Shiksha Mandal's

Bajaj College of Science, Wardha

(An Autonomous Institution)

Department of Chemistry

Proposed Syllabus for Four Year B.Sc. Honors with Chemistry as Major

Major / Department Specific Course (DSC)

Semester I course in
Chemistry

Syllabus under Autonomy

(Draft discussed and approved in BOS Meeting 18-April-2023 to be implemented from Academic Session 2023-24)

Shiksha Mandal's

Bajaj College of Science, Wardha

Programme Objectives B. Sc. with Chemistry as Major

- The basic objective of this programme is to impart the theoretical as well as practical knowledge of the subject to the students.
- Also the students should understand the concepts of chemistry in order to interrelate and interact to the other subject like mathematics, physics, biological science etc.
- Students should develop a broad foundation in chemistry that stresses scientific reasoning and analytical problem-solving ability with a molecular perspective.
- Students should get exposures to a wide range of experimental techniques using modern instrumentation.
- Students may acquire the skills in handling scientific instruments, planning and performing laboratory experiments
- An effort to inculcate the skills of observations and drawing logical inferences from the scientific experiments among the students.
- They should be able to analyze the given scientific data critically and systematically and possess the ability to draw the objective conclusions.

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Programme Learning Outcomes B.Sc. with Chemistry as Major

- After completion of B.Sc. with Chemistry as one of the subjects, students will gain the important fundamental knowledge of the subject.
- Students will develop a broad foundation in chemistry that stresses scientific reasoning and analytical problem solving with a molecular perspective.
- They will be able to find the physical, chemical nature the elements identify their role in the daily life.
- The skills of observations and drawing logical inferences from the scientific experiments will be inculcated among the students.
- Students will develop an interdisciplinary approach so as to connect the concepts of chemistry to the other scientific domains.
- The exposures to a wide range of experimental techniques will enable students to extend their knowledge to various opportunities in the government or corporate services particularly in the field of food safety, health inspector, pharmacist, chemist, forensic expert etc.
- Students will acquire the skills in handling scientific instruments, planning and performing laboratory experiments
- They will be able to analyze the given scientific data critically and systematically and possess the ability to draw the objective conclusions.

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Syllabus of B.Sc. I Semester I

SUBJECT – CHEMISTRY (Major/ DSC)

UCH110T: (Fundamentals of Inorganic and Organic Chemistry)

[60 Hrs] **[4 Credits]**

Course Description: -

The purpose of this course is to introduce the learners with fundamentals of inorganic and organic chemistry. The journey of science from classical to quantum which boosted the quest for study of atomic structure, the periodic properties and their trends are stressed upon in inorganic chemistry units. Learners will also be introduced with the basic theories in chemical bonding. The very fundamental concepts of organic chemistry are introduced along with stereochemistry. The study has been extended to aliphatic hydrocarbons. The topics studied in this course will be helpful in understanding the concepts introduced in subsequent semesters.

Course Objectives: -

1. To reinforce the basics of Inorganic Chemistry with special reference to atomic structure.
2. To understand periodic table and periodicity of properties of elements.
3. To understand various covalent bond theories especially VSEPR and Valence Bond Theory and ionic bonding with respect to various physical properties.
4. To understand fundamental concepts in organic chemistry like electronic displacements, bond fissions, classification of reagents, reactive intermediates and types of reactions.
5. To differentiate between various types of stereoisomerism and to understand fundamentals of optical, geometrical and conformational isomerism.
6. To understand the chemistry of alkanes and alkynes with respect to their methods of preparation and chemical reactions.

Course Learning Outcomes: -

On completion of this theory course, students will-

- Know basics of atomic structure of elements.
- Gain knowledge about periodicity which will help them in understanding structure of atom and variations in periodic properties of elements.
- Understand types of bonding and theories related to chemical bonding.
- Learn about ionic solids and polarization theories.
- Realize the basics of organic chemistry.
- Learn the important aspects of stereochemistry.
- Gain knowledge about various aspects of hydrocarbons like alkanes and alkynes.

The topics of this course cover mainly the fundamentals of the subject.

Contents:-

Unit I: Atomic Structure **(10 Hrs)**

Recapitulation of atomic models, Failure of classical mechanics and Foundation of Quantum mechanics: Explanation on the basis of Black body radiation, Photoelectric effect, Hydrogen atom spectra, Bohr's model of Hydrogen atom (No derivation), Planck's quantum theory, de Broglie's hypothesis (Explanation and Derivation). Heisenberg's uncertainty principle (Explanation), Quantum numbers, shapes of s, p, and d orbitals, Aufbau principle, Pauli's exclusion principles and Hund's rule of maximum multiplicity. Electronic Configuration of elements and ions (Z =1 to 30).

Unit II: **Periodic Properties**: **(10 Hrs)**

Atomic and ionic radii, (Covalent radii, van der Waals radii & metallic radii), ionization Potential (Definition, Factors affecting & trends in Periodic table), Electron gain enthalpy and electronegativity (Definition & trends in Periodic table).Pauling's and Mulliken's scale of electronegativity. Effective nuclear charge and Slater's rule with some exercises.

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Unit III: Chemical Bonding **(10 Hrs)**

A. Covalent Bond: Recapitulation of Bond Theories, Valence shell electron pair repulsion (VSEPR) theory to NH_3, SF_4, ClF_3, and H_2O, Limitations of VSEPR, Valance bond theory,Formation of Hydrogen molecule, directional characteristics of covalent bond, types of covalent bond, overlap criterion and bond strength. Bond energy, bond length, Bond order& Bond angle. Limitations of VBT. Need of concept of hybridization, Hybridization, and its types (sp, sp^2, sp^3, sp^3d, sp^3d^2, sp^3d^3).

B. Ionic bond: Introduction, Lattice energy and its calculation by using Born- Haber cycle. Solvation energy and solubility of ionic solids, polarizing power and polarisability of ions, Fajans rule.

Unit IV: Basics of Organic Chemistry **(10 Hrs)**

A. Bonding of carbon atom in alkanes, alkenes & alkynes. Types of electronic displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation (definition and examples). Bond Fission: Homolytic fission and Heterolytic fission. Nucleophiles and electrophiles (definition and examples).

B. Reactive Intermediates: Carbocation, Carbanion, free radical, carbene and nitrene, (Definition, formation, geometry, stability and one reaction each). Types of organic reactions ─ addition, substitution, elimination, rearrangement (definition and examples).

Unit V: Stereochemistry **(10 Hrs)**

Concept of isomerism. Types of isomerism with suitable examples

A. **Optical isomerism**-elements of symmetry, molecular chirality, enantiomers, stereogenic centre (lactic acid as example). Optical activity, chiral and achiral molecules with two stereogenic centres (Tartaric acid) diastereo-isomers, mesocompound. Relative and absolute configuration, sequence rules, D & L and R & S system of nomenclature, resolutions of racemic mixture and its types, inversion, retention and racemization, asymmetric synthesis.

B. **Geometrical isomerism:** E & Z system of nomenclature, geometric isomerism in maleic acid and fumaric acid and 2-butene. **Conformational isomerism:** Conformational analysis of ethane and n-butane. Newman's projection and sawhorse formulae. Difference between configuration and conformation.

Unit VI: Aliphatic Hydrocarbons I: (10 Hrs)

A. **Alkanes:** Preparation: Catalytic hydrogenation, Wurtz reaction, from Grignard reagent. Reactions: Free radical Substitution i.e., Halogenation with mechanism.

B. **Cycloalkanes:** Introduction, Baeyer's strain theory. Ring strain in small rings cyclopropane and cyclobutane. Theory of strainless rings. Introduction to conformations of cyclohexane: Boat and Chair, axial and equatorial bonds.

C. **Alkynes:** Nomenclature, Methods of formation of acetylene from - calcium carbide, dehydrohalogenation of dihalides. Chemical reaction - hydroboration, & polymerization. Oxyacetylene flame. Acidity of alkynes.

Reference Books:

Inorganic Chemistry

- Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
- Cotton, F.A., Wilkinson, G. & Gaus, P.L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.
- Douglas, B.E., McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry*, John Wiley & Sons.
- Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Education India, 2006.
- *Principles of Inorganic Chemistry*, Puri, Sharma, Kalia
- *Shriver and Atkins Inorganic Chemistry*. 5th Edition, Oxford University Press

Organic Chemistry

- Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. *Organic Chemistry*, John Wiley & Sons (2014).
- McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
- Sykes, P. *A Guidebook to Mechanism in Organic Chemistry,* Orient Longman, New
- Delhi (1988).
- Eliel, E.L. *Stereochemistry of Carbon Compounds*, Tata McGraw Hill education, 2000.
- Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
- Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
- Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry,* S. Chand, 2010.
- P. S. Kalsi *Organic Stereochemistry,* Narosa Publishing House

UCH110P: Fundamentals of Practical Chemistry

[60 Hrs] **[2 Credits]**

Course Description: -

The purpose of this course is to inculcate basic practical skills among the learners. They will learn to perform experiments of specific aims with correct techniques. The learners will develop skills to observe, record and analyze data. They will be able to interpret the experimental data and to improve analytical skills

Course Objectives:-

1. To understand fundamentals of volumetric analysis and to perform and apply volumetric titrations.
2. To learn to identify extra element and functional group in given organic compound.
3. To learn to purify solid and liquid organic compounds and to study the criteria of their purity.

Course Outcomes:-

On completion of the practical course students will-

- Understand the calibration of apparatus.
- Learn the basics of volumetric analysis with various concentration units. This will help students to gain skills required for solution preparation that can help them to get jobs at quality control units of industries.
- Be able to compare the acid neutralizing capacities of various antacids available in market and also compare the acetic acid content of commercially available vinegars.
- Understand the basics of organic compound analysis enabling them to detect elements and functional groups in given samples. This will equip them to work at forensic labs.
- Gain the skills to purify compounds and test their purity. This skill can be useful while working in variety of laboratories and industries.

Inorganic Chemistry

1. Calibration of pipette.
2. Preparation of standard solution of an acid (oxalic acid) & a base (sodium bicarbonate) by weighing and calculation of concentrations in terms of strength, normality, molarity, molality, formality, % by weight, % by volume , ppm, ppb and mole fraction.
3. Preparation of standard solution of hydrochloric acid by dilution and calculation of concentrations in terms of strength, normality, molarity, molality, formality, % by weight, % by volume , ppm, ppb and mole fraction.
4. Determination of strength of HCl & CH_3COOH using NaOH volumetrically (Discussion of acid-base indicator theories is expected).
5. Determination of acetic acid in commercial vinegar using NaOH.
6. Determination of alkali content in antacid tablet using HCl.

Organic Chemistry

1. Detection of elements (N, S, Cl, Br, I) in organic compounds.
2. Detection of functional groups. (-COOH, Phenolic –OH, -CHO, Aromatic -NH_2, -$CONH_2$).
3. Purification of solid compounds by crystallization (from water)
4. Purification of liquids by distillation.
5. Calibration of thermometer
6. Criteria of Purity: Determination of melting points
7. Criteria of Purity: Determination of boiling points

Reference Books:-

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

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Department of Chemistry

Proposed Syllabus for Four Year B.Sc. Honors with Chemistry as Major

Major / Department Specific Course (DSC)

Semester II course in
Chemistry

Syllabus under Autonomy

(Draft discussed and approved in BOS Meeting 18-April-2023 to be implemented from Academic Session 2023-24)

Shiksha Mandal's

Bajaj College of Science, Wardha

Syllabus of B.Sc. I Semester II

SUBJECT – CHEMISTRY (Major/ DSC)

UCH120T: Concepts of Inorganic and Physical Chemistry

[60 Hrs] **[4 Credits]**

Course Description: -

The purpose of this course is to introduce the learners with important concepts of inorganic and physical chemistry. The focus is given on extending the study of periodic properties and their trends to the s-. p-, and d- block elements. Learners will also be introduced with the states of matter. The fundamental concepts of chemical thermodynamics are introduced along with thermochemistry.

Course Objectives:-

1. To learn name, symbol, electronic configuration, trends, properties and important applications of s –block elements and to study some of their important compounds.
2. To learn name, symbol, electronic configuration, trends, properties and important applications of p –block elements and to study some of their important compounds.
3. To extend the study of periodic table to the position, physical and chemical properties of first, second and third transition series elements.
4. To understand the behavior of gases, ideal gas as a model system, its extension to real gases and different physical properties of liquids.
5. To study various laws of crystallography and elaborate crystal structures of some compounds
6. To study and understand the tenets of thermodynamics pertaining to First Law of thermodynamics and to correlate between change in enthalpy of various reactions.

Course Outcomes: -

After studying this theory course, students will-

- Learn about the position and various physical and chemical properties of s- and p- b actinides.
- Know the important theories of gaseous state and learn the properties of liquids.
- Know the fundamentals of solid state and structure determination.
- Understand the fundamentals of chemical thermodynamics.

Contents: -

Unit I: s -block elements and Noble Gases (10 Hrs)

A. s-block elements

Comparative study: Electronic configuration, atomic and ionic radii, Ionisation potential, Reducing properties. Diagonal Relationships (Li-Mg).

B. Hydrogen bonding. Classification and effect of Hydrogen bonding on viscosity, solubility, melting point and boiling point. Applications of s-block elements.

C. Chemistry of Noble Gases: Chemical properties of the noble gases, Chemistry of Xenon, Structure, and bonding in xenon fluorides (XeF_2, XeF_4 and XeF_6) and oxyfluorides ($XeOF_2$ and $XeOF_4$).

Unit II: p-block elements (10 Hrs)

A. Comparative study of groups 13 to 17: Atomic and ionic radii, Ionisation potential, electron affinity, electronegativity, redox properties. Diagonal relationship (B-Si).

B. Hydrides: Comparative study with respect to structure of NH_3, PH_3, AsH_3 and SbH_3.

Oxides and Oxyacids of Phosphorous: Structure of P_2O_3, P_2O_5, H_3PO_3 and H_3PO_4 with their Applications.

Peroxyacids of sulphur: Preparation and structure of Caro's and Marshall's acids & Applications

Hydrides of boron: Structure and bonding of diborane , structure of borazine Applications of p- block elements.

C. Preparation, properties and structure of tetrasulphur tetranitride (S_4N_4) and Interhalogen compounds. Polyhalides (Structure of I_3^- and ICl_4^-).

Unit III: (10 Hrs)

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

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 behavior.

Unit IV: States of Matter (10 Hrs)

A. Gaseous State: Kinetic theory of gases (Postulates), kinetic gas equation (no derivation), deduction of various gas laws from kinetic gas equation (Boyle's, Charles', Graham's, Avogadro's laws). Maxwell's distribution of velocities (graph and qualitative discussion), Effect of temperature on molecular velocities. Different types of molecular velocities - most probable, R.M.S. and average, their expressions and numericals. Concepts of Mean free path, collision diameter and collision number. Explanation of deviation of real gases from ideal behavior, Compressibility factor and Boyle temperature. van der Waal's equation of state,

Critical phenomenon, Andrew's isotherm of a real gas (CO_2) and its comparison with van der Waal's isotherm.

B. Liquid State: Important interactions in liquid state – dipole-dipole, dipole-induced dipole, induced dipole-induced dipole; Properties of liquids i) Surface tension: Explanation, Drop number method of determination, (Numericals) ii) Viscosity: Explanation, coefficient of viscosity, Method of determination by Ostwald viscometer. (Numericals)

Unit V: Solid State **(10 Hrs)**

Laws of crystallography i) Law of constancy of interfacial angles ii) Law of rationality of indices iii) Law of symmetry, symmetry elements in crystals. Unit cell, space lattice, orientation of lattice place - Miller indices and Numericals. Bravais lattices, crystal systems, X-ray diffraction of crystal, derivation of Braggs' equation. Determination of crystal structure of NaCl, KCI and CsCl by powder method.

Unit-VI Thermodynamics **(10 Hrs)**

A. Basic concept of thermodynamics: system, surrounding, types of system (closed, open & isolated), thermodynamic variables, intensive & extensive properties, thermodynamic processes: isothermal, adiabatic, isobaric, isochoric, cyclic, reversible & irreversible. State function & path functions, Zeroth law of thermodynamics, First law of thermodynamics, concept of heat capacity, heat capacity at constant volume and at constant pressure, their relationship. Calculations of w, q, ΔE & ΔH for reversible expansion of ideal gases under isothermal and adiabatic conditions (Numericals).

B. Thermochemistry: Standard states, Heat of reaction, enthalpy of formation, enthalpy of combustion, enthalpy of solution, enthalpy of neutralisation, relation between heat of reaction at constant volume and constant pressure. Hess's law of constant heat of summation & its applications (Numericals).

Reference:-

Inorganic Chemistry

- Lee, J.D. *Concise Inorganic Chemistry,* ELBS, 1991.
- Cotton, F.A., Wilkinson, G. & Gaus, P.L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.
- Douglas, B.E., McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry*, John Wiley & Sons.
- Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Education India, 2006.
- *Principles of Inorganic Chemistry*, Puri, Sharma, Kalia
- *Shriver and Atkins Inorganic Chemistry*. 5th Edition, Oxford University Press

Physical Chemistry

- S.H. Marron and C.F.Pruton. *Principles of Physical Chemistry*,4th edition
- Samuel Glasstone. *Textbook of Physical Chemistry*,
- Ira Levine, *Physical Chemistry*, 5th Edition, 2002 Tata McGraw Hill Publishing Co. Ltd.
- G.M. Barrow, *Physical Chemistry*, 6th Edition, Tata McGraw Hill Publishing Co. Ltd. New Delhi.
- Atkins, P. W. & Paula, J. de Atkins *Physical Chemistry* 9th Ed.,Oxford UniversityPress2011.
- Puri, Sharma and Pathania. *Principles of Physical Chemistry*,

- Castellan, G. W. *Physical Chemistry 4th Ed.,* Narosa 2004.
- Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.,* Prentice-Hall 2012.
- McQuarrie, D. A. & Simon, J. D. *Molecular Thermodynamics* Viva Books Pvt. Ltd.: New Delhi 2004.
- Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. *Commonly Asked Questions in Thermodynamics.* CRC Press: NY 2011
- http://nsdl.niscair.res.in
- http://ocw.mit.edu

UCH120P: Concepts of Practical Chemistry

[60 Hrs] **[2 Credits]**

Course Description: -

The purpose of this course is to impart important practical skills to the learners. They will learn to perform experiments with specific aims using appropriate apparatus. The learners will develop skills to observe, record and analyze data. They will be able to interpret the experimental data and to improve analytical skills. The learners will learn to apply theoretical concepts in experiments and corelate between the theory and practicals.

Course Objectives:-

1. To perform quantitative estimation through the redox and complexometric titrations.
2. Know determination of some important properties of liquids.
3. Learn to determine thermodynamic parameters of a reaction.

Course Learning Outcomes:-

On completion of the practical course students will-

- Understand redox and complexometric titrations including analysis of hardness of water. This enables students to work on water treatment plants etc.
- To learn to determine surface tension, coefficient of viscosity of a liquid and thermodynamic properties like heat capacity of calorimeter and enthalpy of a reaction, solubility and heat of solubility.

Contents:-

Inorganic Chemistry

1. Estimation of Fe(II) by dichromate using internal indicator.
2. Determination of Zn by complexometric titration with EDTA
3. Determination of total, permanent and temporary hardness of water by EDTA
4. Estimation of sodium carbonate content of washing soda

Physical Chemistry

1. To determine co-efficient of viscosity of organic liquids by using Ostwald's viscometer.
2. Determination of surface tension of organic liquids by using stalagmometer.
3. Determination of heat capacity of calorimeter for different volumes.
4. Determination of integral enthalpy of solution of KNO_3
5. Determination of enthalpy of ionization of acetic acid.
6. Study of the solubility of benzoic acid in water and determination of heat of solution.

Reference Books

- Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.
- Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
- Das R. C., Behra B., Experimental Physical Chemistry, Tata McGraw Hill.

- Yadav J. B., Advanced Practical Physical Chemistry, Goel Publishing House.
- Alexander Findlay, Levitt B. P., Findlay's Practical Physical Chemistry, Longman, London