Course Name : Master of Science
Discipline : Chemistry
CHOICE BASED CREDIT SYSTEM
(For those who joined in June 2022 and after)
Course Scheme:

Self-Learning Course:

Year	Sem	Subject	Credit	Ext =Tot	Subject Code	
II	III	**APPLIED CHEMISTRY**	5	100 = 100	**P22CHSL31**	**Revised 40%**
II	III	CRITICAL ANALYSIS OF GATE/CSIR-NET QUESTIONS	5	100 = 100	P19CHSL32/ P22CHSL32	No Change

SELF LEARNING (PG Only)
APPLIED CHEMISTRY

Credit: 5 **Subject Code: P22CHSL31**
Total marks: 100

Objectives:

1. To provide knowledge about chemistry based Applied Chemistry
2. To design and conduct experiments relevant to Product of chemistry, as well as to analyze theproduct
3. The learners should have awareness about production, isolation and properties of essential fuels, and its constituents.
4. To improve usage of chemistry for modern technology in match industry, paints and pigments

Outcome

1. Understood the principles and Background to Chemical compounds in modern life
2. Make the students acquire knowledgefor the synthesis of Chemical compounds
3. Integrate knowledge with critical thinking to solve problems.
4. Develop skills in analysing and grading soaps.
5. Acquire advanced knowledge about industrially importantmatch industry, Paints and pigments which would be helpful in pursuing a carrier in such industries

Unit I FUELS

Classification of fuels – Calorific value- characteristics of a good fuel- Comparison between solid, liquid and gaseous fuels - Coal –chemical constitution and types – Petroleum - classification and composition- Petrol- Kerosene-Diesel- Comparative account of diesel and petrol – Cracking - Knocking - Octane rating - Diesel- index- Natural gas - Coal gas - Oil gas – Producer gas - Water gas- Biogas.

Reference:

1. P. C. Jain & M. Jain, Engineering Chemistry, DhanpatRai Publishing Company, 2000.
2. B. K. Sharma, Industrial Chemistry, Goel Publishing House, Meerut, India, 1994.
3. https://www.lkouniv.ac.in/site/writereaddata/siteContent/202004132159500424ranvijay_engg_Fuels.pdf

Unit II MATCH INDUSTRY

Advantages of Safety matches over Lucifer matches – Preparation, properties and uses of chemicals in matchstick head**:** $KClO_3$, KNO_3, Sulphur, Antimony sulphide, Borax, MnO_2, Wax, Glue and Potassium dichromate.

Body composition of colour and/or star matches: Colour matches: $KClO_3$, Barium nitrate, Strontium nitrate, Shellac, Lamp black, Paris green, Resin, Denatured sprit. Manufacturing process of matchsticks – Dipping process: Wax dipping and chemical dipping , drying - automation process.

Manufacture of conventional fireworks products: Flower pot, Ground chackra, Sparkles, Pencil, Crackers, Rockets and Atom bomb, Aerial Shots – Fuse making – Caps and ring caps – gun powder, serpent egg.

Reference:

1. P. L. Sony, "Text Book of Inorganic Chemistry" Mohan Katya Sultan Chand and Sons – New Delhi, 2013.
2. K. N. Ghosh, "The principles of fire works" 1987, Sivakasi.
3. http://www.treesforlife.info/fao/Docs/P/x5860e/x5860e05.htm

UNIT-III Corrosionand Chemical toxicology

Corrosion: - Definition – classification of corrosion; Dry (or) Direct chemical corrosion – oxidation corrosion and its mechanism, corrosion by other gases. Liquid metal corrosion – wet (or) Electrochemical corrosion – mechanism. Forms of corrosion – control (or) prevention of Corrosion.

Chemical toxicology: Toxic chemical in the environment – toxic chemical in air – toxic chemical in water – biochemical effects of lead, mercury, carbon monoxide, nitrogen oxides, sulphur dioxide and cyanide.

Reference

1. Enginnering chemistry by P.C Jain and Monika Jain, Dhanpar Raj Publishing company (p) Ltd – New Delhi.
2. Applied Chemistry by N. Ravisanker, B. Narayanasamy and K. Ilangovan. National Pathippaham – Srivilliputtur.

UNIT-IV PAINTS AND PIGMENTS

Paints and pigments - formulation, composition and related properties. Oil paint, vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings (electrode and electrolytic), metal spraying and anodizing.

Reference:

1. B. K. Sharma, Industrial Chemistry, Goel Publishing House, Meerut, India, 1994.
2. P. C. Jain & M. Jain, Engineering Chemistry, DhanpatRai Publishing Company, 2000.
3. https://edu.rsc.org/download?ac=517777

UNIT V Characterization and Application of Detergents

Characterization and Application of Detergents, Principal groups of synthetic detergents, Anionic detergents, Cationic detergents, Non-ionic detergents, Amphoteric detergents, Industrial methods of preparation of Detergents, Concept of hard and soft water, Removal of hardness of water, Oil and fat, General idea of Suds regulators, builders, additives, Manufacture of Shampoos. Theories of glyceride structure, Hydrolysis of glycerides, Use of oil in the manufacturing of soap, Principle of soap cleaning, Analysis of soaps as per BIS standards the use of enzymes in detergents

Reference:

1. Industrial Chemistry by B. K. Sharma, 9th Edn.
2. https://nios.ac.in/media/documents/SrSec313NEW/313_Chemistry_Eng/313_Chemistry_Eng_Lesson31.pdf

Model Question

1. How fuels are classified. Give one example for each

2.Define calorific value. Explain higher & lower calorific value

3. Explain the following (i) Compressed natural gas (CNG) (ii) Liquidpetroleum gas. (LPG) (iii) Compressed Natural Gas: (CNG)

4. What are the various gasification processes of solid fuels?

5. Explain kinetics of solid fuel combustion

6. With a neat sketch explain petroleum refining process by fractional distillation.

7. Interpret the following i) Cracking ii) Polymerization

8. Define the term corrosion and differentiate it from erosion

9.Discuss the different types of corrosion that we commonly come across.

10. Discuss the importance of design and material selection in controlling corrosion.

11.Explain with suitable examples the corrosion due to differential aeration and dry corrosion?

12.What is the mechanism by which rusting occurs?

13. Distinguish between wet and dry corrosion

14. Analyse the impact of heavy metals in toxicology.

15. Discuss briefly the toxicological impact of domestic waste

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CRITICAL ANALYSIS OF GATE/CSIR-NET QUESTIONS

Credit: 5 **CODE:** P19CHSL32/ P22CHSL32
Total Marks: 100

Course Outcomes:
Students, after successful completion of the course, will be able to

- Understand the fundamentals of chemistry concepts
- Apply and solve the chemistry problems
- Prepare for the competitive exam
- Pass the competitive exam successfully

Unit-I :

- **Equilibrium:** Laws of thermodynamics. Standard states. Thermochemistry. Thermodynamic functions and their relationships: Gibbs-Helmholtz and Maxwell relations, van't Hoff equation. Criteria of spontaneity and equilibrium. Absolute entropy. Partial molar quantities. Thermodynamics of mixing. Chemical potential. Fugacity, activity and activity coefficients. Chemical equilibria. Dependence of equilibrium constant on temperature and pressure. Non-ideal solutions. Ionic mobility and conductivity. Debye-Hückel limiting law. Debye-Hückel-Onsager equation. Standard electrode potentials and electrochemical cells. Potentiometric and conductometric titrations. Phase rule. Clausius-Clapeyron equation. Phase diagram of one component systems: CO_2, H_2O, S; two component systems: liquid-vapour, liquid-liquid and solid-liquid systems. Fractional distillation. Azeotropes and eutectics. Statistical thermodynamics: microcanonical and canonical ensembles, Boltzmann distribution, partition functions and thermodynamic properties.
- **Kinetics:** Transition state theory: Eyring equation, thermodynamic aspects. Potential energy surfaces and classical trajectories. Elementary, parallel, opposing and consecutive reactions. Steady state approximation. Mechanisms of complex reactions. Unimolecular reactions. Kinetics of polymerization and enzyme catalysis. Fast reaction kinetics: relaxation and flow methods. Kinetics of photochemical and photophysical processes.
- **Surfaces and Interfaces:** Physisorption and chemisorption. Langmuir, Freundlich and BET isotherms. Surface catalysis: Langmuir-Hinshelwood mechanism. Surface tension, viscosity. Self-assembly. Physical chemistry of colloids, micelles and macromolecules.

Unit-II :

- **Main Group Elements:** Hydrides, halides, oxides, oxoacids, nitrides, sulfides – shapes and reactivity. Structure and bonding of boranes, carboranes, silicones, silicates, boron nitride, borazines and phosphazenes. Allotropes of carbon. Chemistry of noble gases, pseudohalogens, and interhalogen compounds. Acid-base concepts.
- **Transition Elements:** Coordination chemistry – structure and isomerism, theories of bonding (VBT, CFT, and MOT). Energy level diagrams in various crystal fields, CFSE, applications of CFT, Jahn-Teller distortion. Electronic spectra of transition metal complexes: spectroscopic term symbols, selection rules, Orgel diagrams, charge-transfer

spectra. Magnetic properties of transition metal complexes. Reaction mechanisms: kinetic and thermodynamic stability, substitution and redox reactions.

- **Lanthanides and Actinides:** Recovery. Periodic properties, spectra and magnetic properties.
- **Organometallics:** 18-Electron rule; metal-alkyl, metal-carbonyl, metal-olefin and metal-carbene complexes and metallocenes. Fluxionality in organometallic complexes. Types of organometallic reactions. Homogeneous catalysis - Hydrogenation, hydroformylation, acetic acid synthesis, metathesis and olefin oxidation. Heterogeneous catalysis - Fischer-Tropsch reaction, Ziegler-Natta polymerization.

Unit-III:

- **Reaction Mechanisms:** Basic mechanistic concepts – kinetic *versus* thermodynamic control, Hammond's postulate and Curtin-Hammett principle. Methods of determining reaction mechanisms through identification of products, intermediates and isotopic labeling. Nucleophilic and electrophilic substitution reactions (both aromatic and aliphatic). Addition reactions to carbon-carbon and carbon-heteroatom (N,O) multiple bonds. Elimination reactions. Reactive intermediates – carbocations, carbanions, carbenes, nitrenes, arynes and free radicals. Molecular rearrangements involving electron deficient atoms.
- **Organic Synthesis:** Synthesis, reactions, mechanisms and selectivity involving the following classes of compounds – alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids, esters, nitriles, halides, nitro compounds, amines and amides. Uses of Mg, Li, Cu, B, Zn and Si based reagents in organic synthesis. Carbon-carbon bond formation through coupling reactions - Heck, Suzuki, Stille and Sonogoshira. Concepts of multistep synthesis - retrosynthetic analysis, strategic disconnections, synthons and synthetic equivalents. Umpolung reactivity – formyl and acyl anion equivalents. Selectivity in organic synthesis – chemo-, regio- and stereoselectivity. Protection and deprotection of functional groups. Concepts of asymmetric synthesis – resolution (including enzymatic), desymmetrization and use of chiral auxilliaries. Carbon-carbon bond forming reactions through enolates (including boron enolates), enamines and silylenol ethers. Michael addition reaction. Stereoselective addition to C=O groups (Cram and Felkin-Anh models).
- **Pericyclic Reactions and Photochemistry:** Electrocyclic, cycloaddition and sigmatropic reactions. Orbital correlations - FMO and PMO treatments. Photochemistry of alkenes, arenes and carbonyl compounds. Photooxidation and photoreduction. Di-π-methane rearrangement, Barton reaction.
- **Heterocyclic Compounds**: Structure, preparation, properties and reactions of furan, pyrrole, thiophene, pyridine, indole, quinoline and isoquinoline.

Unit-IV:

- **Structure:** Postulates of quantum mechanics. Time dependent and time independent Schrödinger equations. Born interpretation. Particle in a box. Harmonic oscillator. Rigid rotor. Hydrogen atom: atomic orbitals. Multi-electron atoms: orbital approximation. Variation and first order perturbation techniques. Chemical bonding: Valence bond theory and LCAO-MO theory. Hybrid orbitals. Applications of LCAO-MOT to H^{2+}, H_2 and other homonuclear diatomic molecules, heteronuclear diatomic molecules like HF,

CO, NO, and to simple delocalized π– electron systems. Hückel approximation and its application to annular π – electron systems. Symmetry elements and operations. Point groups and character tables. Origin of selection rules for rotational, vibrational, electronic and Raman spectroscopy of diatomic and polyatomic molecules. Einstein coefficients. Relationship of transition moment integral with molar extinction coefficient and oscillator strength. Basic principles of nuclear magnetic resonance: nuclear *g* factor, chemical shift, nuclear coupling.

- **Radioactivity:** Decay processes, half-life of radioactive elements, fission and fusion processes.
- **Bioinorganic Chemistry:** Ion (Na^+ and K^+) transport, oxygen binding, transport and utilization, electron transfer reactions, nitrogen fixation, metalloenzymes containing magnesium, molybdenum, iron, cobalt, copper and zinc.
- **Solids:** Crystal systems and lattices, Miller planes, crystal packing, crystal defects, Bragg's law, ionic crystals, structures of AX, AX_2, ABX_3 type compounds, spinels, band theory, metals and semiconductors.

Unit-V:

- **Stereochemistry**: Chirality of organic molecules with or without chiral centres and determination of their absolute configurations. Relative stereochemistry in compounds having more than one stereogenic centre. Homotopic, enantiotopic and diastereotopic atoms, groups and faces. Stereoselective and stereospecific synthesis. Conformational analysis of acyclic and cyclic compounds. Geometrical isomerism. Configurational and conformational effects, and neighbouring group participation on reactivity and selectivity/specificity.
- **Biomolecules**: Structure, properties and reactions of mono- and di-saccharides, physicochemical properties of amino acids, chemical synthesis of peptides, structural features of proteins, nucleic acids, steroids, terpenoids, carotenoids, and alkaloids.
- **Instrumental Methods of Analysis:** UV-visible spectrophotometry, NMR and ESR spectroscopy, mass spectrometry. Chromatography including GC and HPLC. Electroanalytical methods- polarography, cyclic voltammetry, ion-selective electrodes. Thermoanalytical methods.
- **Spectroscopy**: Applications of UV-visible, IR, NMR and Mass spectrometry in the structural determination of organic molecules.
