

Semester-I

Chemistry MAJOR

Paper code: CHEM1011
Paper title: Basic Chemistry-I
Credits 3 + 1

Course objective

- Several fundamental aspects of inorganic, organic and physical chemistry is discussed for the basic understanding of the students
- The topics covered will help the students for studying higher in chemical sciences
- Easy organic chemistry practical using several chemical and physical methods will enhance the basic knowledge of students' hands-on training

Course outcome

- Students will be introduced with several basic aspects of theory and practical of chemical sciences. This will grow the foundation of the subject for studying various advanced topics in future semesters.

Theory

Credit: 3

Atomic structure

6 Hours

Bohr's theory- its limitations and atomic spectra of hydrogen atom, Sommerfeld's theory, 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, Radial and angular wave functions for hydrogen atom, radial and angular distribution curves, shapes of s, p, d and f orbitals, Pauli's exclusion principle, Hund's rules and multiplicity, exchange energy, Aufbau principle and its limitations, Ground state Term symbols of atoms and ions for atomic number up to 30

Periodic properties

6 Hours

Modern IUPAC periodic table, effective nuclear charge, screening effects and penetration, Slater's rules, atomic radii, ionic radii (Pauling's univalent), covalent radii, lanthanide contraction; ionization potential, electron affinity and electronegativity (Pauling's, Mulliken's and Allred-Rochow's scales) and factors influencing these properties, group electronegativities, group trends and periodic trends in these properties in respect of s-, p- and

d-block elements, secondary periodicity, relativistic Effect, inert pair effect

Acids and bases

6 Hours

Acid-Base concept- Arrhenius concept, theory of solvent system (in H_2O , NH_3 , SO_2 and HF); Bronsted-Lowry's concept, relative strength of acids, Pauling's rules, Lux-Flood concept, Lewis concept, group characteristics of Lewis acids, solvent levelling and differentiating effects, thermodynamic acidity parameters, Drago-Wayland equation, superacids, gas phase acidity and proton affinity, HSAB principle, acid-base equilibria in aqueous solution (proton transfer equilibria in water), pH, buffer, acid-base neutralisation curves, indicator, choice of indicators, concept of organic acids and bases, effect of structure, substituent and solvent on acidity and basicity, proton sponge, gas-phase acidity and basicity

Fundamentals in Organic chemistry

12 Hours

Electron displacement phenomena and physical properties: inductive effect, field effect, hyperconjugation, mesomeric effect, resonance energy, bond polarization and bond polarizability, electromeric effect, steric effect, steric inhibition of resonance, influence of hybridization on bond properties, bond dissociation energy (BDE) and bond energy, bond distances, bond angles, concept of bond angle strain (Baeyer's strain theory), melting point/boiling point and solubility of common organic compounds in terms of covalent & non-covalent intermolecular forces, polarity of molecules and dipole moments, relative stabilities of isomeric hydrocarbons in terms of heat of hydrogenation, heat of combustion and heat of formation, calculation of formal charges and double bond equivalent (DBE)

Reactive intermediates: carbocations (carbenium and carbonium ions), carbanions, carbon radicals, carbenes, benzyne and nitrenes, generation and stability, structure using orbital picture and electrophilic/nucleophilic behaviour of the reactive intermediates (elementary idea)

Concept of aromaticity: Hückel's rules for aromaticity up to [10]-annulene (including mononuclear heterocyclic compounds up to 6-membered ring), concept of antiaromaticity and homoaromaticity, non-aromatic molecules, Frost diagram, elementary idea about α and β , measurement of delocalization energies in terms of β for buta-1,3-diene, cyclobutadiene, hexa-1,3,5-triene and benzene

Properties of Gases*4 Hours*

Ideal and real gases: Deviation of gases from ideal behaviour, compressibility factor, Boyle temperature, Andrew's and Amagat's plots, van der Waals equation and its features, its derivation and application in explaining real gas behaviour, Dieterici equation of state, existence of critical state, critical constants in terms of van der Waals constants, law of corresponding states, virial equation of state, van der Waals equation expressed in virial form and significance of second virial coefficient, intermolecular forces (Debye, Keesom and London interactions, Lennard-Jones potential - elementary idea)

Chemical Kinetics-I*5 Hours*

Rate law, order and molecularity: Introduction of rate law, extent of reaction, rate constants, order, forms of rate equations of first-, second- and n-th order reactions, pseudo first-order reactions (example using acid catalyzed hydrolysis of methyl acetate), determination of order of a reaction by half-life and differential method, opposing reactions, consecutive reactions and parallel reactions (with explanation of kinetic and thermodynamic control of products with all steps of first order)

Temperature and theories of reaction rate: Temperature dependence of rate constant; Arrhenius equation, energy of activation, rate-determining step and steady-state approximation – explanation with suitable examples.

Thermodynamics-I*6 Hours*

Zeroth and 1st law of Thermodynamics: intensive and extensive variables, state and path functions, isolated, closed and open systems, zeroth law of thermodynamics, concept of heat q , work w and internal energy U , statement of first law, enthalpy H , relation between heat capacities, calculations of q , w , U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions, Joule's experiment and its consequence

Thermochemistry: standard states, heats of reaction, enthalpy of formation of molecules and ions and enthalpy of combustion and its applications, laws of thermochemistry, bond energy, bond dissociation energy and resonance energy from thermochemical data, Kirchhoff's equations and effect of pressure on enthalpy of reactions, adiabatic flame temperature, explosion temperature

Reference Books/ Journals

- Lee, J. D. Concise Inorganic Chemistry ELBS, 1991.
- Douglas, B.E. and McDaniel, D.H. Concepts & Models of Inorganic Chemistry Oxford, 1970.
- Atkins, P. Shriver & Atkins' Inorganic Chemistry 5th Ed. Oxford University Press (2010).
- Cotton, F.A., Wilkinson, G. and Gaus, P.L., Basic Inorganic Chemistry 3rd Ed.; Wiley India.
- Sharpe, A.G., Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005.
- Huheey, J. E.; Keiter, E.A. & Keiter, R.L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson, 2006.
- Mingos, D.M.P., Essential trends in inorganic chemistry. Oxford University Press (1998).
- Winter, M. J., The Orbitron, <http://winter.group.shef.ac.uk/orbitron/> (2002). An illustrated gallery of atomic and molecular orbitals.
- Burgess, J., Ions in solution: basic principles of chemical interactions. Ellis Horwood (1999).
- Clayden, J., Greeves, N. & Warren, S. Organic Chemistry, Second edition, Oxford University Press, 2012.
- Smith, J. G. Organic Chemistry, Tata McGraw-Hill Publishing Company Limited.
- Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Pathak & Saha, Organic Chemistry (Volume-1), Books and Allied (P) Ltd.
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd., (Pearson Education).
- Morrison, R. T. Study guide to organic Chemistry, Pearson.
- Atkins, P. W. & Paula, J. de Atkins' Physical Chemistry, Oxford University Press.
- Castellan, G. W., Physical Chemistry, Narosa Publishing House.
- McQuarrie, D. A. & Simons, J. D. Physical Chemistry: A Molecular Approach, Viva Press.
- Engel, T. & Reid, P. Physical Chemistry, Pearson.
- Maron, S. & Prutton, Principles of Physical Chemistry, Collier Macmillan Ltd.
- Mortimer, R. G. Physical Chemistry, Elsevier.
- Ball, D. W., Physical Chemistry, Thomson Press.
- Glasstone, S. & Lewis, G.N. Elements of Physical Chemistry.
- Rakshit, P.C., Physical Chemistry, Sarat Book House.
- Zemansky, M. W. & Dittman, R.H. Heat and Thermodynamics, Tata-McGraw-Hill.
- Rastogi, R. P. & Misra, R.R. An Introduction to Chemical Thermodynamics, Vikas Publishing House.
- Clauze & Rosenberg, Chemical Thermodynamics: Basic concepts & Methods, John Wiley & Sons, 2008.
- Sharma, K. K. & Sharma, L. K., A Textbook of Physical Chemistry, Vikas Publishing House.
- Rajaram, J. Chemical Thermodynamics: Classical, Statistical and Irreversible, Pearson.
- Chatterjee Hrishikesh, Physical Chemistry (Volume-1), Platinum Publisher
- Kapoor, K.L., Textbook of Physical Chemistry (Volume 1 and Volume-2), McGraw Hill Education

Ghoshal, A. Numerical problems & short questions on Physical Chemistry, Books and Allied (P) Ltd.
 Bajpai, D. N., Advanced Physical Chemistry, S. Chand Publication.
 Levine, I. N. Physical Chemistry, Tata McGraw-Hill.

Practical

Credit: 1

Separation, purification and melting point determination

Separation of components of a binary solid mixture based on solubility by using common laboratory reagents like water (cold, hot), dil. HCl, dil. NaOH, dil. NaHCO₃, etc., purification of any one of the separated components by crystallization and determination of its melting point. The composition of the mixture may be of the following types: Benzoic acid/*p*-toluidine, *p*-nitrotoluene/*p*-anisidine, benzoic acid/benzophenone, urea/benzophenone, salicylic acid/*p*-nitrotoluene, etc.

Determination of boiling point

Boiling points of common organic liquid compounds e.g., ethanol, cyclohexane, ethyl methyl ketone, cyclohexanone, acetylacetone, anisole, crotonaldehyde, mesityl oxide, etc
 [Boiling points of the chosen organic compounds should preferably be less than 160°C]

Identification of a pure organic compound by chemical test(s)

Solid compounds: oxalic acid, succinic acid, resorcinol, urea, glucose and salicylic acid.
 Liquid Compounds: acetic acid, ethyl alcohol, acetone, aniline and nitrobenzene

Reference Books/ Journals

Bhattacharyya, R. C, A Manual of Practical Chemistry.
 Vogel, A. I. Elementary Practical Organic Chemistry, Part 2: Qualitative Organic Analysis, CBS Publishers and Distributors.
 Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
 A.K. Manna, Practical Organic Chemistry, Books & Allied (P) Ltd.
 Ghosh, Das Sharma, Majumdar, Manna, Chemistry in Laboratory, Santra Publication (P) Ltd.

Chemistry MINOR

Paper code: CHEM1021

Paper title: General Chemistry-I

Credit: 3 + 1

Course objective

- Several fundamental aspects of the subject are discussed so that the principles can be useful for studying other branches of science (physical and/or biological sciences)
- Practical experiments are designed in such a way that the students of other disciplines can have an experience of hands-on training in chemistry at the primary level

Course outcome

- On studying the course, the students will have an idea of chemical sciences, which may be applied for in-depth study of other science streams.

Theory**Credit: 3****Atomic structure***6 Hours*

Bohr's theory for hydrogen atom (simple mathematical treatment), atomic spectra of hydrogen and Bohr's model, Sommerfeld's model, quantum numbers and their significance, Pauli's exclusion principle, Hund's rule, electronic configuration of many-electron atoms, Aufbau principle and its limitations

Periodic properties*6 Hours*

Classification of elements on the basis of electronic configuration: general characteristics of s-, p-, d- and f-block elements, positions of hydrogen and noble gases, atomic and ionic radii, ionization potential, electron affinity and electronegativity, periodic and group-wise variation of above properties in respect of s- and p- block elements

Acids and bases*7 Hours*

Brönsted–Lowry concept, conjugate acids and bases, relative strengths of acids and bases, effects of substituent and solvent, differentiating and levelling solvents, Lewis acid-base concept, classification of Lewis acids and bases, Lux-Flood concept and solvent system concept, hard and soft acids and bases (HSAB concept), applications of HSAB process, acidity and basicity of common organic compounds

Aliphatic hydrocarbons*10 Hours*

Functional group approach for the following compounds to be studied in context of their preparations, properties, structures and reactions

Alkanes (up to 5 carbons): preparation- catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis using Grignard reagent; Reaction mechanism for free radical substitution, halogenation

Alkenes (up to 5 carbons): preparation- elimination reactions, dehydration of alcohols and dehydrohalogenation of alkyl halides, *cis* alkenes (partial catalytic hydrogenation) and trans alkenes (Birch reduction), reactions- *cis*-addition (alkaline KMnO_4) and trans-addition (bromine) with mechanism, addition of HX [Markownikoff's (with mechanism) and anti-Markownikoff's addition], hydration, ozonolysis, oxymercuration-demercuration and hydroboration-oxidation reaction

Alkynes (up to 5 carbons): preparation- acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal dihalides, formation of metal acetylides, addition of bromine and alkaline KMnO_4 , ozonolysis and oxidation with hot alkaline KMnO_4

Ideal and real gases

5 Hours

Concept of pressure and temperature, Deviation of gases from ideal behaviour, compressibility factor, Boyle temperature, Andrew's and Amagat's plots, van der Waals equation and its features, derivation and application in explaining real gas behaviour, existence of critical state, critical constants in terms of van der Waals constants, law of corresponding states

Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only)

Thermodynamics-I

7 Hours

Intensive and extensive properties state and path functions, isolated, closed and open systems, zeroth law of thermodynamics, concept of heat, work, internal energy and statement of first law; enthalpy, H , relation between heat capacities, calculations of q , w , U and H for reversible, irreversible and free expansion of gases

Standard states, heat of reaction, enthalpy of formation of molecules and ions, enthalpy of combustion and its applications, laws of thermochemistry, bond energy, bond dissociation energy and resonance energy from thermochemical data, Kirchhoff's equation and effect of pressure on enthalpy, adiabatic flame temperature, explosion temperature

Chemical Kinetics-I

4 Hours

Introduction of rate law, order and molecularity, extent of reaction, rate constants, rates of first-, second- and n-th order reactions and their integrated forms (with derivation), pseudo first order reactions, determination of order of a reaction- half-life and differential method, opposing reactions, consecutive reactions and parallel reactions (elementary idea)

Theories of reaction rate: Temperature dependence on reaction rate, Arrhenius equation, energy of activation

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- Lee, J. D. Concise Inorganic Chemistry ELBS, 1991.
- Douglas, B.E. and McDaniel, D.H. Concepts & Models of Inorganic Chemistry Oxford, 1970.
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Clauze & Rosenberg, Chemical Thermodynamics: Basic concepts & Methods, John Wiley & Sons, 2008.

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Chatterjee Hrishikesh, Physical Chemistry (Volume-1), Platinum Publisher

Kapoor, K.L., Textbook of Physical Chemistry (Volume 1 and Volume-2), McGraw Hill Education

Ghoshal, A. Numerical problems & short questions on Physical Chemistry, Books and Allied (P) Ltd.

Maron, S. & Prutton, Principles of Physical Chemistry, Collier Macmillan Ltd.

Levine, I. N. Physical Chemistry, Tata McGraw-Hill.

Practical

Credit: 1

Determination of boiling points

Boiling points of common organic liquid compounds e.g., ethanol, cyclohexane, ethyl methyl ketone, cyclohexanone, acetylacetone, anisole, crotonaldehyde, mesityl oxide, etc.

Identification of a pure organic compound

Solid compounds: oxalic acid, succinic acid, resorcinol, urea, glucose, benzoic acid and salicylic acid.

Liquid Compounds: acetone, aniline and nitrobenzene

Reference Books/ Journals

Bhattacharyya, R. C, A Manual of Practical Chemistry.

Vogel, A. I. Elementary Practical Organic Chemistry, Part 2: Qualitative Organic Analysis, CBS Publishers and Distributors.

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

Manna, A.K., Practical Organic Chemistry, Books & Allied (P) Ltd.

Ghosh, Das Sharma, Majumdar, Manna, Chemistry in Laboratory, Santra Publication (P) Ltd.

MULTIDISCIPLINARY

Paper code: CHEM1031

Paper title: Chemistry for Household Importance

Credit: 3

Course objective

- Several topics related to everyday life have been included to grow interest among students for the subject

Course outcome

- The study of the topics may be helpful for the students to get employment

Theory

Credit: 3

Food chemistry: Food additive, food flavor, adulterant, preservative, artificial sweeteners

8 Hours

Drugs and pharmaceuticals: Structure and function, antipyretic and analgesic drugs – aspirin, paracetamol, ibuprofen

8 Hours

Vitamins: Vitamin C and B₁₂

2 Hours

Antibiotics: Penicillin, sulphaguanidine, chloramphenicol

4 Hours

Glass and ceramics: Definition and manufacture of glasses, optical and colour glasses

6 Hours

Surface chemistry: Soaps and detergents

2 Hours

Chemistry of fuels: Conventional and non-conventional energy sources, classification of fuels, calorific values of fuels like kerosene, coal, coal gas, petrol, liquefied petroleum gas, octane number, biogas

15 Hours

Reference Books/ Journals

Thapar, Food Chemistry, Pacific Book International

Gayatri Baidya, Textbook of Food Chemistry, Book Rivers

Mandal, S.K., Pharmaceutical Chemistry and Production: An Introductory Textbook Rebeca

Ghanta; Bentham Science Publishers 2022, ISBN: 978-1-68108-890-7

Sengupta, S., Application Oriented Chemistry Books Syndicate Pvt. Ltd., 2000

SKILL ENHANCEMENT COURSE

Paper code: CHEM1051

Paper title: Drugs and pharmaceuticals

Credit: 3

Course objective

- Design and development of several organic drugs
- The very detail discussion for growing of very clear idea about the drugs, their synthesis and physiological action

Course outcome

- The clear idea about the drugs may not only grow the general sense about the synthesis and mode of action of the drugs but also help them to have employment in pharmaceutical industry.

Theory

Credit: 3

Drug discovery, design and development, synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (aspirin, paracetamol, ibuprofen), antibiotics (penicillin, chloramphenicol), antibacterial and antifungal agents (sulphonamides, sulphanethoxazol, sulphacetamide, trimethoprim); antiviral agents (acyclovir), central nervous system agents (phenobarbital, diazepam), cardiovascular (glyceryl trinitrate), antilaprosy (dapsone), HIV-AIDS related drugs (AZT-Zidovudine)

45 Hours

Reference Books/ Journals

Patrick, G. L. Introduction to Medicinal Chemistry, Oxford University Press, UK, 2013.

Singh, H. & Kapoor, V.K. Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan, Pitampura, New Delhi, 2012.

Foye, W.O., Lemke, T.L. & William, D.A.: Principles of Medicinal Chemistry, 4th ed., B.I. Waverly Pvt. Ltd. New Delhi.

El-Mansi, E.M.T., Bryce, C.F.A., Ddmain, A.L., Allman, A.R., Fermentatias Microbiology and Biotechnology, 2nd Ed. Taylor & Francis.

Prescott & Dunn's Industrial Microbiology, 2004, CBS Publisher.

Semester-II

Chemistry MAJOR

Paper code: CHEM2011

Paper title: Basic Chemistry-II

Credit: 3 + 1