemistry, Arcler Press.
13. Eliel, E. L.; Wilen, S. H.(1994),Stereochemistry of Organic Compounds; Wiley: London.
14. Singh, S.P.; Prakash, O.,(2017), Reaction Mechanism in organic chemistry, Laxmi
15. Mann, F. G.; Saunders, B. C. (2009), Practical Organic Chemistry, Pearson Education.
16. Ahluwalia, V.K.; Dhingra, S. (2004),Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press.
17. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R.(2012),Vogel's Textbook of Practical Organic Chemistry, Pearson.
18. Leonard, J.; Lygo, B.; Procter, G. Advanced Practical Organic Chemistry, CRC Press.



B.Sc. Semester – IV
Minor 3: BCH2T03
Organic Chemistry-2 (Functional group chemistry)
Theory 2 credits + Practical 1 credit

Course Outcomes

On completion of the course, the student will be able to:

1. Understand preparation, properties and reactions of haloalkanes, haloarenes and oxygen containing functional groups.
2. Use the synthetic chemistry learnt in this course to do functional group transformations.
3. To propose plausible mechanisms for various reactions.
4. Suggest synthesis routes for desired product from initial reactant.
5. Identify given organic compound by systematic chemical analysis.
6. Synthesize derivatives of given organic compound.

Unit-I : 7.5h

Orientation : Activating ($-\text{OH}$, $-\text{NH}_2$) and deactivating ($-\text{Cl}$, $-\text{NO}_2$, $-\text{COOH}$) substituents, their orientation and directive influence on further electrophilic substitution, o/p ratio. Methods of formation and chemical reactions of alkyl benzene (Toluene) and biphenyl.

Alkyl halides : Nomenclature, classification, methods of formation, chemical reactions. Mechanism of nucleophilic substitution reactions of alkyl halides S_N^1 and S_N^2 with energy profile diagrams. Factors affecting S_N^1 and S_N^2 mechanisms.

Polyhalogen compounds : Chloroform and carbon tetrachloride – formation and chemical reactions.

Nuclear and side chain halogen derivatives of benzene: Halobenzene and benzyl halide preparation and reactions.

Unit-II: 7.5h

A) Alcohols : Classification and nomenclature,

Monohydric alcohols : Methods of formation by reduction of aldehydes, ketones using H_2/Ni , hydrolysis of alkyl halides, addition of Grignard reagent to aldehydes and ketones. Reactions of alcohol.

Dihydric alcohols : Methods of formation, chemical reactions of vicinal glycols, oxidative cleavage ($\text{Pb}(\text{OAc})_4$ and HIO_4) and Pinacol – pinacolone rearrangement.

Trihydric alcohols : Methods of formation, chemical reactions of glycerol.

B) Phenols : Structure and bonding, Preparation of phenols from cumene, chlorobenzene (Dows and Raschig process) and diazonium salts. Physical properties and acidic character, Resonance stabilization of phenoxide ion, Reactions of phenols, Electrophilic aromatic substitution, acetylation and carboxylation, Claisen rearrangement, Gatterman synthesis reaction Mechanism of (i) Fries Rearrangement, (ii) Reimer-Tiemann reaction.

Unit-III: 7.5h

Aldehydes and ketones : Nomenclature and structure of the carbonyl group, synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides and ketones from nitriles. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensation, Wittig reaction, Mannich reaction, oxidation of aldehydes



(by KMnO_4 , Tollen's reagent and Fehling solution), Baeyer-Villiger oxidation of Ketones, Cannizzaro reaction with mechanism, MPV, Clemmensen, Wolf-Kishner, LiAlH_4 and NaBH_4 reductions,

Unit-IV: 7.5h

A) Carboxylic Acids : Nomenclature, structure and bonding, Physical properties, acidity of carboxylic acids, effect of substituents on acid strengths preparation of carboxylic acids (from G.R. and cyanides), Reactions of carboxylic acids, Hell-Volhard-Zelinsky reactions. Reduction of carboxylic acids, Mechanism of decarboxylation. Methods of formation and chemical reactions of unsaturated monocarboxylic acids (crotonic acid and cinnamic acid).

Dicarboxylic acids : Methods of formation and effect of heat and dehydrating agents. (Succinic acid, Phthalic acid).

B) Carboxylic acid derivatives : Structure and nomenclature of acid chlorides, esters, amides and acid anhydrides. Interconversion of acid derivatives by nucleophilic acyl substitution. Preparation of carboxylic acid derivatives, Chemical reactions, Mechanism of esterification and hydrolysis (acidic and basic).

Organic Chemistry Practical (1 credit): BCH2P03


Complete analysis of simple organic compound involving following steps:

1. Preliminary examination
2. Detection of elements
3. Detection of functional group
4. Determination of melting point/ boiling point.
5. Preparation of derivative and its melting point/ boiling point.
6. Performance of specific test, if any.

Note: At least eight compounds should be analyzed.

Reference books

1. Morrison, R. N.; Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Janice Smith, Organic Chemistry, 7th Edition, McGraw Hill with solution manual
4. Bruice, P. Y. Organic Chemistry, 6th Edition, Pearson Education with solution manual
5. Francis A. Carey, Robert M. Giuliano Organic Chemistry, 8th Edition McGraw Hill with solution manual
6. Marc Loudon, Jim Parise 7th Edition, W. H. Freeman with solution manual
7. David Klein Organic Chemistry, John Wiley & Sons Inc with solution manual
8. Ahluwalia, V.K.; Bhagat, P.; Aggarwal, R.; Chandra, R. (2005), Intermediate for Organic Synthesis, I. K. International.
9. Solomons, T. W. G.; Fryhle, C. B. ; Snyder, S. A. (2016), Organic Chemistry, 12th Edition, Wiley.
10. Chandra, R. ; Singh, S.; Singh, A. (2019), Organic reactions and their nomenclature, Arcler Press.
11. Mann, F. G.; Saunders, B. C. (2009), Practical Organic Chemistry, Pearson Education.
12. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012), Vogel's Textbook of Practical Organic Chemistry, Pearson.
13. Ahluwalia, V.K.; Aggarwal, R. (2004), Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press.



B.Sc. Semester – IV
Minor 4: BCH2T04
Physical Chemistry-1 (Thermodynamics, gaseous and liquid states)
Theory 2 credits + Practical 1 credit

Course Outcomes

By the end of the course, students will be able to:

1. Solve fundamental mathematical function based problems in chemistry.
2. Understand the three laws of thermodynamics, concept of State and Path functions, extensive and intensive properties.
3. Derive the expressions of ΔU , ΔH , ΔS , ΔG , ΔA for ideal gases under different conditions.
4. Evaluate thermodynamics of various physical and chemical processes.
5. Analyse and explain properties of ideal gas, real gas and liquids.
6. Evaluate thermodynamic constants through calorimetric studies.
7. Use various properties of liquids for determination of their concentration and composition.

Unit-I : 7.5h

Mathematical concepts and Introduction to Thermodynamics

(A) Mathematical concepts for Chemists: Logarithmic relations, Curve sketching, Linear graphs calculation of slopes, Differentiation of functions like kx , e^x , x^n , $\sin x$, $\log x$, etc., Maxima and Minima, Partial differentiation, Integration of useful/relevant functions, Permutations and combinations (introductory), Factorials, Concept of units with reference to C.G.S. and S.I. units, Inter-conversion of units.

(B) Introduction to Thermodynamics: Definitions of some common thermodynamic terms: system, surrounding, etc. Types of system (closed, open and isolated), Homogeneous and heterogeneous systems, intensive and extensive properties, thermodynamic processes (isothermal, adiabatic, isobaric, isochoric, cyclic, reversible and irreversible) State function and path functions and their differentiation, concept of heat and work.

Unit-II: 7.5h

Fundamentals of Thermodynamics and Thermochemistry

(A) Statements of first law of thermodynamics, definition of internal energy and enthalpy, heat capacity, heat capacity at constant volume and at constant pressure, Joule-Thomson experiment, Joule-Thomson coefficient and inversion temperature, calculations of w , q , E and H for expansion of gases for isothermal and adiabatic conditions for reversible process.

(B) Thermochemistry : Standard states, standard enthalpy of formation, enthalpy of combustion, enthalpy of solution, enthalpy of dilution, enthalpy of neutralization, enthalpy of ionization, Hess's law of constant heat of summation and its applications, Heat of reaction, relation between heat of reaction at constant volume and constant pressure. Average bond energy, bond dissociation energy and its calculations from thermochemical data. Numerical problems.

Unit- III: 7.5h

Gaseous State

(A) Postulates of kinetic theory of gases, derivation of kinetic gas equation, deduction of various gas laws from kinetic gas equation (Boyle's law, Charles's law, Avogadro's law, Graham's law, Dalton's law. Qualitative discussion of the Maxwell-Boltzmann distribution of molecular velocities. Effect of



temperature on molecular velocities. Different types of molecular velocities (most probable, R.M.S. and average and expressions for them), their inter relationships. Definitions of collision diameter, collision number, mean free path.

(B) Ideal gas and real gases, behavior of real gases, deviations from ideal behavior, explanation of the terms - Compressibility factors and Boyle temperature. Causes of deviation from ideal behaviors. Vander Waal's equation of state, explanation of behaviour of real gases on the basis of van der Waal equation. Andrew's experiment on critical phenomenon of CO₂. Continuity of states. The isotherms of Van der Waals equation, Relation between critical constants and Van der Waals constants. Reduced equation of state and law of corresponding states. Numerical problems.

Unit- IV: 7.5h

Liquid State

(A) Intermolecular forces, structure of liquids (a qualitative description), structural differences between solids, liquids and gases, liquid crystals, Classification, structure of Nematic and Cholesteric phases, Thermography, liquid crystal display and seven segment cell.

(B) Properties of liquid :

i) Surface tension : Explanation, methods of determination, Capillary rise method and drop number method, Parachor value and its application.

ii) Viscosity : Explanation, coefficient of viscosity, Effect of temperature on Viscosity, relative viscosity, specific viscosity and intrinsic viscosity and reduced viscosity. Method of determination by Ostwald viscometer.

iii) Refractive index : specific refraction, molar refractions and chemical constitution. Method of determination by Abbe's Refractometer. Numerical problems.

Physical Chemistry Practical (1 credit): BCH2P04

1. To determine the heat of solution of potassium nitrate calorimetrically
2. To determine heat of ionization of acetic acid calorimetrically.
3. To determine solubility of benzoic acid at different temperatures and hence to determine heat of solution of benzoic acid.
4. Determination of relative viscosity of unknown liquid by Ostwald viscometer.
5. To determine the percentage composition of given binary mixture (Ethanol-water) by viscosity method.
6. Determination of surface tension of a given liquid by drop number method (Stalagmometer method)
7. To compare cleansing power of two samples of detergent.
8. To determine parachor value of -CH₂ group by surface tension method.
9. To determine refractive index, specific and molar refraction of given liquid by Abbe's refractometer.

Note: At least eight experiments should be performed.

Reference books

6. Peter, A.; Paula, J. de. (2011), Physical Chemistry, 9th Edition, Oxford University Press.
7. Castellan, G. W. (2004), Physical Chemistry, 4th Edition, Narosa.
8. Kapoor, K.L.(2015), A Textbook of Physical Chemistry, Vol 2, 6th Edition, McGraw Hill Education.
9. Kapoor, K.L.(2013), A Textbook of Physical Chemistry, Vol 3, 3rd Edition, McGraw Hill Education.



10. McQuarrie, D. A.; Simon, J. D. (2004),Molecular Thermodynamics, Viva Books Pvt. Ltd. Levine, I.N.(2010),Physical Chemistry, Tata Mc Graw Hill.
11. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A.; Will, S.(2011),Commonly asked Questions in Thermodynamics. CRC Press.
12. Khosla, B.D.; Garg, V.C.; Gulati, A. (2015),Senior Practical Physical Chemistry, R. Chand & Co, New Delhi.
13. Kapoor, K.L. (2019),A Textbook of Physical Chemistry, Vol.7, 1st Edition, McGraw Hill Education.
14. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P.(2003),Experiments in Physical Chemistry, 8th Edition, McGraw-Hill, New York.

