Shri Shivaji Education Society Amravati's

Shri Pundlik Maharaj Mahaviydalaya Nandura, Dist- Buldana

Affilated Sant Gadge Baba Amravati University Amravati

Department of Chemistry

Class:- B.Sc-I, Semester-II

Code of the Course/Subject:-Chemistry (CHE) Theory, (Total Number of Periods): 84

Course Outputs:

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

1. apply the knowledge gained by studying types of bonding, solvation, hybridization and molecular geometries.
2. Draw the correct molecular structures, bond order and bond length.
3. synthesize commercially important compounds of varying carbon backbone.
4. Choose correct synthetic approach to prepare derivatives of industrially important molecules.
5. Solve numerical problems related to crystalline state.
6. Acquire skills to use chemical kinetics to develop mechanism of chemical reactions.

Theory Syllabus

Unit	Content
Unit I	**Periods: 14** **A) Ionic bonding:** Definition of ionic bond. Factors affecting ionic bond formation (energetic of ionic bond formation ionization energy, electron affinity and lattice energy). Born-Haber's cycle to determine lattice energy. Solvation and solvation energy, factors affecting solvation energy. **B) Polarization**: Definition, polarizing power, polarizability, effect of polarization on nature of bond. Fajan's rules of polarization and its applications. **C) Valence bond theory**: Directional nature of covalent bond. Hybridization, types of hybridization to explain geometries of $BeCl_2$, BF_3, CH_4, PCl_5, SF_6 and IF_7
Unit II	**Periods: 14** **A) VSEPR Theory**: Various rules under VSEPR theory to explain molecular geometry (following examples may be taken to explain various rules- $SnCl_2$, CH_4, NH_3, H_2O, SF_4, ClF_3, XeF_4, XeO_3, PCl_3. Limitations of VSEPR theory **B) Molecular Orbital Theory:** Postulates of MO theory. LCAO approximation. Formation of bonding and antibonding MOs. Rules for LCAO. MO energy level diagram. Concept of bond order. MO structure of homonuclear diatomic

	molecules of namely He_2, H_2, N_2 and O_2. Stability sequence of species of O_2 i.e. O_2, O_2^+, O_2^{2+}, O_2^- and O_2^{2-}. Paramagnetic nature of O_2. MO structure of heteronuclear diatomic molecules viz. NO, HF and CO (Coulson's structure). Explanation of important properties of CO viz. – triple bond, almost nonpolar nature, electron donor and acceptor behavior. Comparison of VB and MO theories.
Unit III	**Periods: 14** **A) Haloalkanes:** Vinyl chloride - Synthesis from acetylene and ethylene dichloride, reactions with aqueous and alcoholic KOH, polymerization. Allyl chloride - Synthesis from propylene, reactions with aqueous and alcoholic KOH. Allyl bromide - Synthesis from propylene using NBS, reaction with HBr. Comparison of reactivity of vinyl and allyl chloride. **B) Haloarenes:** Chlorobenzene - Synthesis from phenol, reaction with acetonitrile. Bromobenzene - Synthesis from silver salt of benzoic acid (Hunsdiecker reaction), Wurtz-Fittig reaction. Iodobenzene - Synthesis from benzene diazonium chloride, Ullmann reaction. Benzyl chloride - Synthesis from toluene and benzene, reactions with Mg and NaCN. Comparison of reactivity of chlorobenzene and benzyl chloride, benzyne intermediate mechanism. **C) Polyhydric alcohols**: Ethylene glycol - Synthesis from ethylene and ethylene dibromide, reactions with PCl_5, CH_3COOH and acetone, dehydrations using conc. H_2SO_4, $ZnCl_2$ and phosphoric acid. Pinacol - Synthesis from acetone and α-diketone, Pinacol-Pinacolone rearrangement (mechanism). Glycerol - Synthesis from propylene and 3-chloropropylene, reactions with HNO_3, HCl and Na, dehydration using $KHSO_4$
Unit IV	**Periods: 14** **A) Phenols:** Phenol - Synthesis from toluene, cumene and salicylic acid, Kolbe's carboxylation reaction, Fries rearrangement, Reimer-Tiemann reaction, bromination, acidity of phenol. **B) Ethers and epoxides:** Diethyl ether - Synthesis from ethanol, Williamson's synthesis, reactions with cold and hot HI and acetic anhydride. Crown ethers - Brief introduction to crown ethers and its applications. Ethylene oxide - Synthesis from ethylene, ring opening reactions with Grignard reagent, HCN and H2S, reduction with Zn + CH_3COOH, dimerization to dioxane (mechanism). Styrene oxide - Synthesis from styrene, ring opening reactions with acid and alkali, reduction with $LiAlH_4$. **C) Thiols and thioethers:** Ethanethiol - Synthesis from ethyl iodide, oxidations with I_2 and H_2O_2. Diethyl sulphide - Synthesis from ethyl bromide, Williamson's synthesis, desulphurization with Raney Ni, decomposition with alkali
Unit V	**Periods: 14** **Crystalline state:** Symmetry in crystal, plane of symmetry, axis of symmetry and point of symmetry. Law of constancy of interfacial angles. Elements of symmetry in cubic crystals. Laws of symmetry. Law of rational indices, Weiss and Miller

	indices of a lattice planes, calculation of interplanar distance d(h,k,l) from Miller indices in a cubic system. Seven crystal systems and fourteen Bravais lattices, Bravais lattices of cubic system. Simple cubic system (S.C.C.), body centered cubic system (B.C.C.) and face centered cubic system (F.C.C.). Calculation of number of constituent units in S.C.C., B.C.C. and F.C.C. Ratio of interplanar distances for 100, 110 and 111 lattice planes in S.C.C., B.C.C. and F.C.C. (No geometrical derivation). Derivation of Bragg's equation for X-ray diffraction, Bragg's X-ray spectrometer method for the determination of crystal structure of NaCl and KCl. Anomalous behavior of KCl towards X-ray. Numerical.
Unit VI	**Periods: 14** **Chemical Kinetics:** Explanation of terms like rate of reaction, order of a reaction and molecularity. Definition with one example of zero, first and second order reaction. Half-life period of a reaction. Derivation of rate equation for first and second order reaction with equal initial concentration and different initial concentration of a reactant. Characteristics of first and second order reaction. Examples of first and second order reaction and their kinetics study with modified rate equation viz. the reactions (i) decomposition of H_2O_2, (ii) reaction between $K_2S_2O_8$ and KI, (iii) hydrolysis of methyl acetate catalyzed by acid, (iv) saponification of ethyl acetate by NaOH and (v) inversion of cane sugar. Determination of order of a reaction by integration, graphical, equifractional change, vant Hoff's differential method and Ostwald's isolation method. Effect of temperature on reaction rates. Arrhenius equation, activation energy and its determination using Arrhenius equation. Numerical.
***SEM:**	**A)** Classify molecules using hybridization, VSEPR theory to predict molecular geometries, sketch Molecular orbital diagram for different molecules. **B)** Comparative reactivity of halobenzene and benzyl halide, determine industrial uses of phenol, diethyl ether and ethylene epoxide. **C)** Numerical associated with crystalline state and chemical kinetics, Determination of crystal structure of NaCl and KCl, Determination of order of reactions, and reaction kinetics.
COs:	By the end of this module, the students will be able to: 1. Create models associated with molecular geometries, hybridization, MO diagrams. 2. Develop synthetic routes for halobenzenes and benzyl halides. 3. Solve numerical problems associated with crystalline state and chemical kinetics
Activities:	Model creation, Chart preparation, memory maps, Class tests, assignments, project, survey, group discussion, industrial visit, or any other innovative pedagogical method. Any two activities be conducted from above. Class tests are compulsory. Equal weightage for each activity.

List of Practical/Laboratory Experiments
(Organic & Physical)
(No. of Periods/Week):- Total 26 per Semester
Code of the Course/Subject:- CHE (PR) (Chemistry Practical)

Course Outcomes

- At the end of Lab/Practical course, students would be able to -
- 1. Analyse the given organic compound qualitatively by different tests.
- 2. Prepare the derivative of the provided substance.
- 3. Illustrate the practical skills in volumetric analysis.
- 4. Differentiate types of titrations e.g. acid-base, redox, etc.
- 5. Comprehend the kinetics of reactions and interpret the experimental data.
- 6. Calculate, communicate and analyse the result.

Complete analysis of simple organic compounds (like urea, thiourea, benzoic acid, Salicylic acid, oxalic acid, glucose, naphthalene, para-toluidine, benzamide, etc.) containing one or two functional groups involving following steps.
i) Preliminary examination
ii) Detection of elements
iii) Detection of functional groups
iv) Determination of melting point
v) Preparation of derivative and determination of its melting point
vi) Performance of spot test, if any

1. Qualitative analysis of compound-1
2. Qualitative analysis of compound-2
3. Qualitative analysis of compound-3
4. Qualitative analysis of compound-4
5. Qualitative analysis of compound-5
6. To determine the strength of oxalic acid by titration with $KMnO_4$.
7. To determine strength of FAS by titration with $KMnO_4$ using internal indicator.
8. Determination of temporary hardness of water sample.
9. To determine the strength of oxalic acid by titration with $KMnO_4$.
10. To determine strength of FAS by titration with KMnO4 using internal indicator.
11. Determination of order of reaction of hydrolysis of methyl acetate by an acid.
12. To study kinetics of saponification of ethyl acetate by NaOH.

Distribution of Marks for Practical Examination

Time: 4 hours (One Day Examination) **Marks: 50**

Exercise-I …….. 18
Exercise-II ……..18
Viva-Voce ……. 07
Record ……...07
Total: 50

Course Material/Learning Resources

Text books:

1. Stereochemistry and mechanism through solved problems by P.S. Kalsi.
2. Text book of Inorganic Chemistry by K.N. Upadhyaya, Vikas Publishing House, Delhi.
3. A Text Book of Chemistry for first Semester of B.Sc. by AUCTA Association and DnyanPath Publication, Amravati

Reference Books:

1. Principles of Inorganic Chemistry by Puri, Sharma and Kalia- S. Naginchand & Co., Delhi.
2. Inorganic Chemistry by A.K. De, Wiley East Ltd.
3. Selected Topics in Inorganic Chemistry by Malik, Tuli and Madan, S. Chand & Co.
4. Concise Inorganic Chemistry by J.D. Lee, ELBS.
5. Inorganic Chemistry by J.E. Huheey- and Kettle, Harper & Row.
6. Advanced Inorganic Chemistry, Vol-I, Satya Prakash, Madan, Tuli, Basu.
7. Organic Chemistry Vol. I, II and III by Mukharjee, Singh and Kapoor- Wiley Eastern.
8. Organic Chemistry by S.K. Ghosh. 11
9. Reaction Mechanism in Organic Chemistry by S.M. Mukharjee and S.P. Singh.
10. Organic Chemistry by J.M. Hornback, 2nd Edition, Brooks Cole Pub
11. Organic Chemistry by TWG Solomons, 8th edition, John Wiley
12. Organic chemistry by R. K. Bansal
13. Physical Chemistry: Walter, J. Moore, 5th edn., New Delhi.
14. Physical Chemistry: G.M. Barrow, McGraw Hill, Indian Edn.
15. Principles of Physical Chemistry: Maron and Prutton.
16. Principles of Physical Chemistry: Puri, Sharma, and Pathania.
17. Physical Chemistry: P.W. Atkins, 6th Edn.
18. Physical Chemistry: Levine
19. Practical Organic Chemistry by F.G. Mann, B.C. Saunders, Orient Longman.
20. Comparative Practical Organic Chemistry (Qualitative Analysis) by V.K. Ahluwalia and Sunita Dhingra, Orient Longman.
21. Comprehensive Practical Organic Chemistry (Preparation and Qualitative Analysis) by V.K. Ahluwalia and Renu Agrawal, Orient Longman.
22. Practical Physical Chemistry: Palit and De.

23. Practical Physical Chemistry: Yadao.
24. Practical Physical Chemistry: Khosla.
25. Advanced Practical Inorganic Chemistry by Gurdeep Raj, Goel Pulishing House, Meerut.

Weblink to Equivalent MOOC on SWAYAM if relevant:
Weblink to Equivalent Virtual Lab if relevant:
Any pertinent media (recorded lectures, YouTube, etc.) if relevant:

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