Major (Core Course) for HONOURS in CHEMISTRY

SEMESTER-I

DS-1

(Credits: Theory-03, Practicals-02)

Theory: 45 Lectures **Marks: 50**

All Units carry equal marks

Unit-1: Atomic Structure & Radioactivity

(15 Lectures)

Bohr's theory for hydrogen atom (simple mathematical treatment), its limitations and 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. Wave mechanics: de Broglie wave equation, Qualitative idea of Heisenberg's Uncertainty Principle. Radial and Angular distribution curves. Shapes of s, p and d orbitals. Exchange energy (qualitative idea).

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.

Unit-2: Basics of Organic chemistry

(15 Lectures)

Nomenclature for acyclic compounds only (trivial and IUPAC), DBE, hybridization(sp", n= 1,2,3) of C, N, O, halogens, bond distance, bond angles, VSEPR, shapes of molecules, inductive and field effects, bond energy, bond polarity and polarisability, dipole moment, resonance, resonance energy, steric inhibition of resonance, hyperconjugation, $\boldsymbol{\pi}$-M.O diagrams of ethylene, butadiene, 1,3,5- hexatriene, allyl cation, allyl anion, allyl radical, HOMO and LUMO in ground and excited states, orbital pictures of allene, carbene(singlet and triplet), vinyl cyanide, Huckel's rule for aromaticity and antiaromaticity (neutral systems 4,6,8,10 annulene, charged systems 3,4,5,7 rings, Frost-diagram, melting point, boiling point, heat of hydrogenation, heat of combustion, hydrogen bonding (intra- and inter-molecular),

crown-ether, concepts of acidity, basicity. Reaction intermediate, carbocation, carbanion, radicals, carbene & stability and generation.

Unit-3: Kinetic Theory of Gas

(15 Lectures)

Concept of pressure and temperature. Nature of the distribution of velocities in one dimension (with derivation), extension to two and three dimensions (without derivation, expression by induction). Maxwell's distribution of speeds in one, two and three dimensions, calculations of average, root mean square and most probable values in each case. Graphical comparison of velocity and energy distribution.

Collision of gas molecules; collision diameter; collision number and mean free path; frequency of binary collisions (similar and different molecules); wall collision and rate of effusion. Viscosity of gases from kinetic theory of gas.

Reference Books:

1. Lee J. D. *Concise Inorganic Chemistry*, 5th Ed., Wiley India Pvt. Ltd., 2008.
2. Douglas, B. E. and McDaniel, D. H. *Concepts & Models of Inorganic Chemistry* Oxford, 1970.
3. Day, M.C. and Selbin, J. *Theoretical Inorganic Chemistry*, ACS publications, 1962.
4. Atkins, P. *Shriver & Atkins' Inorganic Chemistry*, 5th Ed., Oxford University Press (2010).
5. Cotton, F.A., Wilkinson, G. and Gaus, P. L., *Basic Inorganic Chemistry 3rd Ed.*, Wiley India.
6. Sharpe, A. G., *Inorganic Chemistry*, 4th Indian Reprint (Pearson Education) 2005.
7. Huheey, J. E.; Keiter, E. A. & Keiter, R.L., *Inorganic Chemistry, Principles of Structure and Radioactivity 4th Ed*., Harper Collins 1993, Pearson, 2006.
8. Atkins, P.W. & Paula, J. *Physical Chemistry*, Oxford Press 2006.
9. Mingos, D.M.P., *Essential trends in Inorganic Chemistry*, Oxford University Press (1998).
10. Winter, M. J., The Orbitron, http://winter.group.shef.ac.uk/orbitron/ (2002). An illustrated gallery of atomic and molecular orbitals.
11. Burgess, J., *Ions in solution: basic principles of chemical interactions*, Ellis Horwood (1999).
12. . Finar, I. L. Organic Chemistry (Vol- 1), 6th Edition, Pearson Education, 2002

13. 2. Sykes, P. A guidebook to Mechanism in Organic Chemistry, Pearson Education, 2003.
14. 3. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
15. 4. Nasipuri, D. Stereochemistry of Organic Compounds, Wiley Eastern Limited.
16. 5. Graham Solomons, T.W. Fryhle, C. B. Organic Chemistry, John Wiley & Sons, Inc.
17. 6. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.
18. 7. Clayden, J., Greeves, N. & Warren, S. Organic Chemistry, Second edition, Oxford University Press, 2012.
19. 8. Carey, F. A., Guiliano, R. M. Organic Chemistry, Eighth edition, McGraw Hill Education, 2012.
20. Castellan, G. W. Physical Chemistry, Narosa
21. 3. McQuarrie, D. A. & Simons, J. D. Physical Chemistry: A Molecular Approach, Viva Press
22. 4. Engel, T. & Reid, P. Physical Chemistry, Pearson
23. 5. Levine, I. N. Physical Chemistry, Tata McGraw-Hill
24. 6. Maron, S. &Prutton Physical Chemistry
25. 7. Ball, D. W. Physical Chemistry, Thomson Press
26. 8. Mortimer, R. G. Physical Chemistry, Elsevier
27. 9. Laidler, K. J. Chemical Kinetics, Pearson
28. 10. Glasstone, S. & Lewis, G.N. Elements of Physical Chemistry
29. 11. Rakshit, P.C., Physical Chemistry Sarat Book House
30. 12. Zemansky, M. W. & Dittman, R.H. Heat and Thermodynamics, Tata-McGrawHill
31. 13. Rastogi, R. P. &Misra, R.R. An Introduction to Chemical Thermodynamics, Vikas
32. 14. Klotz, I. M. & Rosenberg, R. M. Chemical Thermodynamics, Wiley

Practical

(60 Lectures/Contact hours) **Marks: 50**

1. **Preparation of Standard solutions**

a) Primary Standard: $K_2Cr_2O_7$, Oxalic Acid

b) Secondary Standard: $KMnO_4$, $Na_2S_2O_3$, Mohr's Salt

2. **Standardization of Secondary Standard Solution: ($KMnO_4$, $Na_2S_2O_3$, Mohr's Salt)**
3. **Identification of Pure Organic Compounds**

   Liquid compounds: methanol, ethanol, acetone, aniline, dimethylaniline, benzaldehyde, chloroform, and nitrobenzene

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

   (Only unknown liquid and solid compounds as specified are to be written in laboratory notebook)

4. **Determination of boiling points of different Organic Compounds**

   Organic liquids with less than 135^0C boiling point may be taken for experiments. Boiling points of two unknown organic compounds should be noted with literature survey (Reference may be incorporated therein)

5. **Determination of molecular properties of liquids**

a. **Study of viscosity** of unknown liquid (glycerol, sugar) with respect to water.

b. Determination of **relative surface tension of a liquid** using Stalagmometer

Reference Book:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis* 6th Ed., Pearson, 2009
2. Practical Workbook Chemistry (Honours), UGBS, Chemistry, University of Calcutta, 2015.
3. Nad A. K., Mahapatra B. and Ghosal A. An Advanced Course in Practical Chemistry, New Central Book Agency (P) Ltd.
4. Ghosh S., Das Sharma M., Majumder D and Manna S. Chemistry in Laboratory, Santra Publication Pvt Ltd
5. Vogel, A. I. Elementary Practical Organic Chemistry, Part 2: Qualitative Organic
6. Analysis, CBS Publishers and Distributors.
7. Viswanathan, B., Raghavan, P.S. Practical Physical Chemistry Viva Books (2009)
8. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson
9. Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007)

10. Palit, S.R., De, S. K. Practical Physical Chemistry Science Book Agency
11. University Hand Book of Undergraduate Chemistry Experiments, edited by
12. Mukherjee, G. N., University of Calcutta
13. Levitt, B. P. edited Findlay's Practical Physical Chemistry Longman Group Ltd.
14. Gurtu, J. N., Kapoor, R., Advanced Experimental Chemistry S. Chand & Co. Ltd.

SEMESTER-II

DS-2

(Credits: Theory-03, Practicals-02)

Theory: 45 Lectures **Marks: 50**

All Units carry equal marks

Unit-1: Acid-Base reactions

(15 Lectures)

Acid-Base concept: Arrhenius concept, theory of solvent system (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. Superacids, proton affinity; HSAB principle. Acid-base equilibria in aqueous solution (Proton transfer equilibria in water), pH, buffer. Acid-base neutralization curves; indicator, choice of indicators. Solubility product, common ion effect and their application in analytical chemistry. (Gr. II A, B & Gr. III A, B).

Unit-2: Stereochemistry

(15 Lectures)

Stereochemistry of acyclic compounds: representation of molecules in Fischer, flying- wedge, Sawhorse and Newman formula and their translations, chirality, elements of symmetry, simple axis (C_n), plane of symmetry(σ), centre of symmetry(i), alternating axis of symmetry (S_n), asymmetry and dissymmetry, optical activity, specific rotation, molar rotation, specific rotation of mixture, Biot's law. Stereoisomerism: enantiomerism, diastereoisomerism, stereogenic centre, systems with chiral centres, stereogenic centres involving C=C, C=N, D/L, R/S, E/Z, syn/anti, cis/trans, meso/dl, threo/erythro nomenclature