

FIRST TERM:

1. The solid state :-

The study of the crystals, laws of crystallography Elements of symmetry. The space lattice, Crystal systems, lattice planes. Weiss & Miller indices, Important planes of cubic lattices. Ratio of inter-planar distances. Diffraction of X-rays, Laue method. Bragg equation., Determination of crystal structure by Bragg method and Power method. Interpretation of X-ray diffraction results. Positions of Na and chlorine atoms in NaCl lattice. Calculation of d_{hkl} and Avogadro's no. (14)

Ref 2 Pages : 195 to 209

Ref 1 Pages : 68 to 69, 77 to 85.

2. Solutions :-

Introduction, Factors affecting solubility, Types of solutions, Ideal solutions, Vapour pressure of ideal solutions and actual liquid pairs. Boiling point diagrams of miscible binary mixtures. Distillation of binary miscible solutions. Azeotropes, Fractionating column. Solubility of partially miscible liquid pairs, vapour pressure and distillation of immiscible liquids. (12)

Ref. 1 Pages : 261 to 264, 270 to 287.

288 to 291 , 294 to 296.

3) Equilibria in electrolytes :-

Ionic strength, Activities and activity coefficients of strong - electrolytes, Determination of activity coefficients by emf method and from the dissociation of weak electrolyte, Debye Huckel theory of activity coefficients (qualitative approach only). The solubility product, Salt effects and solubility (effect of salt with and without common ion) Activity coefficient from solubility measurement. (8)

Ref. 1 Pages : 338, 434, to 442, 460 to 464.

Ref. 2

Ref. 3 Pages : 701 to 705.

4. Electrochemical cells :-

Classification of electrochemical cells, chemical cells with and without transference, Concentration cells, Electrode concentration cells without transference. Electrolyte concentration cells with and without transference, Liquid junction potentials.

Applications of emf measurement : Determination of solubility product, measurement of PH using hydrogen gas, quinhydrone and glass electrodes, determinations of ionic product of water, potentiometric titrations.

(14)

Ref. 1 Pages 497 to 520.

Ref. 2 Pages 534 to 535, 549 to 550.

SECOND TERM :

5. Kinetics of homogeneous reactions :

Introduction, measurement of reaction rates, order and molecularity of reactions. First order reactions , Examples of first order reactions : thermal decomposition of azoisopropane; decomposition of hydrogen peroxide; hydrolysis of methyl acetate; inversion of cane sugar.

Second order reactions, Examples of second order reaction thermal decomposition of acetaldehyde ; saponification of an ester (ethyl acetate)

Third order reactions with equal initial concentrations of reactants and the expression of half life period of such reactions.

Pseudomolecular reactions, methods for the determination of order of a reactions, effect of temperature on reaction velocity, Energy of activation. (14)

Ref. 1 Pages : 548 to 555, 557 to 559.

: .. 561 to 564, 571 to 574.

Ref. 2 Pages : 606 to 608, 610 to 611, 616 to 618.

6. Investigation of molecular structure :-

Molar refraction, Electrical polarization of molecules. permanent dipole moments, determination of dipole moments by Temperature method, Dilute solution method and refractive index method.

Molecular structure and dipole moment

(6)

Ref. 1 Pages : 691 to 700.

7. Photochemistry :

Introduction, Lambert's law, Beer's law, Grotthus - Draper law, Einstein's law of photochemical equivalence, Quantum yield, Primary and secondary processes, Apparent discrepancies between Einstein's law and the experimental results, Consequences of light absorption by atoms and molecules, Experimental study of photochemical reactions.

Photochemical gas reactions : Photolysis of ammonia, Hydrogen-chlorine reaction

Photosensitized reactions, fluorescence and phosphorescence, chemiluminescence. (12)

Ref. 1 Pages : 715 to 716, 775 to 781

784 to 787, 788 to 789

Ref. 2 Pages : 656 to 662, 665 to 669.

672 to 677.

8. Nuclear Chemistry :-

Classification of nuclides, Nuclear stability, Nuclear potential, Binding energy.

Radioactivity : Radioactive elements, General characteristics of radioactive decay, Decay kinetics, Units of radioactivity. Decay rate of mixture of unrelated radionuclides, Alpha decay, Beta decay.

Detection and measurement of radioactivity : Specific ionization, Behaviour of ion pairs in electric field, Ionization chamber. Proportional counter, Geiger-Muller counter.

Applications of radioactivity : Radiochemical principles, Reaction mechanism, Structure determination, Dating by tritium content, C-14 dating. (16)

Ref. 4 Pages : 4 to 13, 91 to 98, 111 to 112,

119 to 120, 247 to 251.

252 to 253, 272 to 274.

Ref. 5 Pages : 199 to 209.

Reference :

1. Principles of Physical Chemistry, S.H. Maron and C.F. Prutton, 4th edition.
(Oxford and IBH publishing company Pvt, Ltd.,)
2. Elements of Physical Chemistry, S. Glasstone and D. Lewis, 2nd edition.
(Mac-Millan and Co.Ltd, London).

3. Physical Chemistry, G.M. Barrow, 2nd edition
(International student edition, Mc-Graw Hill Book Co.)
4. Essentials of Nuclear Chemistry, H.J. Arnikar 2nd
edition (Wiley Eastern Ltd.)
5. Sourcebook on Atomic Energy, S. Glasstone.
3rd edition (An east west edition)
D. van Nostrand Co.Inc.
6. Nuclear and Radiochemistry, G. Friedlander, J.W. Kennedy
J.M. Miller, 2nd edition (John Wiley and Sons Inc.
7. Introduction to Nuclear Physics and Chemistry, B.G.
Harvey (Prentice Hall of India Pvt. Ltd.)

Paper VI (Inorganic Chemistry)
Section I (First term)

1) MOLECULAR ORBITAL TREATMENT: (10)

- a) Molecular orbital energy level diagrams for
 - i) Heteronuclear diatomic molecules: NCl, CO, NO⁺
 - ii) Heteronuclear polyatomic molecules: CO₂, BeH₂
- b) Multicentre bonding in electron deficient molecules:
B₂H₆
- c) Three centre bonding in XeF₂
Ref. 1. Pages- 73 to 74.
Ref. 2. Pages- 67 to 70, 78 to 82.
Ref. 3. Pages- 76 to 79.

2) CHEMISTRY OF d-BLOCK ELEMENTS: (10)

Position of d-block elements in the periodic table and their electronic configurations.

Trends in properties of elements, Manufacture of iron and steel and compounds of iron such as iron carbonyls, haemoglobin, ferro-ferricyanides and ferrocenes.

Ref. 1- Relevant pages.

3) SOLVENTS AND SOLUTIONS, ACIDS AND BASES: (10)

Donor and acceptor properties, protic and aprotic solvents
Rules governing the strength of oxyacids, Trends in the strength of hydracids, oxyacids; Lux-Flood concept and Lewis concept. Hard and soft acids and bases.

Ref.2. Pages 163 to 173.

Ref.3. Pages 183 to 193.

4) CORROSION AND PASSIVITY. (8)

Corrosion, Atmospheric and Immersed corrosion, Mechanism of corrosion (Theory of corrosion) Factors influencing corrosion. Factors pertaining to the metal, factors pertaining to the medium, factors pertaining to external influences. Protection of metals. Methods pertaining to metals, method pertaining to external influences. Passivity of metals, Passivity theories, Electrochemical passivity.

Ref.11 Paper 491 to 503.

5) INORGANIC POLYMERS:

Basic concepts and definitions, classification of polymers. Comparative study of organic and inorganic polymers Classification of inorganic polymers, polymer back-bone Homoatomic polymers, Polymers containing B, Si. and P. Fluorocarbon, heteropolymers, silicones, phosphonitrilic compounds, PON polymers, Borazole and its derivatives.

Ref.4. Pages - 1 to 19.

6) MAGNETIC PROPERTIES OF CHEMICAL SUBSTANCES : (6)

Importance of magnetism in transition element chemistry Explanation of the terms magnetic moment, magnetic susceptibility. Types of magnetism- paramagnetism, diamagnetism, ferromagnetism, antiferromagnetism and ferrimagnetism. Curie law Curie-Weiss law, Variation of magnetic susceptibility with temperature. Use of magnetism in the determination of structure of complexes, Gouy method, Spin only formula. Determination of number of unpaired electrons in a complex.

Ref.5. Pages 633 to 644.

Ref.6. Pages 527 to 535.

7) CO-ORDINATION CHEMISTRY:

a) Double salts, chelate, complex, formation constant,
b) Werner's theory.- stereochemistry of Werner's complexes with co-ordination number 4 and 6, Geometrical and optical isomerism.

c) Sidgwick's theory-E.N concept. Limitation of Sidgwick model.

d) Valence bond theory - Hybridization and shape of complex. Structure and magnetic moment of complexes. Limitations of V.B. Theory. Inner and outer orbital complexes.

e) Crystal field theory - Assumptions, Applications of CFT to octahedral, tetrahedral, square planar and tetragonal complexes, CFSE, Evidence of CFSE and its .6

calculations. Magnetic moment of metal complexes, crystal field spectra, Jahn Teller distortion with reference to octahedral complexes, Spectrochemical series, Nephelauxetic effect, Limitations of CFT.

f) Molecular orbital theory- Molecular orbital energy level diagram for octahedral complexes such as $(\text{Ni}(\text{NH}_3)_6)^{2+}$, $(\text{CoF}_6)^{-3}$, $(\text{Co}(\text{CN})_6)^{-3}$ without π -bonding. Charge transfer spectra. Effect of π -bonding in complexes definition of ligand field theory, Comparison of VBT, CFT and MOT.

Ref.6. Pages- 425 to 471.

Ref.7. Pages- Relevant pages.

Ref.8. Pages- 23 to 56.

8) CHEMISTRY OF f-BLOCK ELEMENTS:

(12)

a) Lanthanides - position of lanthanides in the periodic table. Lanthanide contraction, effect of lanthanide contraction on chemistry of lanthanides and post lanthanides. Occurrence and separation of lanthanides by ion exchange method and solvent extraction method. Applications of lanthanides.

b) Actinides - Position of actinides in the periodic table, Actinides and their electronic configuration, oxidation states, General methods for preparation of transuranic elements, Nuclear fuels.

Metallurgy of Thorium : Occurrence and extraction from thoria and monazite sand. Preparation of metal by electrical method. Van-Arkel method. Physical and Chemical properties. Use of thorium in gas mantles, as nuclear fuel and in atomic energy.

Ref.1. Pages 394 to 404 and 406 to 416,

Ref.9. Pages 849 to 882.

Ref.10. Pages 727 to 731.

REFERENCES :

Ref.1. A new concise Inorganic Chemistry, 3rd Edn by J.D. Lee

Ref.2. Basic Inorganic Chemistry, by Cotton and Wilkinson.

Ref.3. Concepts and Models of Inorganic Chemistry, 1970.

by Douglas and Daniels.

Ref.4. Progress in Inorganic Chemistry, by Lippert and Leigh.

Ref.5. Advanced Inorganic Chemistry, by Cotton and Wilkinson.

Ref.6. Theoretical Principles of Inorganic Chemistry, 1992,

by G.S. Manku.

Ref.7. Theoretical Inorganic Chemistry 2nd Edn, by Day and Selbin.

Ref.8. Co-oxidation Chemistry, 1st Indian Edn, 1979,

by F. Basolo and R. Johnson.

Ref.9. Advanced Chemistry of Rare elements. 1975.,
by Satya-Prakash.

Ref.10. A Text-book of Inorganic Chemistry.
by A.K. De. (Wiley Eastern Ltd.) 6th Edn.

Ref-11. An Introduction to electrochemistry by S.Gladstone
2nd Edn.

Paper VII (Organic Chemistry)
SECTION-I (FIRST TERM)

1. Structure, Reactivity and Mechanisms. (8)
- a) Conjugated systems.
 - b) Benzene and aromaticity.
 - c) Necessary conditions for delocalisation.
 - d) Factors affecting electron availability.
 - e) Inductive effects, Time variable effects (Electromeric effect) and Mesomeric effect.
 - f) Hyper-conjugation.
 - g) Steric effects.
 - h) Tautomerism.

Ref.I. Pages 11 to 28.

2. Strength of Acids and Bases. (10)
- a) Introduction- Theories of acids and bases.
 - b) Acids and pKa values, bases and their pkb values.
 - c) Origin of acidity in organic compounds.
 - d) Factors affecting strength of Acids and Bases.
 - e) Simple aliphatic acids.
 - f) Substituted aliphatic acids.
 - g) Phenols and aromatic carboxylic acids.
 - h) Dicarboxylic acids.
 - i) Aliphatic and aromatic bases.
 - j) Heterocyclic bases (Pyrrole and Pyridine)

Ref.I , Pages 53 to 74.

3. Nucleophilic substitution at saturated Carbon: (12)
- a) Relation between kinetics and mechanism. SN^1 & SN^2 mechanisms.
 - b) Stereochemical Implications of mechanism.
 - i) SN^2 mechanism: Inversion of configuration.
 - ii) Determination of relative configuration.
 - iii) SN^1 Mechanism: racemisation,

- iv) SN^1 Mechanism: retention of configuration.
- c) Factors affecting nucleophilic substitution reactions.
 - i) Effect of solvents.
 - ii) Effect of structures.
 - iii) Effect of entering group.
 - iv) Effect of leaving group.

Ref. I - Pages 77 to 92, 96 to 99.

4. Elimination Reactions (8)

- a) Elimination reactions.
- b) E1, E2, E1cB mechanism.
- c) Stereochemistry of Elimination E_2 .
- d) Orientation in E2 and E1, Saytzeff and Hofmann.
- e) Elimination Vs Substitution.

Ref. I Pages 246 to 262.

5. Aromatic Electrophilic Substitution. (10)

- a) Friedel craft's alkylation and acylation, Diazo-coupling reactions.
- b) Orientation in monsubstituted benzene.
- c) Ipso-substitution.
- d) Electrophilic substitution in other aromatic compounds naphthalene, pyridine, pyrrole.

Ref. I- Pages 141 to 150, 152 to 156, 161 to 163.

SECTION- II

6. Electrophilic addition to $C=C$ (6)

- a) Addition of Halogens.
- b) Effect of substituents on rate of additions.
- c) Orientation of addition.
- d) Other addition reactions.
 - i) Hydration
 - ii) Hydroxylation
 - iii) Hydrogenation
 - iv) Ozonolysis.

Ref. I- Pages 178 to 194,

7. Nucleophilic addition to $C=O$ (10)

- a) Structure and Reactivity.
- b) Addition of water, alcohols, Thiols, Hydrogen cyanide $NaHSO_3$, Aldride ions $LiAlH_4$, $NaBH_4$, Aluminium isopropoxide. Derivatives of ammonia.
- c) Carbon Nucleophilic addition :-
 - i) Carbanion formation stability,

- ii) Grignard's reactions,
- iii) Aldol condensations.
- iv) Perkin condensations.
- v) Claisen condensations.

Ref: 1- Pages 203 to 230

8. Natural Products

(8)

Terpenoids & Alkaloids ; Introduction, Classification general methods for structure determination of terpenoids & alkaloids Study of Citral & Atropine with respect to structure determination and synthesis.

Ref. II Pages 354 to 358, 361 to 362.

Ref. II Pages 696 to 705, 721 to 726.

9. Spectroscopic methods

(24)

A) Introduction :

- i) Meaning of spectroscopy, Nature of electromagnetic radiations, wavelength, frequency, energy, amplitude, wave number and their relationship; Different unit of measurements of wave length frequency. Different region of electromagnetic radiations.
- ii) Interaction of radiation with matter excitation of molecules to different energy level such as rotational vibrational and electronic waves.
- iii) Types of spectroscopy and advantages of spectroscopic methods.
Ref. III, IV, V, Relevant pages.

B) Ultra violet spectroscopy:

- i) Introduction , Nature of uv curve, Beers law, absorption of uv by organic molecules leading to different electronic excitations ($\sigma - \sigma^*$, $\pi - \pi^*$, $n - \sigma^*$, $n - \pi^*$)
 - ii) Terms used in uv spectroscopy, chromophore, Auxochrome Bathochromic shift, Hypsochromic shift, Hyperchromic shift,
 - iii) Effect of conjugation on position of uv band. Calculation of λ_{max} by Woodward & Fieser Rules for dienes and enones, Colour and visible spectrum.
 - iv) Applications of uv spectroscopy
 - a) Determination of structure.
 - b) Determination of stereochemistry (Cis and trans)
- Ref. III, IV, V, VI Relevant pages.

C) Infra-Red IR Spectroscopy

- 1) Introduction, principles of IR spectroscopy, Fundamental modes of vibration. Types of vibrations, condition for absorption of IR radiations, parts of IR spectrum, Fundamental group region, finger print region
- 2) Characteristics of Infra-red absorption of the following groups.
 - a) Alkanes, Alkenes, Alkynes.
 - b) Alcohols and Ethers.
 - c) Alkyl halides.
 - d) Carbonyl compounds. (-CHO, C=O, -COOR, -COOH)
 - e) Amines and Amides.
 - f) Aromatic compounds, and their substitution pattern.
- 3) Effect of the following factors on IR absorption. Inductive effect, Resonance effect, Hydrogen bonding.
- 4) Application of IR Spectroscopy.
 - a) Determination of structure., Identification of functional groups.
 - b) Study of chemical reactions.
 - c) Hydrogen bonding.

Ref. III, IV, V, VI, Relevant pages.

D) NMR Spectroscopy.

- a) Introduction, principles of NMR spectroscopy, magnetic and non-magnetic nuclei without mathematical details.
- b) Nuclear resonance, chemical shift, molecular structure shielding and de-shielding, Measurement of chemical shift (δ scale and τ scale) TMS as reference and its advantages.
- c) Peak area (integration) , Spin-Spin coupling (peak splitting) Coupling constant. J value (only first order coupling to be discussed.)
- d) Application of NMR Spectroscopy.

Ref. III, IV, V, VI, Relevant pages.

E) Spectral problems based on uv, IR and NMR.

Relevant problems from Ref. III, IV, and V.

Spectral data such as λ_{max} values, IR frequencies and chemical shift and coupling constant should be provide to the students.

Reference Books :

- I. : A guide book to reaction mechanism.
by Peter & Sykes. Vth and VI th Edition.
- II : Organic chemistry by Finar. V th Edition.
- III: Organic Chemistry by Morrison & Boyd VI th Edition.
- IV : Spectroscopic methods in organic chemistry.
by Williams Fleming IV Edition.
- V : Spectroscopy of Organic compounds,
by P.S. Kalsi, Wiley Eastern.
- VI : Organic Chemistry
by Pine. V th Edition.

PAPER-VIII (ANALYTICAL CHEMISTRY)
SECTION - I (First Term)

1) GRAVIMETRIC ANALYSIS : (10)

Common ion effect, Solubility product, Completeness of precipitation, Complex ions, Effect of acids, temp, and solvent upon the solubility of precipitate. Supersaturation and precipitate formation. Co-precipitation. ^{Post} Precipitation from homogeneous solution, Filtration, washing, drying and ignition of the precipitate. Thermogravimetric method of analysis.

Ref. I. Pages- 23 to 34, 403 to 415.

2) ORGANIC PRECIPITANTS USED IN INORGANIC ANALYSIS : (8)

- i) Dimethyl glyoxime. ii) Cupferron, iii) Cupron,
iv) Alpha-nitroso-B-naphthol. v) 8-Hydroxyquinoline.

Advantages and drawbacks of these reagents.

Ref.1. Pages-419 to 429.

3) SOLVENT EXTRACTION : (10)

Principles of solvent extraction, distribution coeff. distribution ratio, relationship between distribution coeff and distribution ratio, factors affecting extraction, extraction efficiency, the percent extracted, solvent extraction

methods, Ion association complexes and formation of chelates (metal chelates) the separation factor, selective extraction of metals, multiple extraction, derivation of an expression for the solute remaining unextracted.

Techniques of solvent extraction : Batch extraction continuous extraction, counter-current extraction and Craig extraction, Advantages of solvent extraction and its applications.

Problems on the solvent extraction.

Ref.2, Pages- 425 to 440.

4) CHROMATOGRAPHY;

Principle of chromatography, match box model, types of chromatography, study of chromatography techniques such as column, ion-exchange, size-exclusion, gas-liquid, paper and thin layer (TLC) chromatography.

Column chromatography :- Principle, dimensions of column, packing of the column, loading the sample, elution and analysis of eluates,

Ion exchange chromatography - Principle, cation exchange and anion exchange resins, separation of metal ions on anion exchanger resins, separation of amino-acids, de-ionisation of water.

Size-exclusion chromatography- Principle, types of gel, the exclusion limit, mechanism of molecular exclusion.

Gas-chromatography- Gas-solid chromatography, principles of gas-liquid chromatography, techniques of GLC, principle and working of thermal conductivity detector and flame ionisation detector.

Ref.2, Pages-441 to 459, 477 to 481.

5) Techniques of Semimicro Qualitative Analysis : (4)

Semimicro apparatus and semimicro analytical operations. (except calculations for centrifuge and calculations of volumes of precipitating agents) Cleaning of apparatus, spotplates and dry reaction paper, semimicro apparatus.

Ref.3, Pages- 165 to 188.

Ref.6, Pages- 248 to 257.

SECTION - II (Second Term)

1) COLORIMETRY AND SPECTROPHOTOMETRY; (12)

Principles of colorimetry- Nature of radiation, interaction of radiation and matter. Essential terms absorbance, absorptivity, radiant power, transmittance etc.

Beer's law and Lambert's law. Factors governing, absorptivity -a) temperature b) solvent. c) wavelength. Deviations from Beer's law. Additivity of absorbance, Simultaneous determination, visual colorimetry, std. series method, duplication method, dilution method, balancing method.

Trace analysis, ultimate precision, some experimental applications, Absorption measuring instruments-essential components of a colorimeter, Difference between colorimeter and spectrophotometer, Filters, monochromators, their advantages and drawbacks. Detector devices such as barrier layer cell, phototube and photomultiplier tube, Photometric instruments. Only single beam instruments are expected.

Ref.1, Pages- 693 to 717.

Ref.4, Pages- 66 to 78

Ref.5, Pages- 144 to 174.

2) NEPHELOMETRY AND TURBIDIMETRY: (4)

Introduction, turbidimetry and colorimetry, nephelometry and fluorimetry, choice between nephelometry and turbidimetry. Theory, instrumentation and applications of nephelometry and turbidimetry.

Ref. 5, Pages- 380 to 390.

3) POTENTIOMETRY : (10)

Brief mention of electrode potential, Nerst equation for electrode potential, various types of electrodes like hydrogen electrode, calomel electrode, silver-chloride electrode, quinhydrone electrode and glass electrode poggendorff compensation method, pH- meter, Potentiometric titrations- theory. acid-base, oxidation- reduction and precipitation titrations. Applications- determination of copper, chromium and manganese, determination of ferric iron with EDTA.

Ref. 1, Pages- 566 to 575, 579 to 584, 591 to 592
596 to 610.

Ref. 4, Pages- 664 to 670, 680 to 687.

Ref. 5, Pages- 455 to 461, 664 to 687.

4) POLAROGRAPHY : (08)

Polarograph, polarisation of electrodes, voltage-current characteristics, characteristics of micro-electrode supporting electrodes, residual current, limiting current diffusion current. Ilkovic equation, polarographic maximum half wave potential (Derivation of expression for half

wave potential not expected)

ancillary equipment for polarography, mercury dropping electrode, polarographic cells, maximum suppressors.

Applications- Determination of half wave potentials and concentrations of Cd, Zn and Mn- ions in KCL solution.

Ref,1, Pages - 632 to 656

Ref. 5, Pages- 478 to 489.

5) FLAME PHOTOMETRY : (7)

Principle, instrumentation, instruments, application such as qualitative analysis and quantitative analysis.

Ref. 1, Pages - 810 to 826.

Ref. 5, Pages - 364 to 376.

6) ATOMIC ABSORPTION SPECTROSCOPY : (7)

Principle-instrumentation- radiation sources, chopper burners, nebulisers, monochromators detectors, Instruments. Interferences between flame photometry and atomic absorption spectroscopy. Applications such as qualitative and quantitative analysis, determination of metallic elements in biological samples.

Ref. 5, Pages- 321 to 342,

Reference Books:

Ref.1. Vogel's Textbook of quantitative Inorganic Analysis.
By Bassett, Denney, Jeffery and Mendham, 4th edition

Ref.2. Analytical Chemistry.
By G.D. Christian, 4th edition.

Ref.3. A Textbook of Macro and Semimicro qualitative Inorganic Analysis.
By A.I. Vogel, 4th edition.

Ref.4. Instrumental Methods of Chemical Analysis.
By Willard, Merritt, Dean & Settle, 6th edition.

Ref.5. Instrumental Methods of Chemical Analysis.
By Chatwal and Anand, 6th edition.

Ref.6. Advanced Experimental Inorganic Chemistry.
By J.N. Gurtu and Kapoor, 1983 edition.

PAPER -IX (INDUSTRIAL CHEMISTRY)

SECTION- I (First Term)

1. (a) General aspects of industrial chemistry : (3)

Introduction, chemical production, raw materials, unit processes, unit operation, quality control process control, Economics of chemical process, chemical process technology, classification of chemical reactions, batch and continuous operations; Industrial chemical reactions, conversions, selectivity and yield.

(b) Pollution and its control in chemical industries (3)

Introduction:

Types of pollution,- air pollution, water pollution, solid waste, disposal problems, Thermal pollution, soil pollution, noise pollution.

Pollution control- Air pollution control, water pollution control. solid wastes.

Important pollutants from fertilizer, sugar, fermentation, Dyes, soaps and Detergent industries.

Ref. 1 to 10 Relevant pages.

2. Ceramics: (10)

Introduction, classification, classification of refractory materials, basic raw materials for ceramics, outlines of process of manufacturing, process of ceramics alongwith flowsheets, Manufacturing process commonly used in ceramics material, Body preparation, forming process, dry process and dust pressings(Flow sheets), extrusion, forming from soft plastic molasses, Slip casting, ceramics finishing, drying of ceramics ware fixing of ceramics, ware, glaze, enamels, ceramic carvings, ferroelectric and ferromagnetic ceramics, properties and applications.

Ref. 1 Pages 173-188. 5

Ref.2. Pages 92-112. .

Ref.3. Pages 149-166.

3. Cement Industry: (08)

Introduction, classification of cements, manufacture of portland cement (dry and wet process), beneficiation by floatation, burning operations, setting and hardening, treatment of clinkers, storage and packing of cement, ...16

special cement.

Ref. 1 Pages 188-192.

Ref.2 pages 170-181.

Ref.4 pages 156-165.

4. Sugar Industry:

(07)

Introduction, manufacture of cane sugar, extraction of juice, compound inhibition process, classification, lime defecation process, Classification by sulphitation. Classification by carbonation, evaporation to make syrup, crystallization, curing of cane sugar, treatment of molasses. A and B refining of raw sugar, flow sheet, recovery of bone char, utilization of bagasse, Manufacture of beet sugar testing and estimation sugar.

Ref.1 Pages 337-351.

Ref.3 pages 553-565.

Ref.4 pages 506-516.

5. Fermentation Industry:

(7)

Introduction, alcohol fermentation, uses of alcohol, alcoholic beverages, theory underlying process of making alcoholic beverages/ manufacture of beer, manufacture of spirit, alcohol from beet sugar, cane sugar molasses, distillation of fermented wort, theory of practical distillation Coffey's Stills, rectified spirit, absolute alcohol, fused oil, proof spirit, denatured alcohol, mechanism of alcohol fermentation.

Ref. 1. pages 216-238.

Ref. 3 pages 578-596. related topics.

6. Petroleum Industry:

(10)

- a) Discovery of Petroleum, origin and reserves.
- b) Exploration methods.
- c) Nature of petroleum- composition of crude oil.
- d) Refining of crude petroleum-desalting and distillation.
- e) Cracking processes, Reforming.
- f) Improving gasoline by additions and reactions antiknock compounds.
- g) Petrochemicals-Variou product. obtained from methane, acetylene, propylene, benzene, phenol in the form of flow-sheets only.

h) Refineries in India- Locations, productions, consumptions and economics.

Ref- 1,3, and 9 Relevant pages.

Section. II (Second Term)

7. Ammonia, Sulphuric acid, Nitric acid, Urea and Triple Superphosphate. (10)

- a) Manufacture of NH_3 Harber process, modified Bosch-Harber process.
Ref. 1 pages 100 -104.
- b) Sulphuric acid- Contact process.
Ref. pages 133-143.
- c) Nitric acid - Ostwald process.
Ref. 1 pages 105-108.
- d) Manufacture of Urea and Triplesuperphosphate.
Ref. 1 Relevant pages.

8. Glass Industry : (8)

Physical properties of glass, classification, chemical properties, effect of different constituents in glass., principle raw materials used in manufacture of glass, chemical reactions, manufacture of glass, shaping, annealing finishing of glass, Spherical glass, fibre glass
Ref. 1 pages 160-171.

9. Electrochemical Industry.: (06)

- a) Electroplating, Plating equipments, cleaning, articles to be plated, factors affecting the nature of electrodeposition, Chromium plating.
- b) Electrorefining of metals. General Principles, Electrorefining of copper.
- c) Electrometallurgy from the electrolysis of fused electrolytes General principles, electrometallurgy of aluminium.
Ref. pages.

10. Dyes.

(7)

- a) Colour, colour and chemical constitution.
Chromophores, auxochromes, Bathchromic and Hypsochromic groups.
- b) Dyes.- Nomenclature, classification according to their constitution, and mode of application.
- c) Synthesis and uses of following dyes.
Methyl orange, Congo red, Eriochrome Black T, Crystal violet, phenolphthalein, Indigotin.
Ref. 3, 7 Relevant pages.

11. Drugs and Pharmaceuticals.

(10)

- a) Introduction to chemotherapy, qualities of good drugs, classification, functional and chemotherapeutic drugs. Meaning of the following terms with one example each Analgesic, Antacid, Antibiotic, Antihistamine, Anti-arrhythmic, Anti-inflammatory, Antiobesity, Cardio-vascular agent, contraceptive agents, cough and cold preparations, diuretics, Laxatives, psychophoreceuticals sedatives, Hypnotics, sulpha drugs.
Ref. 3, 8, 9, 10 Relevant pages.
- b) Synthesis and uses of following.
Xylocaine, Benadryl, Antipyrine, Paracetamol, Sulphadiazine, Benzocaine.
Ref.10 Relevant pages.

12. Soaps and Detergents.

(7)

Introduction, Meaning of the term soap and detergents Raw material, Surfactants, Straight chain alkyl benzenes, Fatty acids and alcohols, Builder, additives, Manufacture of detergents- flowsheet, soap manufacture, typical soaps.

Ref.3, 529-549 Relevant pages only.

Note: In all above topics chemical engineering aspects are not expected.

References :

- Ref.1 : Industrial Chemistry by R.K. Das II 1976.
- Ref.2 : Elements of ceramics Norton II Edition 1974.
- Ref.3.: Shreve's chemicals Processes Industries, George Austin V th Edition.
- Ref.4: Chemical Processess Industries, Shreve and Brink 4 th Edition 1977.

- Ref.5 : Polymer Science, V.R. Gowarikar- 1986.
Ref.6 : Organic Chemistry, Morrison Boyd 5th Edition 1989.
Ref.7 : Organic Chemistry, I.L. Finar Vol. I.
Ref.8 : Organic Chemistry, I.L. Finar Vol. II.
Ref.9 : Riegel's Handbook of Industrial Chemistry ,
S.A. Kent 1974.
Ref.10: Synthetic organic Chemistry, G.R. Chatwal.
(Himalaya Publishing House)

Paper X (Optional) Nuclear Chemistry.
Section I - First Term .

1. The Atomic Nucleus: (4)
Nucleus and its properties, Classification of nuclides,
Nuclear stability and factor affecting the nuclear
stability.
Ref. 1. pages 3 to 14 and 20 to 23.
2. Nuclear Models: (8)
The shell model; The periodicity in nuclear properties,
salient features of shell model, merits of the shell
model, The Liquid drop model. Semi empirical mass equ-
ation, application of semiempirical binding energy equ-
ation.
Limitations of liquid drop model.
Ref. 1. pages 51 to 57, 65 to 74, and 74 to 79.
Problems on the above topic.
3. Radioactivity :
Types of radioactive decay, Decay schemes, General
characteristics, Decay kinetics, Alpha active nuclides.
The range and ionizing power, Energy spectrum; Geiger-
Nuttall's law, Theory of alpha decay. Beta decay: types
of beta decay, Absorption and range through matter,
Energetics and spectrum, neutrino, fermi theory of Beta
decay, (mathematical details are not expected) Gamma
emission; Nuclear isomerism, isomeric transition, in-
ternal conversion, The Auger effect.
Ref. pages 91 to 126.
Ref.3. pages 358 to 363.
Ref.1. pages 137 to 143.

4. Nuclear Reactions : (12)

Bethe's notation, types of nuclear reactions, conservations in nuclear reactions, specific nuclear reactions : Photonuclear reaction, Thermonuclear reactions, reaction cross section, The compound nucleus Theory.

Ref. 1. Pages 148 to 163 and 168 to 183.

5. Nuclear Fissions: (8)

The process of nuclear fission, fission fragments, their mass distribution, charge distribution, fission energy, fission cross section and Thresholds, fission neutrons, Theory of nuclear fission.

Ref. 1. Pages 186 to 202.

Section - II, (Second Term.)

1. Nuclear reactors:

Fission energy, The natural uranium reactor, The four factor formula, The classification of reactor. Power, Research and breeder reactors, nuclear reactors in India , Reprocessing of spent fuels.

Ref.1. Pages 209 to 224.

2. Detection and measurement of nuclear radiations, (10)

specific ionization, behaviour of ion-pairs in electric fields. The ionization chambers, proportional counters, Geiger Muller counters, Scintillation counters, Semi-conductor detector.

Ref. 2 Pages 198 to 203 and 211 to 222.

3. Applications of radioactivity: (16)

Typical reactions involved in the preparation of radio isotopes, The Szilard-Chalmers reaction, Radio-chemical principles in the use of tracers physics chemical, Analytical application.

(1) Isotope dilution analysis.

(2) Neutron activation analysis.

(3) Radiometric titration.

Age determination, medical application, agriculture application, industrial applications.

Ref. 1. Pages 226 to 276.

4. Radiation Chemistry: (12)

Interactions of radiations with matter, passage of neutrons through matter, .. Units for measuring radiation absorption. Radiation dosimetry. Radiolysis of water, Free radicals in water radiolysis, Radiolysis of some aq. solution, Time scale of radiolytic event.

Ref. 1. Pages 284 to 307.

5. Radiation safety precautions: (4)

Biological effects of radiation, safety standards, safe working methods.

Ref. 4. Pages 322 to 328.

Reference :

Ref. 1. Essentials of Nuclear Chemistry by H.J. Arnikar.

Ref. 2. Sourcebook on energy by Samuel Glasstone, III, rd Edition.

Ref. 3. Nuclear physics by Irving Kaplan II nd Edn.

Ref, 4. Introduction to Nuclear Physics and Chemistry. by B.G. Harvey.

PAPER X - B (OPTIONAL) (I) POLYMER CHEMISTRY (THEORY)Section - I (First Term)

1. INTRODUCTION. (6)
 Brief history, Polymers-Definition-Preparation. Classification Molecular forces and chemical bonding in polymers.
 Ref : 1, Pages 1 to 14,
 Ref : 2, Pages 1 to 16.
2. CHEMISTRY OF POLYMERISATION. (12)
 Introduction, chain polymerisation, Free radical polymerisation, Ionic polymerisation Co-ordination polymerisation, Step polymerisation, Ring opening polymerisation.
 Ref : 1, Pages 15 to 64,
3. POLYMERISATION TECHNIQUES. (6)
 Bulk-polymerisation, Solution polymerisation, Suspension polymerisation, Emulsion polymerisation, Melt polycondensation, Solution polycondensation, Interfacial condensation, Salient features of different polymerisation techniques.
 Ref : 1, Pages 71 to 79, 82 to 84

Section - II (Second Term)

4. GLASS TRANSITION TEMPERATURES. (2)
 What is glass transition temperature?
 Factors influencing the glass transition temperatures.
 Importance of glass transition temperature.
 Ref : 1, Pages 150, 163-167, 171-172.
5. SOME IMPORTANT POLYMERS. (8)
 Polyethylene, Polypropylene, Polystyrene, Polyacrylonitrile, Polyvinyl chloride, Teflon, Phenol-Formaldehyde, Polyurethanes, Polysters, Melamine formaldehyde resins, epoxy polymers and silicones.
 Ref : 1, Chapter 9 - relevant pages.
6. POLYMER INGREDIENTS. (4)
 Fillers, Coupling agents, Plasticisers antioxidants, Heat stabilizers, Ultraviolet stabilizers, flame retarders, colourants cross linking agents, Miscellaneous additives.
 Ref : 2, Pages 471 - 475