

REGISTRAR:-

In continuation of this office Circular No.UG/167 of 2008 dated April, 2008 forwarding therewith the revised syllabus in the subject of Chemistry at the F.Y.B.Sc. examination, the Principals of the affiliated colleges in Science, are hereby informed that a corrected revised syllabus in the subject of Chemistry at the F.Y.B.Sc. examination is as per Appendix.

The earlier Circular No.UG/167 of 2008 dated 22nd April, 2008 has been treated as cancelled.

MUMBAI-400 032
6th June, 2008.

for REGISTRAR

The Principals of the affiliated colleges in Science.

4C4.26 /27.02.2008

No.UG/216 -A of 2008; MUMBAI-400 032 6th June, 2008.

Copy forwarded with compliments for information to :-

The Dean, Faculty of Science,
The Chairman, Board of Studies in Chemistry
The Controller of Examinations,
The Co-ordinator, University Computerization Center.

for REGISTRAR

The Director, Board of College and University Development, the Deputy Registrar (Eligibility and Migration Section), the Director of Students Welfare, the Executive Secretary, the Vice-Chancellor, the Personal Assistant to the Pro-Vice-Chancellor, the Registrar and the Assistant Registrar, Administrative sub-center, Ratnagiri for information.

The Controller of Examinations (10 copies), the Finance and Accounts Officer (2 copies), the Deputy Registrar, Enrolment and Migration Section (5 copies), Publications Section (5 copies), the Deputy Registrar, Statistical Unit (2 copies), the Deputy Registrar (Accounts Section), Vidyanagari (2 copies), the Deputy Registrar, Distance Education, (10 copies), the Director, Institute of Distance Education, (2 copies), the Deputy Registrar, University Computer Center (IDE Building), Vidyanagari, (2 copies), the Deputy Registrar (Special Cell), the Deputy Registrar, (PRO), the Assistant Registrar, Academic Authorities Unit (2 copies) and the Assistant Registrar, Executive Authorities Unit (2 copies). They are requested to report on the concerned resolution.

27.2.2008

UNIVERSITY OF MUMBAI



Revised Syllabus

For

F.Y.B.Sc

In

Chemistry

(With effect from the academic year 2008-2009)

FYBSc Revised Syllabus
(with effect from the year 2008-09)

PAPER I

Numerical problems are expected on all topics

Total Lectures: 90

TERM I

UNIT I

STUDY OF STATES OF MATTER:

15L

GASES: Introduction, ideality and kinetic theory of gases(only postulates), gas laws, Maxwell's distribution of velocities(graph & qualitative discussion), real gases, compressibility factor, Boyle temperature, van der Waals equation of state, critical phenomena, liquefaction of gases based on Joule Thomson effect.

LIQUIDS: Introduction, study of viscosity and its determination using Ostwald's viscometer, study of surface tension and its determination using stalagmometer.

SOLIDS: Introduction, amorphous and crystalline solids, crystallography. Crystal systems, concept of space lattice and unit cell.

UNIT II

1. BONDING AND STRUCTURE OF ORGANIC COMPOUNDS:

8L

- 1.1 Allotropy of carbon: Structure and properties of diamond, graphite, fullerenes, carbon nanotubes.
- 1.2 Hybridization: sp^3 , sp^2 , sp hybridization of carbon and nitrogen; sp^3 and sp^2 hybridizations of oxygen in Organic compounds.
- 1.3 Overlap of atomic orbitals: Overlaps of atomic orbitals to form σ and π bonds, shapes of organic molecules.
- 1.4 Electronic effects in organic molecules: Polarization or Inductive effect – Nature; polarity of a covalent bond, dipole moment and its effect on properties of molecules, such as m.p./b.p., solubility; Polarizability effect; Delocalized bonds – Resonance, drawing of resonance structures of different conjugated systems, resonance energy and stability of conjugated systems; Hyperconjugation.
- 1.5 Bonds weaker than a covalent bond: Hydrogen bond – nature, effect of on m.p./b.p., solubility in water; van der Waals forces.

Structure of common functional groups: Geometry and electronic structure in order to understand their reactivity.

Nomenclature of organic compounds:

7L

Functional groups and types of organic compounds, basic rules of IUPAC nomenclature.

Nomenclature of mono- and bi- functional compounds on the basis of priority order, of the following classes of compounds: alkanes, alkenes, alkynes, haloalkanes, alcohols, ethers, aldehydes, ketones, carboxylic acids, carboxylic acid derivatives (acid halides, esters, anhydrides, amides), nitro compounds, nitriles, and amines; including their cyclic analogues.

Nomenclature of aromatic compounds: mono-, di-, and poly- substituted benzenes, with not more than two functional groups. Monosubstituted fused polycyclic arenes - naphthalene, anthracene, and phenanthrene.

UNIT-III

1. Scope and importance of Inorganic Chemistry

2L

2. Periodic Table and periodicity of properties-

5L

2.1 Long form of periodic table

2.2 Atomic and ionic radii;

2.3 Ionisation of atoms;(formation of cations and anions)

2.4 Effective nuclear charge and its calculation using Slater's rules;

2.5 Electronegativity and its determination by Pauling's, and Mulliken's methods

(Numerical problems expected);

2.6 Polarizability(Fajan's rules)

3. Concepts for qualitative analysis

8L

3.1 Types of qualitative analysis

3.2. Factors affecting precipitation equilibria (solubility product) in qualitative

analysis (numerical problems expected)

3.2.1. Common ion effect;

3.2.2. pH effect;

3.3.3. Complexation;

3.3.4 Ionic strength;(uncommon ion effect)

3.3.5. Oxidation states

(Examples to illustrate the abovementioned factors may be selected from the schemes for qualitative analysis in the laboratory work).

TERM-II

UNIT IV

1. CHEMICAL KINETICS:

10 L

1.1 Rate of reaction, definition of rate constant, measurement of reaction rates, order and molecularity, integrated rate equations for zero, first and second order reactions (for second order reactions only $a=b$ to be considered), kinetic characteristics of first and second order reactions, pseudo first order reactions.

1.2 Methods of determining order of reaction by
a) Integration method b) Graphical method c) Equi-fraction method
d) Ostwald's isolation method.

1.3 Effect of temperature on rate of a reaction, temperature coefficient, Arrhenius equation.

1.4 Catalysis : characteristics of catalyzed reactions, classification & examples.

2. PHOTOCHEMISTRY:

5L

2.1 Laws of photochemistry, photon yield (quantum yield) and its determination, primary and secondary reactions, reasons for high and low quantum yield, study of photochemical reactions:
i) reaction between hydrogen and chlorine, ii) dissociation of hydrogen iodide.

2.2 Photo sensitizers and photosensitized reactions, , photochemical smog, ozone depletion, concept of flash photolysis.

UNIT V

1. STEREOCHEMISTRY OF ORGANIC COMPOUNDS

8 L

1.1 Isomerism - Types of isomerism: Structural isomerism (chain, position and functional) and Stereoisomerism.

1.2 Chirality - Configuration, chirality and enantiomers, stereogenic/chiral centre, asymmetric carbon atom, Representation of configuration by "flying wedge formula" and projection formulae - Fischer, Newman and Sawhorse. The interconversion of the formulae.

1.3. Stereochemistry of carbon compounds with one, and two similar and dissimilar asymmetric carbon atoms; enantiomers, diastereomers, and racemic mixtures and their properties, threo, erythro and meso-isomers.

1.4 Diastereomerism (Geometrical isomerism) due to restricted rotation around carbon-carbon double bond.

1.5 Conformations: Conformations of ethane. Difference between configuration and conformation.

2. ALKENES, CYCLOALKENES, ALKADIENES, AND ALKYNES:

7L

- 2.1 Introduction: Concept of elements of unsaturation; applications of alkenes, cycloalkenes, alkadienes and alkynes. Olefin polymerization, heat of hydrogenation and stability.
- 2.2 Preparation of alkenes and cycloalkenes (up to 6 carbon atoms): Dehydration of alcohols, Dehydrohalogenation of haloalkanes – E1 and E2 mechanisms.
- 2.3 Reactions of alkenes and cycloalkenes (up to 6 carbon atoms): Hydrogenation, epoxidation, permanganate oxidation, ozonolysis, halogenation, addition of HX – Markovnikov's and anti- Markovnikov's additions (with mechanisms); formation of halohydrins, hydroboration-oxidation.
- 2.4 Alkadienes: Types of alkadienes and their stabilities – cumulated, isolated, conjugated; Reactions of conjugated dienes – 1,2- and 1,4-additions, Diels-Alder reaction.
- 2.5 Preparation of alkynes: Dehydrohalogenation of vicinal dihalides and haloalkenes, from metal carbides.
- 2.6 Reactions of alkynes: Hydration, Addition of HX, selective hydrogenation to cis- and trans-alkenes, acidity of terminal alkynes, preparation of metal acetylides and their alkylation.

UNIT-VI

1. CHEMISTRY OF CO-ORDINATION COMPOUNDS:

8L

- 1.1 Distinction between double salts and co-ordination compounds;
- 1.2 Experimental evidences of co-ordinate bond formation;
- 1.3 Terms involved in co-ordination compounds;
- 1.4 IUPAC nomenclature;
- 1.5 Werner's theory of co-ordination compounds;
- 1.6 Effective atomic number rule
- 1.7 Isomerism in coordination compounds
 - 1.7.1. Ionisation isomerism;
 - 1.7.2. Hydrate isomerism;
 - 1.7.3. Linkage isomerism;
 - 1.7.4. Co-ordination position isomerism;
 - 1.7.5. Stereoisomerism-geometrical and optical isomerism, with special reference to Co-ordination Number 4 and 6
- 1.8. Applications of coordination compounds

2. COMPARITIVE CHEMISTRY OF GROUP-13 ELEMENTS:

7L

- 2.1 Trends in metallic character, oxidation states, melting and boiling points inert pair effect
- 2.2 Structures of electron deficient compounds with reference to boron hydrides;
- 2.3 Chemistry of aluminum compounds: halides, oxides and alkyls



PAPER-II

Total Lectures:90

Numerical problems are expected on all topics

TERM-I

UNIT I

1. THERMODYNAMICS:

12 L

First law of thermodynamics, internal energy, enthalpy, isothermal and adiabatic processes, P-V-T relation for adiabatic process, second law of thermodynamics, need for the law,, Carnot's cycle, mechanical efficiency, concept of entropy, physical significance of entropy, entropy changes accompanying change of state and transition.

Helmholtz and Gibb's free energies, relation between them, criteria of spontaneity.

2. PRESENTATION OF EXPERIMENTAL DATA:

3L

- Graphical representation of experimental data: equation of straight line, slope and intercept and their significance.(with relevant examples)
- Significant figures: concept , rules and examples.

UNIT II

1. MECHANISM OF ORGANIC REACTIONS:

9L

- 1.1. Bond breaking processes: Representation of electronic movement by curved arrows, Homolytic and heterolytic fissions, Assigning of formal charge to given atom.
- 1.2. Formation, structure and stability of carbocations, carbanions, and carbon radicals.
- 1.3. Types of reagents: Electrophiles and nucleophiles; Acids and bases: Lowry-Bronsted and Lewis concepts, carbon acids; Classifications of reactions on the basis of mechanisms.
- 1.4. Study of mechanisms: (a) S_N1 and S_N2 reactions – Effect of structure of substrate, leaving group, solvent, nucleophile. (b) Aldol reaction – Base catalysed simple and crossed aldol reactions of aldehydes and ketones.

2. ALKANES AND CYCLOALKANES :

6L

- 2.1 Introduction: Applications of alkanes and cycloalkanes, general formula, lack of reactivity in alkanes. Concept of angle strain – Stability and reactivity of cycloalkanes up to 6 C atoms.

- 2.2. Sources: Petroleum oil – Composition, refining, cracking – thermal and hydrothermal, thermodynamics in the process, reformation; Natural gas – Importance of methane.
- 2.3. Physical properties
- 2.4. Chemical properties: Combustion - Alkanes as fuel, heat of combustion, octane number concept, antiknocking agents, fuel related issues – depletion of feedstocks, pollution; Isomerization; Free radical halogenation – Mechanism, thermodynamics, factors affecting product distribution, reactivity-selectivity principle.

UNIT-III

1. CHEMICAL BONDING AND MOLECULAR STRUCTURE:

- 1.1 Ionic Bond: Formation of ionic bond, lattice energy, salivation energy, Born-Haber cycle and Kapustinski's equation (Numerical Problems expected) 4L
- 1.2 Covalent Bond:- Lewis electron dot structures; single and multiple bonding, coordinate bond 1L
- 1.3 Valence Bond theory: - 10L
- 1.3.1 sigma and pi-bonding,
- 1.3.2 Theory of hybridization, with respect to equivalence of contributing atomic orbitals in following examples: CH_4 , NH_3 and H_2O
- 1.3.3 Energetics of hybridization;
- 1.3.4 Types of hybridization: sp , sp^2 , sp^3 , with illustrations like BeCl_2 , BF_3 , SiCl_4 ,
- 1.4 Shapes of Chemical species on the basis of V.S.E.P.R. Theory:- like NH_3 , ClF_3 , BrF_3 , Icl_2^{-1} , TeF_5^{-1} , PX_3 (X=halides),

TERM II

UNIT IV

1. CHEMICAL CALCULATIONS:

9L

Methods of expressing concentration of solutions- molarity, normality, molality, mole fraction, formality, dilution of solutions, interconversion between different concentration units, concept of milliequivalents, millimols, ppm and ppb.

Primary and secondary standards, preparation of standard solutions, calculation of concentration of commercial samples of acids and bases like hydrochloric acid, sulphuric acid, acetic acid and ammonia.

Use of computers in chemical calculations.

2. INTRODUCTION TO MOLECULAR SPECTROSCOPY:

6L

Nature of electromagnetic radiation, interaction of emr with matter- absorption, emission, fluorescence and scattering. Energy types and energy levels for atoms and molecules. Types of spectroscopy, quantization of energy, basic equation of spectroscopy, regions of electromagnetic spectrum and different types of spectroscopy. General applications of different spectroscopic techniques. (qualitative discussion-information to be given in tabular format).

UNIT V

1. Aromaticity and Aromatic Hydrocarbons

4L

- 1.1. Aromaticity: Characteristic properties of aromatics compounds, Huckel's rule, aromaticity and antiaromaticity, resonance energy.
- 1.2. Aromatic hydrocarbons: (a) Benzenoid hydrocarbons: benzene, naphthalene, anthracene, phenanthrene.
(b) Nonbenzenoid ions: Cyclopropenium, cyclopentadienide, cycloheptatrienium cation.
- 1.3. Antiaromatic hydrocarbons: Cyclobutadiene, structure of cyclooctatetraene.

2. Reactions of aliphatic organic compounds and their interconversions

11L

- 2.1 Reactions of Alkyl halides with: Aqueous Alkali, Alcoholic alkali (dehydrohalogenation), Potassium cyanide. Conversion of alkyl cyanide further to primary amine and carboxylic acid; Ammonia, Silver salt of carboxylic acid, Sodium Alkoxide, Formation of Grignard Reagent, Wurtz reaction.
- 2.2 Reactions of Alcohols with: Sodium Metal, HX, PCl_3 , PCl_5 , SOCl_2 , Dehydration, Oxidation of primary, secondary and tertiary alcohols.
- 2.3 Reactions of Aldehydes and Ketones:
Addition to carbonyl compounds: - (i) HCN. (ii) Grignard Reagent. Condensation reaction with hydroxylamine. Aldol Condensation.
Reduction of Aldehydes and Ketones: - (i) Catalytic Reduction. (ii) Clemenson's Reduction. (iii) Reduction with LiAlH_4 and NaBH_4 , (iv) Wolff-Kishner reduction. Haloform Reaction.
- 2.4 Reactions of Acids, Esters and Amides:
2.4.1 Acids: Salt formation, Anhydride formation, Amide formation, Acid halide formation, Ester formation, Formation of alkanes.
2.4.2 Hydrolysis of Esters with acids and alkalies, Reaction of esters with Grignard Reagent, Hydrolysis of amides, Reduction of amides, Hoffmann bromamide reaction.
- 2.5 Reactions of Amines :
2.5.1. Formation of amines from - nitroalkanes, oximes
2.5.2 Acetylation of amines with acetic anhydride and acetyl chloride, Action of nitrous acid on primary, secondary and tertiary amines, Methylation of

primary, secondary and tertiary amines, yielding quaternary ammonium salts; Hoffmann elimination.

Note: Each reaction should be studied with respect to compounds with up to six carbon atoms. Based on these and the reactions of alkanes, alkenes and alkynes, multistep synthesis of compounds having one functional group are expected; the number of carbon atoms in each being not more than six. No mechanisms are expected.

UNIT-VI

1. Basic bioinorganic Chemistry: Introduction, essential and non-essential elements in biological systems; role of metal ions such as Na, K, Fe and Cu in biological systems; 2L
2. Environmental Chemistry:- 6L
 - 2.1 Study of various gaseous pollutants, such as oxides of nitrogen, carbon and sulphur with respect to (i) sources of emission; (ii) fate; (iii) health hazards; and (iv) control measures;
 - 2.2 Green House effect, Ozone layer depletion, and its consequences
3. Comparative Chemistry of group-14 elements:- 7L
 - 3.1 Trends in metallic character, oxidation states, melting and boiling points inert pair effect;
 - 3.2 Catenation and allotropy with special reference to carbon (to include study of fullerenes);
 - 3.3 Chemistry of silicon with special reference to methods of purification zone refining and single crystal method
 - 3.4 Introduction of silicones with reference to methods of preparation and their uses.

PRACTICAL SYLLABUS

PHYSICAL CHEMISTRY :

1. Study of the acid catalysed hydrolysis of methyl acetate. (rate constant to be evaluated graphically and from calculations)
2. Study of the base catalysed hydrolysis (saponification) of ethyl acetate. (rate constant to be evaluated graphically and from calculations)
3. To determine the strength of commercial sample of hydrochloric / acetic acid. (Standard solution of succinic acid to be prepared, NaOH solution to be supplied.)
4. Ostwald's viscometer-To determine the viscosity of the given liquid.

4. Inorganic semi-micro qualitative analysis of a sample containing two anions and any four cations from the groups given below:*

** Group-A) Pb^{2+} , Cu^{2+} , Fe^{3+} , Ni^{2+} , Zn^{2+} , Ca^{2+} , Mg^{2+} , NH_4^{1+} ;

Group-B) NH_4^{1+} , K^{1+} , Al^{3+} , Cd^{2+} , Mn^{2+} , Ba^{2+} , Co^{2+} , Mg^{2+} ;

Group C) K^{1+} , Fe^{3+} , Sr^{2+} , Cu^{2+} , Cr^{3+} , Ni^{2+} , Al^{3+} , Mg^{2+} ;

Anions: CO_3^{2-} , SO_4^{2-} , NO_3^{-} , Cl^{-} , Br^{-} , I^{-} , Complexities of anions not expected)

* Minimum two mixtures belonging to each group should be analysed

** Sulphide in any form should not be used for precipitation of cations

REFERENCE BOOKS

PHYSICAL CHEMISTRY

1. The Elements of Physical Chemistry:

P. W. Atkins (1996)

2nd Edition, Oxford University Press.

2. Physical Chemistry:

David W. Ball (2003)

Thomson Brooks/Cole

1st Indian Reprint 2007

Printed in India by Akash Press, Delhi

3. Chemistry:

Raymond Chang (1994)

5th Edition, McGraw Hill, Inc.

4. Physical Chemistry:

Ira N. Levine (1995)

4th Edition, McGraw Hill, Inc.

5. Physical Chemistry:

G. M. Barrow

6th Edition, Tata McGraw Hill Publishing House Ltd., New Delhi.

6. Physical Chemistry:

G. W. Castellan

3rd Edition, Narosa Publishing House, New Delhi.

7. Physical Chemistry:

G. K. Velumpallie (1997)

Prentice Hall of India Ltd., New Delhi.

8. Schaum Outline Series:

i) College Chemistry-7th Edition

ii) Physical Chemistry-2nd Edition

McGraw Hill, Inc.

ORGANIC CHEMISTRY

- (1) Systematic Nomenclature of Organic Chemistry: A Directory to Comprehension and Application on Its Basic Principles, D. Hellwinkel, Springer Verlag, 2001.
- (2) Stereochemistry of Carbon compounds, E. L. Eliel, Tata McGrawhill, New Delhi.
- (3) Organic Chemistry, Paula Bruice, Pearson Education, New Delhi.

- (4) Organic Reaction Mechanism, V.K. Ahluwalia and R.K. Parashara, Narossa Publications.
 - (5) Organic Chemistry, J. McMurry, Asian Books Pvt. Ltd.
 - (6) Organic Chemistry, T.W.G. Solomons and C.B. Fryhle, John Wiley and Sons.
- Organic Chemistry, Vol. I and II, Roger Macomber, Viva Low Price Students Edition.

INORGANIC CHEMISTRY

1. Theoretical Inorganic Chemistry, M.C. Day and J. Selbin; *second Edition, East-West press, 1969*
2. Modern Inorganic Chemistry, William Jolly *Second (special Indian) Edition, Tata-McGraw-Hill pub, 1991.*
3. Basic Inorganic Chemistry:
F.A. Cotton, G. Wilkinson and P.L. Gaus,
3rd Edition, John Wiley and Sons. (1995)
4. Inorganic Chemistry, D.F. Shriver and P.W. Atkins,
3rd Edition, Oxford University Press. (1999)
5. Spot Tests in Inorganic Analysis Feigl ELSIVIER Publication Anger.
6. Physical Chemistry, K.J. Laidler and J.H. Meiser, *second, CBS Pub (this is also the first Indian Edition) 1999*
7. University Chemistry, Third Edition, Bruce Mahan, *Narosa Pub., 1975.*
8. Ions in Aqueous Systems, Therald Moeller and Rod O'Connor, *McGraw-Hill Book Co., 1972.*
9. Inorganic Chemistry: Principles of Structure and Reactivity, Huheey, E.A. Keiter and R.L. Keiter, *Fourth Edition, Addison-Wisley Publishing Co. (1993)*
10. Inorganic Chemistry: Principles of Structure and Reactivity Huheey, E.A. *3rd Edition, Addison-Wisley Publishing Co*
11. Comparative Inorganic Chemistry Bernard Moody, *3rd Edition, CBS Publishers, New Delhi (1996)*
12. Concepts and Models of Inorganic Chemistry, B Douglas, D.Mc. Daniel and J Alexander, *Third Edition, John Wiley and Sons Inc. (1994)*
13. Vogel's Textbook of Quantative Chemical Analysis: Revised by G.H. Jeffery, J. Bassett, J. Mendham and R.C. Denney, *(1996) Fifth Edition, ELBS Publications*
14. Chemistry of Elements N.N. Greenwood and Earnshaw
Pergamon Press, UK.
15. Nature of Chemical Bond L. Pauling, *Third Edition, Cornell University Press, Ithaca NY (1960)*
16. Fundamental Concepts of Environmental Chemistry Second Edition, G.S. Sodhi, *Narosa Publishig House.*

SCHEME OF EXAMINATION
F.Y.B.Sc. Chemistry (Revised Syllabus)
(effective from 2008-2009)

Session I

- | | |
|--|----|
| a. Crystalization or Characterization of Organic Compound. | 20 |
| b. Volumetric OR Inorganic Preparation | 08 |

Total - 28

Session II

- | | |
|------------------------------------|----|
| a. Commercial Analysts OR Kinetics | 20 |
| b. Gravimetric OR Qualitative | 12 |

Total - 22

3) Written Test on safety 08

&

4) Written Test on Organic, Inorganic, Physical Practicals 06
 With one question of 2 marks each.

5) Journal 06

Total - 20

Written test can be given at the beginning of Session I & Paper to be collected after 15 minutes. The schedule can be as follows :

9.00 a.m. to 9.15 a.m.	:	Written Test
9.15 a.m. to 12.15 p.m.	:	Session I
12.15 p.m. to 1.00 p.m.	:	Lunch
1.00 p.m. to 4.00 p.m.	:	Session II

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