

## Syllabus Allied Chemistry for B.Sc. Physics

### SEMESTER-1

17UPHDA02	<b>DSE Allied 2: Chemistry -1</b>	4 hrs./wk	4 Credits
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#### Unit-1: Atomic Structure and Periodic Properties (10 Hrs.)

##### (1) Atomic Structure & Periodicity :

- Dual nature of electron, De-Broglie's equation, Heisenberg's uncertainty principle, quantum numbers, Aufbau principle, Pauli's exclusion and Hund's rule for electron configuration.
- Periodicity in atomic properties and its causes, explanation of general trends of periodic properties: atomic and ionic radii, ionization potential, electronegativity and electron affinity.

##### (2) Chemistry of s and p block elements

- Special characteristics such as metallic character, polarizing power, hydration energy, inert pair effect, relative stability of different oxidation state, diagonal relationship of (1) lithium with magnesium (2) boron with silicon and (3) beryllium with aluminum, anomalous behavior of Li and Be, formation of complex compounds, catenation, allotropy (diamond and graphite-their structure, properties and its uses).

#### Unit-2: Chemical bonding (10 Hrs.)

##### (3) Chemical bonding in Co-valent Compounds:

- Covalent bond: Valence bond theory and its limitations. Concept of hybridization:  $sp$  ( $\text{BeCl}_2$ ),  $sp^2$  ( $\text{BF}_3$ ),  $sp^3$  ( $\text{SiH}_4$ ),  $sp^3d$  ( $\text{PCl}_5$ ) and  $sp^3d^2$  ( $\text{SF}_6$ ).
- Stereochemistry of inorganic molecules: Sidgwick Powell rule and VSEPR theory.  
Structure of molecules:  $\text{SnCl}_2$ ,  $\text{SO}_4^{2-}$ ,  $\text{CO}_3^{2-}$ .
- Basic concept of MO theory. Bonding and anti-bonding molecular orbitals. Gerade and ungerade molecular orbitals.  $\sigma$ -molecular orbital and  $\sigma^*$ -molecular orbital,  $\pi$ - molecular orbital and  $\pi^*$ -molecular orbital. Conditions for effective combinations of atomic orbitals. Energy level diagrams of  $\text{B}_2$ ,  $\text{C}_2$ ,  $\text{N}_2$ ,  $\text{O}_2$ ,  $\text{F}_2$ ,  $\text{CO}$ ,  $\text{NO}$ ,  $\text{CO}_2$  (with s-p mixing and orbital interaction) with calculation of bond order and magnetic moment. Comparison of MO theory and VB theory.

#### Unit-3: Organic Chemistry (10 Hrs.)

##### (4) Basic Organic chemistry and Aliphatic hydrocarbons containing $\sigma$ bond

- Nomenclature of organic compounds (Only acyclic - IUPAC-1993).  
Electronic displacements: Inductive, electromeric, mesomeric effects and hyper conjugation.  
Applications of inductive effect to bond length, dipole-moment, reactivity of alkyl halides, relative strength of acid, basicity of amines.

- Homolytic and heterolytic fission, curly arrow rules, Reaction intermediates: carbocation, carbanion, free radical, carbenes and benzyne (formation by cleavage type, structure, relative stabilities, generation). Types of organic reagents: Nucleophiles and electrophiles.
- Types of organic reactions: Substitution, addition, elimination and rearrangement. Nucleophilic substitution reaction mechanism ( $S_N1$  &  $S_N2$ ) for alkyl halides.
- Introduction to stereochemistry: Configuration, Fischer projection formula, homomers and enantiomers. Geometrical isomerism: cis-trans, C.I.P rules with E/Z notations.

#### Unit-4: Organic Chemistry

(10 Hrs.)

##### (5) Aliphatic hydrocarbons (acyclic)

###### Chemistry of alkanes:

- Formation of alkanes: Wurtz reaction, Wurtz-Fittig reactions. Free radical substitutions : Halogenation-relative reactivity and selectivity.

###### Hydrocarbons containing carbon-carbon $\pi$ bonds

- Formation of alkene elimination reactions, dehydration of alcohols, dehydrohalogenation of alkyl halides, dehalogenation of vicinal and geminal dihalides.
- Mechanism of E1, E2, E1cb reactions, Saytzeff and Hofmann eliminations. Electrophilic addition reactions and their mechanisms (Markownikov/Anti Markownikov rule).
- Formation of alkynes: Dehydrohalogenation of vicinal and geminaldihalides, dehalogenation of tetrahalides.
- Reactions of alkynes: Acidity, electrophilic addition reactions like halogenation, hydrohalogenation, hydration, hydroboration, addition of carbene and catalytic hydrogenation. Nucleophilic addition with hydrogen cyanide and alcohol, hydration to form carbonyl compounds, alkylation of terminal alkynes.
- Reactions of alkenes: Oxymercuration-demercuration, hydroboration oxidation, ozonolysis, reduction (catalytic), syn and anti-hydroxylation (oxidation), 1,2-and 1,4- addition reactions in conjugated dienes, Diels-Alder reaction.

#### Unit-5: Physical Chemistry

(10 Hrs.)

##### (6) Chemical kinetics

- Concept of chemical kinetic: rate of chemical reaction, concentration dependence of reaction rate specific reaction rate constant, order and molecularity of the reaction. Factors affecting rate of the reaction.
- Definition, derivation of integrated rate equations for zero, first and second (same and different reactants) order reactions, their characteristics and half -life periods.
- Determination of the order of reaction: (1) Hit and trial method or Integration method and its limitations (2) Fractional change method, (3) Oswald's isolation method (4) graphical method and (5) Van't Hoff differential method. Concept of activation energy. Derivation of Arrhenius equation and determination of activation energy by integrated equation and graphical methods.
- Theories of reaction rates: Collision theory and absolute reaction rate theory of

bimolecular reactions and qualitative comparison. Numerical.

**(7) Adsorption (04 Hrs.)**

- Introduction, types of adsorption (physical and chemical), characteristics and factors affecting adsorption. Adsorption isotherm and Freundlich equation. Langmuir theory of adsorption: assumptions, derivation, modification in equation at very low and high pressure, limitations and applications of adsorption.

**(8) Catalysis (04 Hrs.)**

- Introduction, types of catalysis (homogeneous and heterogeneous), characteristics of catalysis, autocatalysis, negative catalysis (Inhibitor), promoters, and catalytic poisoning. Activation energy and catalysis. Theories of catalysis: (1) Intermediate compound formation and (2) adsorption theory, active centers. Enzyme catalysis and its characteristics.

**Text Books:**

1. Bansal, Raj K. (2009, Fifth) *A Textbook of Organic Chemistry*. New Delhi: New Age International (ISBN: 978-81-224-2025-8).
2. Bahl, Arun; Bahl, B. S.; Tuli, G. D. (2010) *Essential of Physical Chemistry*. New Delhi : S. Chand (ISBN No. 81-219-2978-4)

**Reference Books:**

**Inorganic Chemistry**

1. Madan, R. L. (2011) *Chemistry for degree student First year*. New Delhi: S. Chand (ISBN: 81-219-3230-0).
2. Lee, J. D. (2002, Fifth edition) *Concise Inorganic Chemistry*. Hoboken: Wiley-Blackwell Science Ltd. (ISBN: 0-632-05293-7).
3. Peter Atkins, Tina Overton, Jonarthan Rourke, Mark Weller & Fraser Armstrong (2010, Fifth edition) *Inorganic Chemistry*. Oxford: Oxford University Press (ISBN: 978-0-19-959960-8).
4. UGC Inorganic Chemistry - H. C. Khera ( Pragati Prakashan).

**Organic Chemistry**

1. Ahluwalia, V. K. (2011, Fourth edition) *Organic Reaction Mechanism*. New Delhi: Narosa (ISBN: 978-81-8487-115-9).
2. T.W. Graham Solomons (2011, 10th edition) *Organic Chemistry*. Hoboken: John Willey & Sons (ISBN: 978-0-470-55659-7).
3. Clayden, Greeves, Warren & Wothers (2012) *Organic Chemistry*. Oxford: Oxford University Press (ISBN: 978-0-19-850346-0).
4. Agrawal, O. P. (2009, 46th edition) *Organic Chemistry: Reaction and Reagents*. Meerut: Krishna Prakashan Media (p) Ltd. (ISBN: 81-87224-65-7).
5. Morrison & Boyd (2009, Sixth edition) *Organic Chemistry*. New Jersey: Pearson Education (ISBN: 978-81-7758-169-0).

**Physical Chemistry**

1. Negi, A. S.; Anand, S. C. (2007, Second edition) *A Textbook of Physical Chemistry*. New Delhi: New age International Publisher (ISBN: 81-224-2005-0).
2. Peter Atkins (2006) *Atkin's Physical Chemistry*. Oxford: Oxford University Press (ISBN: 9780198700722).

3. Arun Bahl; B.S. Bahl (2009, First edition) *Numerical Problems in Physical Chemistry*. New Delhi: S. Chand (ISBN: 81-219-3084-7).
4. Madan, R. L. (2011) *Chemistry for degree student Second year*. New Delhi: S. Chand (ISBN: 81-219-3538-5).
1. Principles of Physical Chemistry, Samuel H. Maron and Carl F. Prutton, Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
2. Physical Chemistry, B. K. Sharma, Goel Publication House. Meerut.
3. Chemical Kinetics, G. R. Chatwal and Harish Mishra, Goel Publication House. Meerut.
4. An Introduction of Physical Chemistry, D. K. Chakrabarty, Narosa Pub. House, New Delhi.

**SEMESTER-1**

<b>17UPHDA04</b>	<b>DSE Allied 4: Chemistry Practical-1</b>	<b>5 hrs./wk</b>	<b>3 Credits</b>
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**1. Organic qualitative analysis [20 marks]**  
**(Minimum 10 compounds)**

Compounds containing one functional group such as phenolic, carboxylic acid, ester, amide, nitro, amine, aldehyde, ketone, alcohol, halogen, anilide, carbohydrate and hydrocarbon.

**List of compounds:**

Benzoic acid, cinnamic acid, phenol,  $\alpha$ -naphthol,  $\beta$ -naphthol, acetone, ethyl methyl ketone, methyl acetate, ethyl acetate, naphthalene, anthracene, aniline, nitrobenzene, benzamide, urea, thiourea, chloroform, acetanilide, carbon tetrachloride, chlorobenzene, bromobenzene.

**2. Volumetric Analysis [20 Marks]**

**Acid-base titrations**

1. To determine the normality, molarity and g/lit of NaOH and HCl using 0.1 N  $\text{Na}_2\text{CO}_3$  solution.
2. Preparation and standardisation of 0.1 N/M NaOH, 0.1 N/M HCl and 0.1 N/m  $\text{H}_2\text{SO}_4$  by 0.1 N/M oxalic acid.
3. To determine the normality, molarity and g/lit of each component in a given mixture of  $\text{NaHCO}_3$  and  $\text{Na}_2\text{CO}_3$  using 0.1N HCl solution.
4. Determination of acetic acid in a commercial vinegar using 0.1M NaOH solution.
5. Determination of alkali in antacid using 0.1M HCl solution.

**3. Physicochemical Exercise [20 Marks]**

1. To determine the specific reaction rate of the hydrolysis of methyl acetate / ethylacetate catalyze by  $\text{H}^+$  ion at room temperature
2. To determine the relative strength between HCl &  $\text{H}_2\text{SO}_4$  by studying hydrolysis methyl acetate catalyze by acid.
3. To determine the rate of adsorption of the given organic acid using animal charcoal.

**Reference Books:**

1. Brian S. Furniss (1989, Fifth edition) *Vogel's Textbook of Practical Organic Chemistry*. Hoboken: John Willey & Sons (ISBN: 0-582-462363).
2. Hassner, A. (2012, Third edition) *Organic Syntheses Based on Name Reactions*. Philadelphia: Elsevier Publishing company (ISBN: 978-0-08-096630-4).
3. Jeffery, G. H.; Bassett, J.; Mendham, J.; Denny, R. C. (1989) *Vogel's Textbook of Quantitative Chemical Analysis*. Hoboken: John Willey & Sons (ISBN: 0-582-44693-7).
4. Jerry R. Mohrig (2010, Third edition) *Techniques in Organic chemistry*. London: W. H. Freeman & Company (ISBN: 1-4292-1956-4).
5. Svehla, G. (1979, Fifth edition) *Textbook of macro and semi micro qualitative analysis*. London: Logman Publishing group (ISBN: 0-582-44367-9).

## SEMESTER-2

17UPHDA06	DSE Allied 6: Chemistry-2	4 hrs./wk	4 Credits
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### Unit-1:

- (1) **Basics of ionic compounds** (7 hrs.)
- Introduction, characteristics of ionic solids, Born Haber cycle and its applications, Max Born equation, limiting radius ratio. Relation between radius ratio, coordination number and crystal structure. Derivation of  $r^+/r^-$  ratio in triangular, planar, square planar, body centered and tetrahedral crystal lattices. Defects in ionic crystals (stoichiometric and non-stoichiometric), study of N & P types of semi-conductors.
- (2) **Solid state** (8 hrs.)
- Nature of solids, unit cells, crystal systems, Bravais lattices and identification of planes. Laws of crystallography: (1) Law of symmetry, (2) Law of constancy of interfacial angles and (3) law of rational indices. Miller and Weiss indices. Derivation of Bragg's law. X-Ray Diffraction methods: Rotating crystal method and powder method. Structures of NaCl, CsCl and KCl. Numericals.

### Unit-2:

- (3) **Chemistry of elements of 3d series** (6 hrs.)
- Introduction, definition, electronic configuration, reversal of energies of 3d and 4s orbitals, physical properties such as atomic properties (atomic radii, Ionic radii, and ionization potential), metallic conductivity, melting point & boiling point, density, reducing properties, tendency of formation of alloys, catalytic properties, magnetic and spectral properties. Calculation of spin only magnetic momentum of inner orbital and outer orbital complexes  $[\text{NiCl}_4]^{-2}$ ,  $[\text{Ni}(\text{CN})_4]^{-2}$ ,  $[\text{FeF}_6]^{-4}$ ,  $[\text{Fe}(\text{CN})_6]^{-4}$ .
- (4) **Basics of co-ordination chemistry** (7 hrs.)
- Warner theory, types of ligands (simple ligands,  $\pi$ -acid ligands, according to number of donating electrons, chelating ligands) with definition and examples. Co-ordination number and geometry related to co-ordination number. Isomerism and its classification (structural and stereo isomerisms). In structural isomerism: (1) ionization (2) hydration (3) co-ordination (4) co-ordination positions (5) polymerization and (6) linkage isomerism. Geometric/cis-trans isomerism in  $\text{ML}_4$  and  $\text{ML}_6$  types of complexes.

### Unit-3:

- (5) **Cycloalkanes** (10 hrs.)
- Introduction and classification of ring system (monocyclic and polycyclic, size, number of carbon atoms common between the two rings).
  - IUPAC nomenclature of cycloalkanes (including simple spiro compounds, fused ring and bridged ring systems-bicyclic only).

- Method of preparation of small ring cycloalkanes: Intra-molecular Wurtz's reaction, Simmons-Smith, Diels-Alder reaction
- Chemical properties of cycloalkanes: Substitution reactions, addition reactions, Baeyer's strain theory and its limitations (puckering).
- Conformations and conformational analysis: Conformation of ethane, propane and butane.

#### Unit-4:

#### (6) Aromatic hydrocarbons (10 hrs.)

- Aromaticity: Criteria for aromatic, non-aromatic and antiaromatic types, applications of Huckel's rule to simple annulene, cyclic carbocation /anion.
- Electrophilic aromatic substitution reactions of benzene with mechanism. Theory of effect of substituents on reactivity and orientation (with resonating structures for activating and deactivating groups).
- Electrophilic aromatic substitution reactions of the followings with mechanisms: Halogenation, nitration, sulphonation, Friedel Crafts alkylation, Friedel Crafts acylation.

#### Unit-5: Physical Chemistry (12 hrs.)

#### (7) Ionic equilibria

- Types of electrolytes. Degree of ionization and factors affecting degree of ionization. Ionization constant and Ionic product of water. Ionization constants of weak acids and bases. Common ion effect and calculation of concentrations of  $\text{OH}^-$  ions ( $\text{NH}_4\text{Cl} + \text{NH}_4\text{OH}$ ) and  $\text{H}^+$  ions ( $\text{H}_2\text{S} + \text{HCl}$ ). Solubility and solubility products of sparingly soluble salts- applications of solubility product.
- Hydrolysis of salts: Definition of hydrolysis of salts. Salts of strong acids and bases. Relation among  $K_h$ ,  $K_a$ , or  $K_b$  and  $K_w$ . Degree of hydrolysis and pH of the solution of salts of weak acids and strong bases, salts of weak bases and strong acids and salts of weak bases and weak acids.
- Buffer solutions: Definition and types of buffer solutions, Buffer action, derivation of Henderson-Hasselbalch equation. Numericals.

#### Text Books:

1. Puri, B. R.; Sharma, L. R. & Kalia, K. C. (2010-11) *Principles of Inorganic Chemistry*. New Delhi: Milestone.
2. Bahl, Arun; Bahl, B. S.; Tuli, G. D. (2010) *Essential of Physical Chemistry*. New Delhi : S. Chand (ISBN No. 81-219-2978-4)

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## SEMESTER-2

17UPHDA08	DSE Allied 8: Chemistry Practical -2	5 hrs./wk	3 Credits
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**1. Qualitative analysis of Inorganic salts: [20 Marks]**

**(Minimum 10 salts-containing two radicals)**

Inorganic salts containing anion: chloride, bromide, iodide, nitrate, nitrite, sulphate, sulphite, sulphide, carbonate, phosphate (soluble & insoluble), oxide, chromate, and dichromate.

**2. Titrimetric Analysis**

**A: Complexometric Titration (Standard solution should be given) [20 Marks]**

1. Quantitative estimation of  $\text{Cu}^{2+}$  in a given  $\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$  solution using 0.01M EDTA solution.
2. Quantitative estimation of  $\text{Ni}^{2+}$  in a given  $\text{NiSO}_4 \cdot 7\text{H}_2\text{O}$  solution using 0.01M EDTA solution.
3. Quantitative estimation of  $\text{Zn}^{2+}$  in a given  $\text{ZnCl}_2$  solution using 0.01M EDTA solution.
4. Determination of total hardness of water by EDTA.
5. Quantitative estimation of  $\text{Fe}^{2+}$  by dichromate method (Internal indicator method)

**B: Redox titrations [20 Marks]**

1. To determine the normality, molarity and g/lit of each component in a mixture of  $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$  and  $\text{H}_2\text{SO}_4$  using 0.1 N  $\text{KMnO}_4$  and 0.1N NaOH solution.
2. To determine the normality, molarity and g/lit of each component in a mixture of  $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$  and  $\text{K}_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$  using 0.1N NaOH and 0.1 N  $\text{KMnO}_4$  solution
3. To determine the normality, molarity and g/lit of  $\text{KMnO}_4$  and  $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$  solution using 0.1 N  $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$  solution.

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4. Jerry R. Mohrig (2010, Third edition) *Techniques in Organic chemistry*. London: W. H. Freeman & Company (ISBN: 1-4292-1956-4).
5. Svehla, G. (1979, Fifth edition) *Textbook of macro and semi micro qualitative analysis*. London: Longman Publishing group (ISBN: 0-582-44367-9).