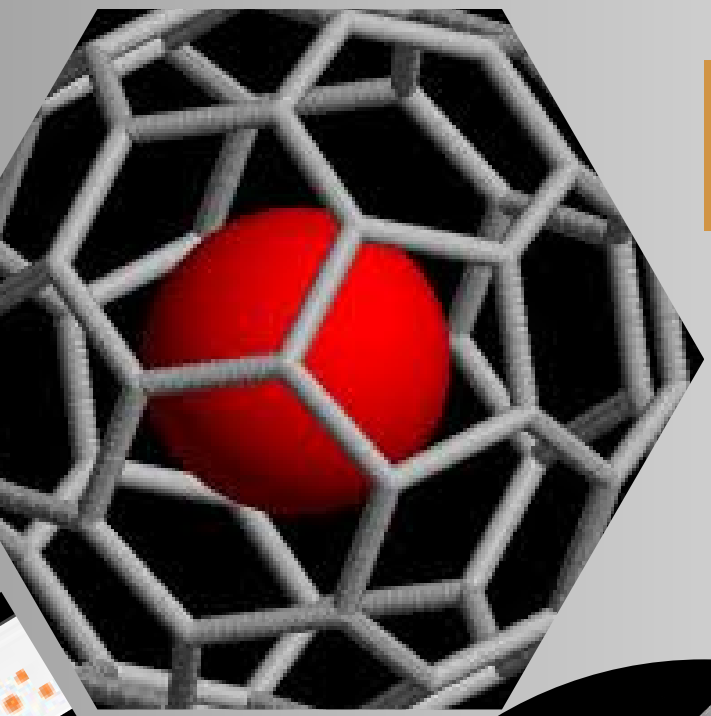
# GOVT. HOLKAR (MODEL, AUTONOMOUS) SCIENCE COLLEGE, INDORE

4 QUALITY EDUCATION

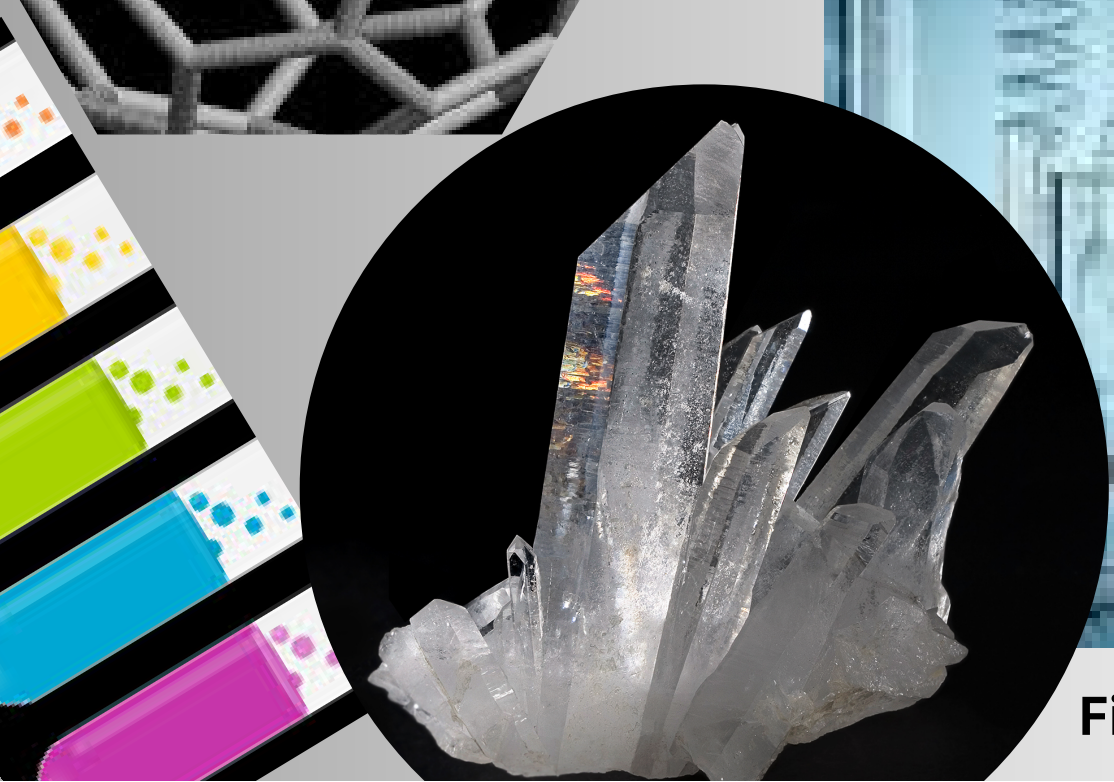
## DEPARTMENT OF CHEMISTRY

Under the guidance of IQAC

# Question Bank for B.Sc. Students



**BASED ON BLOOM'S TAXONOMY**



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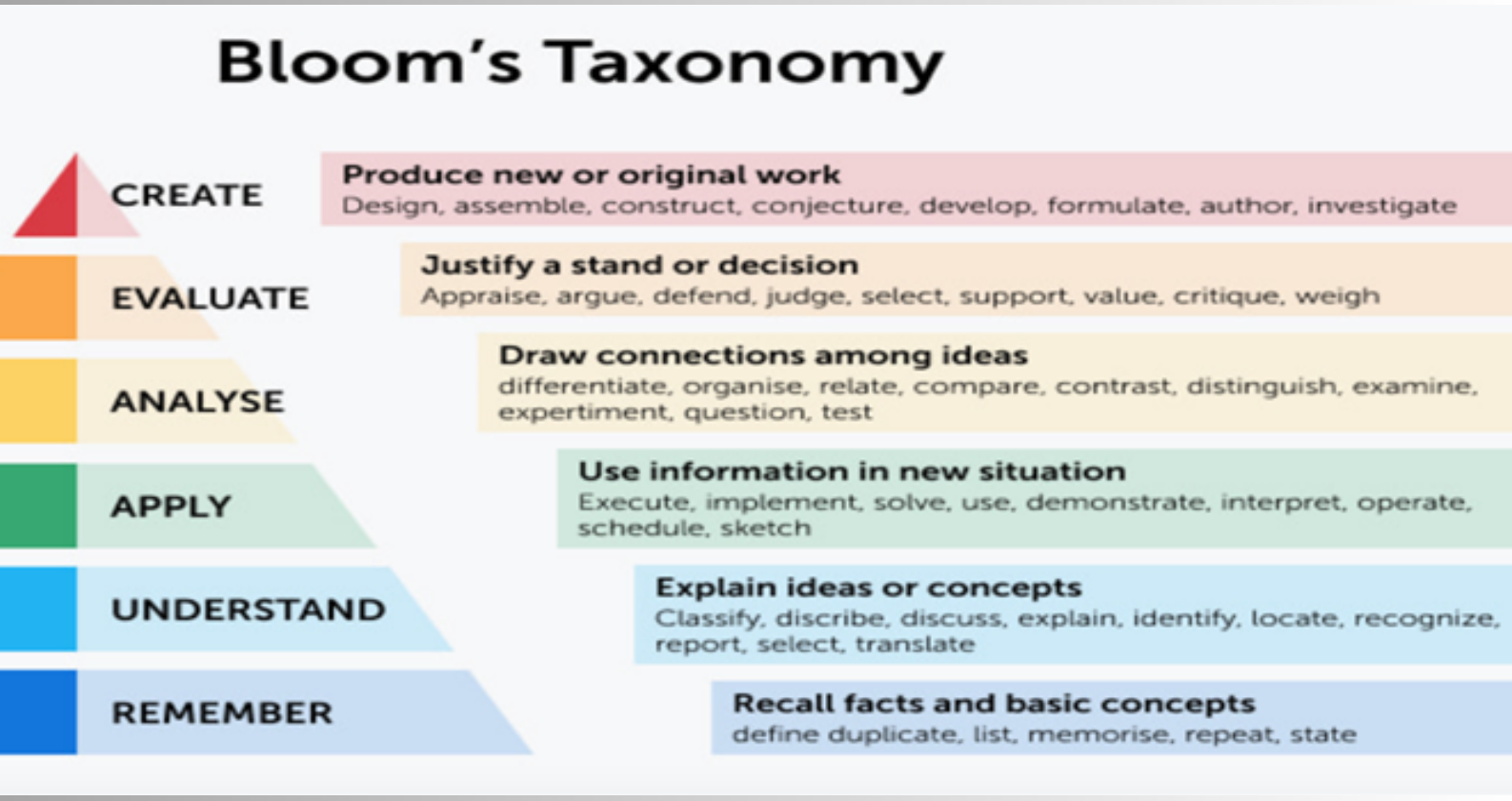
# EXPECTATIONS FROM STUDENTS TO UNDERSTAND AND SOLVE QUESTIONS AS PER THE UNDERMENTIONED LEVELS OF BLOOM'S TAXONOMY




# https://www.valamis.com/hub/blooms-taxonomy

# DISCLAIMER

THIS QUESTION BANK IS PREPARED SOLELY FOR EDUCATIONAL AND INFORMATIONAL PURPOSE SO THAT THE STUDENTS HAVE AN IDEA OF ASSESSING THE BLOOM'S LEVELS OF QUESTIONS ASKED AND ACCORDINGLY ANSWER THEM. THE QUESTIONS HAVE BEEN COMPILED FOR PRACTICE PURPOSE ONLY AND IT IS NOT NECESSARY THAT QUESTIONS IN EXAMINATIONS MAY COME FROM THIS QUESTION BANK. THIS QUESTION BANK HAS NOT BEEN PREPARED FOR ANY COMMERCIAL GAIN. THE AUTHORS WILL NOT BE RESPONSIBLE FOR ANY TYPOGRAPHICAL ERROR.

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## Department of Chemistry

## QUESTION BANK

## FOR

## B.Sc. STUDENTS

**# Questions are Colour-coded as per Colour scheme below according to Bloom's Taxonomy**

| | | | |
|---|---|---|---|
| Bloom's Level I | Remember | -- | Blue |
| Bloom's Level II | Understanding | -- | Light Blue |
| Bloom's Level III | Apply | -- | Green |
| Bloom's Level IV | Analyse | -- | Yellow |
| Bloom's Level V | Evaluate | -- | Orange |
| Bloom's Level VI | Create | -- | Red |

# B.Sc. I Semester (Major)

# Fundamentals of Chemistry

## Unit – I

**Very Short Answer Type Questions –**

Q.01) Write name and use of one chemical technique used in Rasshala?

Q.02) Draw the diagram of patana yantra?

Q.03) For which purpose Dhup yantra was used?

Q.04) Write use of Adhapatana and Kosthi yantra?

Q.05) Give names of two furnaces used in metallurgy in ancient India?

Q.06) Describe Bohr's atomic model?

Q.07) What is de-Broglie principle?

Q.08) Explain Heisenberg's uncertainty principle?

Q.09) Explain Pauli's exclusion principle?

Q.10) Write electronic configuration of Cu (29)?

**Short Answer Type Questions -**

Q.01) Write names and uses of two chemical techniques used in Rasshala?

Q.02) Draw the diagram of Svedani & Patana yantra?

Q.03) Write short note on few furnaces used in ancient India?

Q.04) What is Rasashastra? Write its importance.

Q.05) Prove that $\lambda = h/mc$

Q.06) Write a short note on spectrum of hydrogen atom?

Q.07) Explain de-Broglie equation and applications?

**HOTSQ**

Q.08) What is Zeeman effect? It affects which quantum number and how it is different from Stark effect?

Q.09) Atomic number of two atoms are 17 and 27. Calculate four quantum numbers of last electron?

Q.10) Write contribution of scientists in metallurgy in ancient India?

**Long Answer Type Questions -**

Q.1) Describe chemical techniques used in ancient India?

Q.2) Describe knowledge of following in ancient India

(1) Furnaces

(2) Metallurgy

(3) Corrosion

(4) Explosives

(5) Alloys

(6) Iron pillar of Mehrauli

Q.3) Describe contribution of ancient Indian scientists in the field of Metallurgy and Ayurveda?

Q.4) Explain Bohr's atomic model. Give its limitations?

Q.5) What is Aufbau prinicple? Illustrate three basic rules and exceptions.

Q.6) Describe spectrum of hydrogen atom. How did Bohr explain it?

Q.7) What do you understand by Heisenberg's uncertainty principle? Highlight its importance.

**HOTSQ**

Q.8) Explain Hunds rule and give electronic configuration of H, Li, N & O according to it?

Q.9) Describe de-Broglie equation and explain the difference between wave length and de-Broglie wave length?

Q.10) Write an essay on contribution of ancient Indian scientists in chemistry?

## Unit – II

**Very Short Answer Type Questions -**

Q.1) What is orbital. Explain between bonding and antibonding orbitals.

Q.2) Calculate bond order of $O_2$, $O_2^+$, and $0_2^-$ ?

Q.3) Identify hybridisation found in $H_2O$, $NH_3$, and $PCl_3$

Q.4) Give four characteristics of Ionic bond.

Q.5) Assign the shape of the molecule for following hybridisations sp, $sp^2$, $sp^3$, $dsp^2$, $sp^3d$, $sp^3d^2$.

Q.6) Give two examples of Lewis acids and Lewis bases.

Q.7) What are Arrhenius acids?

Q.8) Interpret Henderson's equation.

Q.9) State indicator suitable for both strong acid, strong base & weak acid, strong base titrations.

Q.10) recognize conjugate acid & base pair

a) $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$

b) $HCl + H_2O \rightleftharpoons H_3O^+ + Cl^-$

Q.11) Report two examples each of acidic buffer and basic buffer.

**Short Answer Type Questions -**

Q.1) Explain why

a) HI is a stronger acid than HF.

b) $BCl_3$ is trigonal planer while $NH_3$ is trigonal pyramidal.

c) Bond angle of $H_2O$ is slightly smaller than ammonia.

Q.2) Write short note on : a) Buffers b) Conjugate acid base pair

Q.3) How does the pH of the solution change when a solution of base is diluted.

Q.4) Why does tooth decay start when pH of mouth is lower than 5.5.

Q.5) Explain with diagram strong base, weak acid neutralization curve.

Q.6) Explain chemical bonding on the basis of Bronsted Lowry concept

Q.7) Explain relative strength of Hydra acids.

Q.8) What is indicator? Explain acid base indicator.

Q.9) Write factors affecting strength of acid & base.

Q.10) Choose Lewis acids and bases from the following examples: $H_2O$, $NH_3$, $SO_3$, $BF_3$, $CO_2$.

**Long Answer Type Questions -**

Q.1) What is Lewis acid & base? Describe its classification.

Q.2) Describe the postulates of VSEPR theory.

Q.3) Explain various type of chemical bonding with example.

Q.4) What is pH? Explain buffer solution. Derive Henderson's equation

Q.5) What is molecular orbital theory? Draw Molecular orbital diagram of $N_2$ & $O_2$

Q.6) Explain Born- Haber cycle taking NaCl as an example.

HOTS Q

Q.7) What is solvation energy? Explain factors affecting solubility of ionic solids.

Q.8) Explain Fajan's Rule with example & give its application.

Q.9) What is hybridisation? Explain sp, $sp^2$, $sp^3$, $dsp^2$, $sp^3d$, $sp^3d^2$ hybridisation

Q.10) Explain on the basis of MOT-

a) Bond order of $O_2^+$ is more than $O_2$.

b) Bond order of $N_2^+$ is less than $N_2$.

## Unit – III

**Very Short Answer Type Questions -**

Q.1) Write two characteristics of ionic bond?

Q.2) Give two examples of Lewis structure?

Q.3) Explain hybridization with one example?

Q.4) Write hybridization found in $H_2O$, $NH_3$ and $PCl_3$?

Q.5) Write geometry of $H_2O$, $CH_4$ and $BeCl_2$ molecule?

Q.6) Explain geometry of $NH_3$ on the basis of VSEPR theory?

Q.7) Give formula to determine bond order by MOT?

Q.8) Write magnetic nature of $N_2$, $F_2$ and $O_2$?

Q.9) What is the difference in bonding and antibonding orbital?

Q.10) Write bond order of $O_2$, $O_2^+$ and $O_2^-$ ?

**Short Answer Type Questions -**

Q.1) What is ionic bond?

Q.2) Write four characteristics of ionic bond?

Q.3) What do you mean by lattice energy?

Q.4) Explain solvation energy with example?

Q.5) Explain role of lattice energy and solvation energy in stability of ionic compounds?

Q.6) Write Born Lande equation?

Q.7) Write short note on Madelung constant?

**HOTSQ**

Q.8) Explain application of Born Haber cycle with example?

Q.9) Explain covalent character in ionic compounds?

Q.10) Write short note on Fajans rule?

**Long Answer Type Questions** -

Q.1) What is ionic bond? Write its general characteristics?

Q.2) What is lattice energy? Discuss various factors which affect lattice energy?

Q.3) Explain Born-Haber cycle and its importance. How is it used to calculate lattice energy of a compound and electron gain enthalpy of an element?

Q.4) What is solvation energy? Explain factors affecting solubility of ionic solids?

Q.5) What do you mean by polarizing capacity and polarization? Describe factors affecting it?

Q.6) Explain Fajan's rule with example and give its applications?

Q.07) Highlight Born-Lande equation used in calculation of lattice energy. Clarify Madelung constant?

**HOTSQ**

Q.8) What is hybridization? Explain *sp*, $sp^2$, $sp^3$, $dsp^2$, $sp^3d$ and $sp^3d^3$ hybridization with example?

Q.9) What is hybridization? Explain the following geometrical shapes:

(i) Trigonal planar, (ii) Tetrahedral, (iii) Octahedral.

Q.10) Explain lp-lp>lp-bp>bp-bp repulsion. Explain geometry of $NH_3$, $H_2O$ and $PCl_5$ on this basis.

**Unit – IV**

**Very Short Answer Type Questions** -

1. Explain inductive effect with example.
2. what is hyper conjugation give example.
3. Give one example each of substitution and elimination reaction.
4. Write order of stability of 1°, 2° and 3° free radicals.
5. What are enantiomers? Write with example.
6. Explain asymmetric carbon atom with example.
7. Give elements of symmetry with example.

8. Explain conditions for molecule to have. optical isomerism & geometrical isomerism.
9. How many geometrical isomers are possible in $CH_3 – CH=CH-CH_2-C_2H_5$.
10. Dichloro-ethylene shows which type of isomerism.
11. Define nucleophiles, electrophiles with examples.

**<u>Short Answer Type Questions</u> -**

Q.1) Write short note on

a) sp hybridisation b) $sp^2$ hybridisation c) $sp^3$ hybridisation.

Q.2) Explain resonance with example.

Q.3) How inductive affects the acid and basic strength of acids and bases.

Q.4) Explain hybridisation in the following compounds:

(a) $H_3C- C\equiv C-CH_3$ (b) $CH_3$ CHO (c) $CH_2=CH-CH_2-CH_3$

Q.5) Explain the following –

a) Tertiary Carbonium ion is more stable than primary & secondary carbonium ion.

b) C=C double bond distance in $C_6H_6$ is less than ethane.

c) Trichloro acetic acid is stronger than acetic acid

d) Pyridine is a weaker base than aliphatic tertiary amine.

e) Alcoholic KOH is more basic than aqueous KOH.

Q.6) What are free radicals. Give methods of preparation, reaction and stability.

Q.7) Give reasons:

1) Electron repelling groups impart stability to carbocation

2) Nucleophile and alkali though identical but are different.

Q.8) What is optical activity? Explain optical isomerism in tartaric acid.

Q.9) What is Walden inversion? Explain with suitable example.

Q.10) What are diastereomers? Write their characteristics. Write difference between diastereomers and enantiomers.

Q.11) Write short notes on

(a) Geometrical isomerism in alicyclic compound and oximes

(b) Sequence Rule and write different groups in order of preference.

Q.12) Explain the following.

(a) Sawhorse projection formula.

(b) Fischer & flying wedge formula.

(c) Newmann Projection formula.

Q.13) Explain E-Z system of nomenclature.

Q.14) What are racemic mixture, racemisation & resolution.

Q.15) Explain why-

a) Racemic mixture does not show optical activity

b) Propionic acid does not show optical activity while lactic acid shows.

**Long Answer Type Questions -**

Q.1) What is conformation? Describe conformational analysis in ethane and butane. Draw potential energy diagram for it.

Q.2) Describe optical isomerism in a compound having two asymmetric carbon atoms.

Q.3) Explain Vant Hoff & LeBell theory of molecular configuration. Explain different forms of tartaric acid on basis of this theory.

Q.4) Describe methods to determine configuration of geometrical isomers.

Q.5) Explain, D, L & R, S, d & l system to show configuration of optically active compounds.

Q.6) Explain mechanism of Walden inversion, Racemisation.

Q.7) What is hybridisation? Explain different types of hybridisation.

Q.8) Write short notes on -

a) Addition reaction

b) Substitution reaction

c) Elimination.

Q.9) Explain homolytic & heterolytic fission of covalent bond with example.

Q.10) What is hyper-conjugation? Explain the significance of hyper-conjugative effect.

Q.11) White short note on

a) Mesomeric effect.

b) resonance

c) Carbanion

d) Carbonium ion

Q.12) Explain with reason-

(1) Trichloroacetic acid is stronger than acetic acid.

(2) Formic acid is stronger than acetic acid.

Q.13) Clarify difference between carbocation & carbanion. Write the order of decreasing stability ions obtained by heterolytic fission of C-Cl bond of $CH_3$ $CH_2CH_2Cl$, $(CH_3)_2$ CHCl, $(CH_3)$ C-Cl.

Q.14) Draw molecular orbital diagrams of molecules of ethane, ethylene, ethyne, with bond angles & bond length.

Q.15) Why –

i) α-chlorobutyric acid is stronger than β- chlorobutyric acid.

ii) Fluoroacetic acid is stronger than Chloro-acetic acid.

Q.16) Explain the stability of carbonium ions, carbanions & free radicals with example.

## Unit - V

**Very Short Answer Type Questions -**

1. Define rate of reaction?
2. What do you mean by activation energy?
3. Discuss the difference between order of reaction and Molecularity?
4. Who gave the concept of pH?
5. What is the Unit of dilution?
6. State Ostwald's dilution law.
7. Write law of mass action.

**Short Answer Type Questions -**

1. What is the effect of PH on solubility?
2. Define salt hydrolysis?
3. Write note on zero order reaction?
4. Describe pseudo Uni-molecular reaction?
5. Write note on half-life period?

**Long Answer Type Questions -**

1. Write an Arrhenius equation and give its importance?
2. Calculate the rate constant for first order reaction?
3. Calculate the rate constant for second order reaction?
4. Explain common Ion effect with example?
5. Ammonium acetate solution has pH greater than 7 what does this indicate?

# B.Sc. I Semester (Minor)

# Analytical Chemistry

## Unit – I

**Very Short Answer Type Questions -**

Q1) Write straight line equation?

Q2) Value of log 1 at base 10 is?

Q3) The value of log 1000 is?

Q4) d/dx sinx

Q5) Find the value of Log of 27 taking base 3

Q6) Write laws of logarithm?

**Short Answer Type Questions -**

Q1) Calculate the following

a) $Y= X^2 + 2x$

b) y= x.Logx

Q2) What is curve sketching?

Q3) Determine the slope and intercept of a straight line 3x + 2y = 7 and draw the graph on notebook.

Q4) Solv d/dx X. sinx

**Long Answer Type Questions -**

Q1) Without using log table find the value of the following:

Log40+Log20-1/2 Log64

Q2) Find maxima and minima for function

$Y = 2x^3 - 3x^2 – 36x + 14$

## Unit – II

**Very Short Answer Type Questions -**

Q1) What is the Unit of molarity in SI Unit?

Q2) What do you mean by mole?

Q3) What do you understand by precision?

Q4) what do you mean by accuracy?

**Short Answer Type Questions -**

Q1) Write note on significant figures with example?

Q2) What do you mean by concept of sampling. Give classification of errors.

Q3) What is difference between 6.0 metre and 6.00 metre (with the help of significant figure)

Q4) Calculate average for the given figure: 7,9 ,2 ,4 ,6 ,12 ,5,11

**Long Answer Type Questions -**

Q1) What do you mean by molarity, molality, normality and mole fraction?

Q2) Calculate the main deviation and variance of the following data: 57, 64,43,67,49,59,44, 47,61,59.

Q3) What do you mean by chemical stoichiometry?

## Unit – III

**Very Short Answer Type Questions -**

Q.1) What is the father of modern digital computer?

Q.2) What is the brain of computer?

Q.3) What is primary memory?

Q.4) What is Internal command?

Q.5) What is full form of DOS?

Q.6) Write some name of operating system?

Q.7) What is the full form of FAT?

Q.8) Full form of PDF is ……

Q.9) Which short cut key is used in word to print a file?

Q.10) Which company made DOS?

**Short Answer Type Questions -**

Q.1) Write an essay on characteristics and limitations of computer system?

Q.2) What are the functional components of computer. Give their relation?

Q.3) Explain ROM, PROM and EPROM?

Q.4) What is memory? Explain different types of memory.

Q.5) Explain ALU in detail?

Q.6) Explain any five input and output devices?

Q.7) Explain the types of operating systems and its need?

**HOTSQ**

Q.8) Write the Basic Commands of DOS?

Q.9) Write the characteristics of Linux operating system?

Q.10) Explain the text editing procedure in MS Word?

**Long Answer Type Questions -**

Q.1) What is spread sheet in MS Excel? Explain its characteristics?

Q.2) What is Microsoft DOS? Throw light on its history and versions?

Q.3) What is computer? Explain its characteristics.

Q.4) Explain the characteristics of computer system?

Q.5) What is personal computer?

Q.6) What is computer hardware?

Q.7) Explain the difference between printer and plotter?

**HOTSQ**

Q.8) Write the name of any four internal systems?

Q.9) What is the purpose of main memory of computer?

Q.10) What are the uses of MS-Power Point? How will the instruction of any institute can be presented by using MS-Power Point.

## Unit – IV

**Very Short Answer Type Questions -**

Q.1) Write technique useful in separation of enantiomers?

Q.2) Softening of water is done by which method?

Q.3) Which method of chromatography is known as moderate pressure method?

Q.4) What is the meaning of the word chromatography in greek?

Q.5) What is the Unit of $R_f$?

Q.6) What are the requirement in chromatography?

Q.7) On the basis of technique. How many types of paper chromatography are illustrated?

Q.8) What is the value of $R_f$? One or less than one.

Q.9) Which paper is required in the laboratory for chromatographic separation?

Q.10) Who defined $R_f$?

**Short Answer Type Questions -**

Q.1) What is chromatography? Why it is better than other techniques of analysis?

Q.2) What is the principle of chromatography? With the help of chromatography, how do we separate the pigments present in black ink?

Q.3) Explain with diagram of the ascending and descending technique?

Q.4) Explain column chromatography with examples?

Q.5) Explain High performance liquid chromatography with examples?

Q.6) Explain both the methods of developing chromatogram in detail?

Q.7) What is flash chromatography and how is it classified?

**HOTSQ**

Q.8) Explain thin layer chromatography in detail?

Q.9) Explain different types of techniques of paper chromatography?

Q.10) What is flash chromatography? Explain.

**Long Answer Type Questions -**

Q.1) Write short notes:

(a) Rf value

(b) Ion exchange

(c) Elution method

(d) Adsorption and Distribution.

Q.2) How to soften water by ion-exchange chromatography?

Q.3) What are the developing reagents and its uses?

Q.4) How a plate is developed in thin layer chromatography?

Q.5) Write the principle of gas chromatography?

Q.6) Explain column chromatography in brief?

**HOTSQ**

Q.7) Write the developing reagents used in separation of amino acids by chromatography?

Q.8) Write the method to separate pigments present in spinach (palak) leaves?

Q.9) Explain Chiral chromatography in brief?

Q.10) How can we separate the first and second group ions by paper chromatography?

## Unit - V

**Very Short Answer Type Questions -**

Q.1) What is Hook's law.

Q.2) Give spectral range of UV & IR spectroscopy.

Q.3) What is auxochrome & chromophores. Give examples.

Q.4) What is the Condition required for a molecules to show UV & IR spectra.

Q.5) What is the role of Nujol in IR spectroscopy?

Q.6) Define emission and absorption spectroscopy.

Q.7) Give the names of types of vibrations in IR spectroscopy.

Q.8) What is the base value of following:

a) Homoannular diene

b) Hateroannular diene

Q.9) Write in increasing order the types of electronic transition in UV spectroscopy.

Q.10) Define the following:

a) Wave length

b) Wave numbers

c) Frequency

**Short Answer Type Questions -**

Q.1) White short note on- a) finger print region, b) Beer Lambert law.

Q.2) How will you differentiate the following by IR spectroscopy

a) o – and p- OH – $C_6H_4$-CHO

b) $CH_5COC_2H_5$ and p- $CH_3C_6H_4COCH_3$

Q.3) Explain selection rules for vibrational and rotational spectra

Q.4) Write short note on-

a) Bathochromic shift

b) Hypsochromic shift.

c) Hyperchromic

Q.5) Explain Beer Lambert' law and its limitations.

Q.6) Explain the following:

a) λ max 275 nm of Benzene less than λ max 375 nm of naphthalene

b) When aniline dissolved in acidic solution

Q.7) Write short note on selection rule.

0.8) Explain the effect of conjugation on λ max.

Q.9) How can you differentiate between free and hydrogenated OH group with the help of UV spectroscopy.

Q.10) How the concentration of unknown solution is determined with the help of ultraviolet spectra.

**Long Answer Type Questions -**

Q.1) Write short note on Wood Ward Fieser Rule.

Q.2) Discuss the application of UV spectroscopy.

Q.3) How many types of electronic transition are possible in ketones, carboxylic acids. Arrange the λ max values of these transitions in increasing order.

Q.4) Explain anthocyanin is a natural pigment. Which colors they impart to the plants.

Q.5) Explain the types of electronic transitions in UV spectroscopy.

Q.6) Give Woodward Fieser rules for conjugated dienes, & unsaturated carbonyl compounds.

Q.7) Explain the effect of conjugation & substitutes on absorption maxima & molar absorptivity.

Q.8) Explain following giving reasons:

(a) λ max of acetone is 279 pm & 264.5mm in hexane & water respectively.

(b) λ max for $CH_2$ =CH-$CH_2$-CH=$CH_2$ is 178 nm while for $CH_2$-CH-CH-$CH_2$- $CH_2$ is 227 nm.

(c) λ max for aniline in neutral medium is 230mm while in acidic medium is 203 mm.

(d) Band intensity decreases with due to Hydrogen bonding.

Q.9) Describe various types of vibrations occurring in organic compounds due to IR radiations!

Q.10) Describe the principle & applications of infra-red spectroscopy.

# B.Sc. I Semester (Open Elective)

**Unit – I & II**

**Very Short Answer Type Questions -**

Q.1) Write the names of famous chemists of ancient times?

Q.2) Write names of Ancient Indian famous texts related to chemistry.

Q.3) Write the names of any two famous texts of Nagarjuna?

Q.4) What is pottery?

Q.5) Give two uses of silver in ancient India?

Q.6) Give two uses of glass in ancient India?

Q.7) In which color were the manuscripts written?

Q.8) Which fibers were used to make clothes in ancient India?

Q.9) Write the definition of 'atom'?

Q.10) Write the names and symbols of some elements?

Q.11) Write the definition of atomic mass?

Q.12) Write the definition of molecule?

Q.13) What are compounds?

Q.14) Write the formula of sodium chloride?

**Short Answer Type Questions -**

Q.1) Write a note on the history of pottery. What was the method of making bricks in ancient India?

Q.2) Write the main steps in traditional brick making?

Q.3) Write the history of cement and its use in ancient India?

Q.4) What substances were required for the manufacture of cement in ancient India?

Q.5) Write a note on metal extraction from minerals?

Q.6) How was the extraction and use of bronze done in ancient India?

Q.7) Write the use of silver and gold in ancient India?

Q.8) Write the uses of metals in ancient times?

Q.9) Write the discovery and use of glass in ancient India?

Q.10) Write a note on the discovery of cosmetics and their prevalence among women?

Q.11) Write the discovery and use of paper and ink?

Q.12) manuscripts were written with which color?

Q.13) Write in brief about the invention of paper and ink.

Q.14) Write note-

(a) Gold and Silver Extraction

(b) Iron extraction

(c) Copper extraction, Zinc extraction

Q.15) Write a note on the fiber fabrics prevalent in ancient India?

Q.16) Briefly explain the history of colours?

Q.17) Write about the colors prevalent in ancient times?

Q.18) What is the contribution of Maharishi Kanad in Chemistry?

Q.19) Write the concepts of atomic theory of Kanad Rishi?

Q.20) Discuss Dalton's theory? Write note-

(a) Dobereiner's Triads

(b) Newlands principle of octaves

(c) Mendeleev's periodic table

Q.21) Write a note on modern periodic table?

**Long Answer Type Questions -**

Q.1) Write an explanitory note on pottery and its prevalent use in ancient India?

Q.2) Write the oldest method and use of making bricks?

Q.3) Write in brief how cement was manufactured in ancient India?

Q.4) What is mineral and its history?

Q.5) Which metals were extracted in ancient times by metal extraction?

Q.6) How was metal used in ancient times?

Q.7) Write the discovery and use of glass?

Q.8) Write a note on the cosmetics used by ancient women?

Q.9) Write a note on the discovery of paper and ink?

Q.10) Explain in detail the oldest method of iron extraction. From where were fibrous clothes and dyes obtained in ancient times? write comment?

Q.11) Describe the history of invention of atom?

Q.12) Write the particle theory of atom?

HOTS Q

Q.13) What are atoms and molecules? Explain with examples?

Q.14) What are atomic numbers? Write the names and symbols of the elements with atomic numbers from 1 to 10?

Q.15) What is the difference between a molecule of an element and a molecule of a compound? Explain in detail with examples?

## Unit – III & IV

**Very Short Answer Type Questions -**

Q.1) Write the names of any two acids found in food?

Q.2) What are Olfactory indicators?

Q.3) What is the common name of the compound CaOCl?

Q.4) Which medicine is used to treat indigestion?

Q.5) What is neutralization reaction?

Q.6) Write the chemical name and formula of washing soda and backing soda?

Q.7) What are mineral acids? Give two examples?

Q.8) Mention the natural sources of any five acids?

Q.9) What is carbonic acid?

Q.10) What is Milk of Magnesia?

Q.11) What happens when baking soda is heated?

Q.12) Write a note on natural indicator?

Q.13) Calculate the pH of pure water?

**Short Answer Type Questions -**

Q.1) Write the names of any two acids found in food items?

Q.2) What is the difference between a weak acid and a strong acid? Explain with examples?

Q.3) Which medicine is used to treat indigestion?

Q.4) What is neutralization reaction? Explain it with example?

Q.5) Write the chemical name and formula of washing soda and baking soda?

Q.6) Write the characteristics of acid and base?

Q.7) Explain the classification of acids on the basis of basicity?

Q.8) What are mineral acids? Give two examples?

Q.9) Mention the natural sources of any five acids?

Q.10) Explain the uses of Hydrochloric Acid (HCl)?

Q.11) What is carbonic acid? Write its uses?

Q.12) What is Milk of Magnesia? Explain its uses?

Q.13) What happens when baking soda is heated? Explain with the help of chemical reaction?

Q.14) Explain the reaction of alkali with metals?

Q.15) Write a note on natural indicator?

Q.16) Explain the acidity and alkalinity of a solution on the basis of pH scale?

Q.17) Write notes on the following –

(a) Antacid

(b) pH scale

(c) Uses of baking soda

(d) $CaCO_3$

(e) Neutral salt

(f) di-basic acid

**Long Answer Type Questions -**

Q.1) Explain the difference between an acid and a base?

Q.2) On what basis are the classification of acids done? Explain each with examples?

Q.3) Describe the physical and chemical properties of acids and bases?

Q.4) What are pointers? Describe the different types of indicators?

Q.5) What is the pH scale? Discuss the importance of pH in daily life?

Q.6) Explain the classification of salts with examples?

Q.7) Describe the natural source, laboratory method and its uses of acetic acid?

HOTS Q

Q.8) Why is sulfuric acid called Amlraj? Their various uses Explain? Q.09) What are the natural sources of tartaric acid? Write a note on the use of this acid?

Q.10) How is ammonia prepared in the laboratory? Describe any five uses of ammonia?

## Unit - V

**Very Short Answer Type Questions -**

Q.01) Write the chemical name of vitamin 'A'?

Q.02) Write the names of fat-soluble vitamins?

Q.03) Write any three names of minerals?

Q.04) Write any five names of trace elements?

Q.05) Write types of fats?

Q.06) Give the basic structure of glucose?

**Short Answer Type Questions -**

Q.01) Write the sources and functions of proteins?

Q.02) Describe the source and biological function of fiber?

Q.03) Write a note on the importance of calcium in the body?

Q.04) What are Vitamins? Write the chemical names of vitamins?

Q.05) Write the names of different vitamins of Vitamin B-complex along with their chemical names?

**Long Answer Type Questions -**

Q.01) What are carbohydrates? Give their classification with examples and explain their importance in daily life?

Q.02) Write an essay on the importance and function of vitamins?

Q.03) Write an essay on micronutrients. Write the biological functions of the following elements- (i) Fe, (ii) Ca, (iii) Zn.

Q.04) Explain the functions and importance of Vitamin B-complex?

Q.05) What is fat? Write their sources and functions?

Q.06) State the sources and functions of fat and protein?

Q.07) What are the fat-soluble vitamins? Write their sources and functions?

Q.08) What is a mineral? Giving their general information about their functions and sources also.

Q.09) Explain the source, functions and importance of proteins?

Q.10) Explain the sources and functions of different types of carbohydrates?

Q.11) Explain in detail the different types of fats?

# B.Sc. II Semester (Open Elective)

**Unit – I to IV**

**Very Short Answer Type Questions -**

Q.01) Define Adulteration in food?

Q.02) What is saccharin?

Q.03) What is the role of preservatives in packaged food products?

Q.04) Name 5 artificial sweeteners?

Q.05) What is fluoride and where it is used the most in everyday life?

Q.06) What are the toxic chemicals used in Tobacco smoke?

Q.07) Difference between pesticides & Insecticide?

Q.08) What is DEET? Give structure.

Q.09) Naphthalene on oxidation gives which product. Draw the structure?

Q.10) What are Antiseptics? Give three example.

**Short Answer Type Questions -**

Q.01) Why Antioxidant are considered safe food additives?

Q.02) What is the composition of alcohol-based hand sanitizers?

Q.03) Write chemical properties & application of boric acid?

Q.04) What are the adverse effect of baking soda ($NaHCO_3$) in powdered form?

Q.05) Write classification of Antiseptics & Disinfectants?

Q.06) Write about adulterations in ghee and detection method?

Q.07) What is HPLC analysis and how it is effective in detection of adulteration in food?

**HOTSQ**

Q.08) How MSG (Monosodium Glutamate) enhances the flavor of food?

Q.09) Is D-glutamate found in mammals and can it be digested without harm?

Q.10) Why use of DDT for malaria control was controversial?

**Long Answer Type Questions -**

Q.01) What are the main types of adulteration, describe in detail?

Q.02) What are the common types of milk adulteration. Explain detection and analysis?

Q.03) What are food additives, give detailed explanation and various classes of food additives?

Q.04) Classify different types of pesticides with target pests?

Q.05) What are the impurities found in monosodium glutamate. Explain in detail?

Q.06) What are the chemicals involved in bakery products?

Q.07) Give structure, bonding and application of domestic phenyl in detail?

**HOTSQ**

Q.08) How is the safety of food additives evaluated?

Q.09) Are natural preservatives effective in maintaining the shelf life of food materials and how?

Q.10) How DEET exposure is different in insects than humans?

# B.Sc. III semester (Major)

## Unit – I

**Very Short Answer Type Questions -**

Q.1) Write two differences of $SN^1$ and $SN^2$ mechanism.

Q.2) Give one example of aliphatic electrophile mechanism.

Q.3) In which reaction $ArS_N^1$ mechanism is found? What is leaving group in it?

Q.4) In which mechanism addition-elimination reaction takes place?

Q.5) Give two example of aromatic electrophilic mechanism.

Q.6) Which among $C_6H_5OH$, $C_6H_5Cl$ and $C_6H_5CH_3$ gives electrophilic reaction most easily?

Q.7) Give two examples of o- and p - directing groups.

Q.8) Give two examples of m- directing groups.

Q.9) Show orientations of distributed compounds of benzene.

Q.10) Give example of reactants of Vilsmeier reaction.

**Short Answer Type Questions -**

Q.1) Explain $S_N^i$ mechanism with an example.

Q.2) Explain neighbouring group participation with example.

Q.3) Explain $S_E^1$ aliphatic electrophilic mechanism with an example.

Q.4) What is the order of $S_NAr$? Explain with one example.

Q.5) Clarify $ArS_N^1$ reaction mechanism with example.

Q.6) Explain arenium mechanism in aromatic electrophilic substitution.

Q.7) Explain directive influence with example.

Q.8) Explain reactivity of o and p - Vs m- directing groups.

Q.9) Explain diazonium coupling.

Q.10) Explain Vilsmeier reaction.

**Long Answer Type Questions -**

Q.1) Give mechanism of nucleophilic substitution reactions in alkyl halides. Draw energy curve for reactions also.

Q.2) What happens on heating n-butyl bromide with alcoholic KOH? Give mechanism of this reaction.

Q.3) Explain $S_N^2$ reactions in alkyl halides. Give its mechanism and energy diagram.

Q.4) Describe mechanism of nucleophilic substitution in aryl halides.

Q.5) Describe benzyne mechanism for nucleophilic substitution in aryl halides.

Q.6) What is electrophilic substitution? Explain electrophilic substitution mechanism in benzenee with suitable examples.

Q.7) What is ortho, para and meta directing influence? Explain their directive influence with example.

HOTsQ

Q.8) $-NO_2$, and -CHO groups are deactivating and m-directing while -OH and $-NH_2$ groups are o- and p- directing with activation, explain.

Q.9) Explain ortho and para directing influence of -OH group.

Q.10) Nitration of toluene gives ortho, para nitrotoluene while nitration of nitrobenzene gives meta-dinitrobenzene. Discuss this statement, electronically.

## Unit – II

**Very Short Answer Type Questions -**

Q.1) Give definition of addition reaction with example.

Q.2) Give two examples of free radical addition reactions.

Q.3) Give one example each of region-selectivity and chemo-selectivity.

Q.4) Write order of reactivity of $C_6H_5CHO$, $C_6H_5COCH_3$ and $C_6H_5COC_6H_5$.

Q.5) Write order of reactivity of $CH_2=CH_2$, $CH_3CH=CH_2$ and $(CH_3)_2\ C=CH_2$ for electrophilic addition reaction.

Q.6) What is the intermediate in Markovnikov's addition according to modern theory?

Q.7) Write two differences in E1 and E2 mechanism.

Q.8) What is the intermediate of ElcB mechanism?

Q.9) Give one example each of favourable substrate and solvent for El mechanism

Q.10) What is the major product of dehydrohalogenation of $CH_3CH(Cl)\ CH_2CH_3$.

**Short Answer Type Questions -**

Q.1) Explain free radical addition reaction by addition of HBr on alkene.

Q.2) Why free radical addition reactions are not given by HI and HCI?

Q.3) Clarify chemo-selectivity with example.

Q.4) Which rules govern orientation in elimination reaction? Explain any one.

Q.5) Explain Mrkovnikov's rule with example.

Q.6) In which addition reaction Anti Markovnikov's rule is applicable? Clarify.

Q.7) Explain mechanism of E1 reaction.

Q.8) Write differences in E1 and E2 mechanism.

Q.9) Write factors affecting elimination reactions.

Q.10) Explain Hoffmann's elimination reaction with example.

**Long Answer Type Questions -**

Q.1) What is addition reaction? Classify them? Explain each with example.

Q.2) What are region-selectivity and chemo-selectivity? What is difference in them? Explain rules which govern region-selectivity.

Q.3) What is orientation? How are region-selectivity and orientation are related with each other? Explain orientation in addition and elimination reactions.

Q.4) What is reactivity? Clarify reactivity of addition reactions with different examples.

Why is nucleophilic addition reaction difficult in alkenes 7 How is it possible in alkenes? Explain with detail.

Q.5) Write short notes on-

(i) Nucleophilic addition mechanism. (ii) Free radical addition mechanism

(iii) Electrophilic addition mechanism (iv) E1 mechanism.

(v) E2 mechanism (vi) E1 cB mechanism

Q.7) Write notes on following rules-

i) Markovnikov (ii) Anti-Markovnikov

(iii) Saytzeff (iv) Hoffmann's elimination.

Q.8) What happens when -

(i) HOCI reacts with propene?

(ii) $(CH_3)_3C\text{-}CH{=}CH_2$ is hydrated?

(iii) 2-Methyl but-1-ene is oxymercurated and demercurated?

(iv) Alkene reacts with CH3CHO in presence of peroxide?

(v) Vinyl benzene reacts with HBr?

Q.9) Write short notes and mechanism of the following:

(i) Aldol reaction

(ii) Cannizzaro's reaction

(iii) Perkin reaction

(iv) Benzoin condensation

(v) Mannich reaction

(vi) Knoevenagel reaction

(vii) Reformatsky reaction

**Unit – III**

**Very Short Answer Type Questions -**

Q.1) Why Grignard reagent is stored in ether?

Q2) Write main use of N-bromosuccinimide.

Q.3) Write name and main use of $CH_2N_2$.

Q.4) Write two methods of preparation of anhydrous $AlCl_3$.

Q.5) Show deprotonation of 1-alkyne by sodamide.

Q.6) Write composition of Ziegler-Natta catalyst.

Q.7) Give two examples of rearrangement on electron deficient nitrogen.

Q.8) Give two examples of rearrangement on electron deficient oxygen.

Q.9) Write two applications of Hoffmann bromide rearrangement.

Q.10) Write class to which Fries rearrangement belongs.

**Short Answer Type Questions -**

Q.1) Write method of preparation of Grignard reagent.

Q.2) Write equations of preparation of 1°, 2°and 3° alcohols from Grignard reagent.

Q.3) Explain allylic bromination from NBS with example.

Q.4) Write methods of preparation and four applications of anhydrous aluminium chloride.

Q.5) How is sodamide prepared? Write its three chemical reactions.

Q.6) Explain rearrangement on electron deficient carbon with example.

Q.7) Clarify benzilic acid rearrangement

Q.8) Write mechanism of Hoffmann's rearrangement.

Q.9) Write the class of Baeyer Villiger rearrangement. Explain its mechanism.

Q.10) Explain Claisen rearrangement.

**Long Answer Type Questions -**

Q.1) Write method of preparation, properties and applications of Grignard reagent.

Q.2 What is the reaction of Grignard reagent with the following?

(i) Ethylene oxide, (ii) CO2, (iii) Sulphur, (iv) CH3CONH2, (v) CH3COCL

Q.3) How is Grignard reagent prepared in laboratory? How will you obtain following from it?

(i) Acetone, (ii) Tertiary butyl alcohol, (iii) Acetic acid.

Q.4) How will you do following conversions using Grignard reagent in any step?

(i) $CH_3Br$ to $C_2H_6$, (ii) $(CH_3)_2CO$ to isobutyl alcohol,

(iii) Acetone to tertiary butyl alcohol, (iv) Acetaldehyde to acetone,

(v) Acetyl chloride to acetone, (vi) Methyl alcohol to ethyl alcohol.

Q.5) How will you synthesize following from a suitable Grignard reagent?

(1) Acetone, (ii) Propan-2-ol, (iii) Propionic acid,

(iv) Tertiary butyl alcohol, (v) Methyl ethyl ketone, (vi) Acetaldehyde.

Q.6) Write method of preparation, properties and applications of NBS.

Q.7) Write reaction of NBS with the following-

(i) $CH_3CH=CH_2$ in presence of water and THF,

(ii) (ii) $CH_3CH=CH_2$ in presence of peroxide,

(iii) $CH_3CH_2COCl$,

(iv) Anisole

(v) OH

|

CH-CH,CH(OH)CH,

Q.8) Write method of preparation, properties and applications of diazomethane.

Q.9) Write an essay on Ziegler-Natta catalyst.

Q.10) What is Grignard reagent. Explain in details.

**Unit – IV**

**Very Short Answer Type Questions -**

Q.1) Write formula of Jones reagent.

Q.2) Write two oxidants having chromium.

Q.3) Which process is adopted for asymmetric epoxidation?

Q.4) Write reaction of $CH_3CH=CH_2$ with Baeyer's reagent.

Q.5) Give main reagent used in Oppenauer oxidation?

Q.6) Give equation of reaction of oxidation of primary alcohol with peracid?

Q.7) Write reduction of carbon-carbon multiple bond.

Q.8) Give two examples of heterogeneous catalyst.

Q.9) Write name and formula of two reagents used in hydride transfer.

Q.10) What is Birch reagent? Write its one use.

**Short Answer Type Questions -**

Q.1) Give two examples each of oxidation and reduction of organic compounds.

Q.2) Write short note on metallic and non-metallic oxidation of organic compounds.

Q.3) How are alkenes oxidised to epoxides? Write two reactions.

Q.4) Write short note on sharpless asymmetric epoxidation.

Q.5) Write name of two reagents used to oxidise alkenes to diols. Explain mechanism of any one.

Q.6) Write four applications of $NaBH_4$

Q.7) Give one example of selective reduction by LiAlH4. Write its two uses.

Q.8) Explain mechanism of Birch reduction.

Q.9) Write thee applications of Clemmensen reduction.

Q.10) Write short note on reduction of nitro compounds.

**Long Answer Type Questions -**

Q.1) Explain oxidation-reduction in organic compounds with example. Explain differences in oxidant used in metallic and non-metallic oxidation giving their names of reagents used.

Q.2) Name carbonyl compounds obtained by oxidation of alcohols. Give name of reagents containing chromium, manganese and silver. Give mechanism of oxidation of alcohol by Jones reagent.

Q.3) How will you obtain following products by oxidation of alkenes? Explain in detail.

(i) Epoxide, (ii) Diol, (iii) Carbonyl compounds.

Q.4) Explain oxidation of amino groups by $KMnO_4$, peracids and peroxides in detail.

Q.5) What do you understand by Sharp less asymmetric synthesis? Write reagents used and mechanism. Write its main applications.

Q.6) Highlight reduction of carbon-carbon multiple bonds, carbonyl groups and nitro compounds in detail.

Q.7) Write an essay on catalytic hydrogenation.

Q.8) What is homogeneous and heterogeneous hydrogenation? Write mechanisms of both.

Q.9) Write method of preparation of $LiAlH_4$, mechanism of reduction and uses.

Q.10) What is catalytic reduction of nitro compounds? Explain any two with mechanism.

## Unit – V

**Very Short Answer Type Questions -**

Q.1) What is photochemical reaction?

Q.2) Write transition of acetone occurring at high wavelength.

Q.3) Which Norrish reaction gives cyclopropanone from cyclobutane?

Q.4) How is fluorescence produced?

Q.5) How is phosphorescence produced?

Q.6) What is internal conversion?

Q.7) In which transition inter system crossing is found

Q.8) Write two differences in thermal chemical and photochemical reactions.

Q.9) Write two differences in fluorescence and phosphorescence.

Q.10) What is inter system crossing.

**Short Answer Type Questions -**

Q.1) Explain photochemical reaction with one example.

Q.2) Explain sensitization with example.

Q.3) Clarify formation of benzapinacol from benzophenone.

Q.4) Write short note on the following:

(i) Photo isomerization.

(ii) Photo sensitization

(iii) Photo reduction

Q.5) Explain electronic excitation with example.

Q.6) Explain Norrish type I reaction.

Q.7) Clarify Norrish type II reaction.

Q.8) Clarify difference in singlet and triplet states.

Q.9) Explain energy transfer in photochemical reactions.

Q.10) Write short note on excited state.

**Long Answer Type Questions -**

Q.1) Explain photochemical reaction with example. What is the principle of photochemical? Clarify relation of electronic excitation with photochemical reactions explaining electronic excitation.

Q.2) Explain modes of energy dissipation with the help of Jablonski diagram in detail.

Q.3) Explain photochemical cis-trans isomerism with example in detail.

Q.4) What is cycloaddition reaction?

Q.5) What is cheletropic reaction?

Q.6) What do you mean by pericyclic reactions? Write their important characteristics.

Q.7) Explain Woodward Hoffmann rules with example. Highlight this rule for electrocyclic reaction, cycloaddition reaction & sigmatropic shift.

Q.8) Write short notes on the following:

(1) Electrocyclic reactions

(ii) Cycloaddition reactions (iii) Sigmatropic shift

Q.9) Explain electrocyclic reaction in details.

Q.10) Explain [2+ 2] and [4+ 2] cycloaddition reactions in details.

Q.11) Explain sigmatropic shift and highlight Cope rearrangement & Claisen rearrangement.

Q.12) Explain Cope and Claisen rearrangements with uses in detail.

# B.Sc. III Semester (Minor)

## Unit – I

**Short Answer Type**

Q.1) Explain magnetic behaviour of d-block elements?

Q.2) What is Lanthanide contraction?

**Long Answer Type**

Q.3) Write 3d, 4d and 5d series electronic configuration?

Q.4) Write symbols and electronic configuration of actinoids? (HOT)

**Very Long Answer Type**

Q.5) What is maharas?(HOT)

Q.6) Write property of d-block elements?

## Unit – II

**Short Answer Type**

Q.1) What is EAN?

Q.2) What is isomerism?

**Long Answer Type**

Q.3) Explain Werner's theory of coordination compound?

Q.4) Explain geometrical isomerism?

**Very Long Answer Type**

Q.5) Explain crystal field theory of coordination complexes? (HOT)

Q.6) Explain structural isomerism in coordination complexs?

## Unit – III

**Short Answer Type**

Q.1) Explain concept of enthalpy?

Q.2) Explain first law of thermodynamics? (HOT)

**Long Answer Type**

Q.3) Describe relation between Cp and Cv? (HOT)

Q.4) Write Joule-Thomson effect?

**Very Long Answer Type**

Q.5) Explain Carnot cycle?

Q.6) Describe Gibbs Helmholtz equation?

## Unit – IV

**Short Answer Type**

Q.1) Write difference between metallic conductor and electrolytic conductor?

Q.2) Write difference between EMF and potential? (HOT)

**Long Answer Type**

Q.3) Explain Kohlrausch law and its application?

Q.4) Explain Ostwald dilution formula? (HOT)

**Very Long Answer Type**

Q.5) What is Standard hydrogen electrode?

Q.6) Explain Nernst equation?

## Unit – V

**Short Answer Type**

Q.1) What is phase rule?

Q.2) Explain azeotropic mixture? (HOT)

**Long Answer Type**

Q.3) Explain water and ethyl alcohol system?

Q.4) Explain Raoults law?

**Very Long Answer Type**

Q.5) Describe Clausius-Clapeyron equation? (HOT)

Q.6) Explain Ferric Chloride - water system?

# B.Sc. III Semester (Open Elective)

## Unit - I

Q.01) Discuss about History of Farming?

Q.02) What is global agricultural research system. Discuss their need, scope and opportunities, role of GARS in promotion of food security?

Q.03) Role of GARS in poverty reduction, environment protection?

Q.04) Discuss on national agricultural research system, consolation groups required for research in international agriculture?

Q.05) Discuss on such programmes:

(a) Rural DP

(b) Community DP

(c) Intensive agriculture district programme

(d) Special group area specific programmes

(e) Integrated rural development programme.

## Unit - II

Discuss different stages of farm management -

(a) Land conservation

(b) Purchase inputs

(c) Purchase of Machinery

(d) Marketing outputs

(e) Development of Infrastructure

(f) Fund acquiring

(g) Utilization of Funds

(h) Planning for Future Prospects

(i) Transaction and financial records

(j) Production records maintenance

(k) Financial Needs

## Unit - III

Q.01) Define soil,compostion, importance, soil texture, productivity and fertility of particular soil?

Q.02) What is Crop nutrition and Nutrients beneficial for soil?

Q.03) Discuss of sources of Nutrients -

(a) Organic Manures

(b) Fertilizers and bio fertilizers

(c) Nutrient Recycling Process through Manures and Fertilizers also.

## Unit - IV

Q.01) Discuss about fertilizers Management and Biological nitrogen Fixation?

Q.02) What are Nitrogenous, Phosphoric and Potash Fertilizers?

Q.03) What are Green Manure Crops and Cover Crops?

Q.04) Stages of integrated nutrient management?

Q.05) What are organic manures their classification and importance of organic manures, properties and methods which are applicable in preparation of Bulky Manures?

## Unit - V

Q.01) Discuss micronutrients?

Q.02) What are FYM compost and oil cake manures?

Q.03) Discuss on weeds, weed control through mechanical, agricultural, biological, chemical methods?

# B.Sc. IV Semester (Open Elective)

# (According to Bloom's Taxonomy)

## Unit - I

**Introduction and classification of dyes**

**Very Short Answer Type Questions -**

Q.01) What are dyes?

Q.02) Write an example of vat dye?

Q.03) Give one example of mordant dye?

Q.04) Write an example of azo dye?

Q.05) Give one example of triphenyl methane dye?

Q.06) Write structural formula of crystal violet?

Q.07) Write structural formula of phenolphthalein?

Q.08) Write a structural formula of Indigo dye?

Q.09) Give one example of nitro dye?

Q.10) Give one example of nitroso dye?

**Short Answer Type Questions -**

Q.01) Give a brief classification of dyes with suitable examples?

Q.02) Write the synthesis of vrystal violet and describe two chemical properties?

Q.03) Give a brief account of triphenyl methane dyes?

Q.04) Write short note on the following

(a) A vat dye

(b) A mordant dye

(c) Chromophore

(d) Auxochrome

(e) Phenolphthalein

Q.05) Give preparation and uses of the following

(a) Fluorescein

(b) Congo red

(c) Methyl orange

(d) Malachite green

(e) Alizarin

(f) Crystal violet

Q.06) "Alizarin is a good dye" why?

Q.07) Give one example of each of the following

(a) A mordant dye

(b) An azo dye

(c) A vat dye

(d) Triphenyl methane dye

Indicate synthesis of any one of them

**HOTSQ**

Q.08) Starting from benzene how would you prepare methyl orange?

Q.09) How can the following be obtained from pthalic acid

(a) Phenolphthalein

(b) fluorescein

Q.10) Convert:

(a) Anthracene to alizarin

(b) Sulphanilic acid to methyl orange

**Long Answer Type Questions -**

Q.01) Give a detailed account of the classification of dyes?

Q.02) Example relationship between colour and constitution?

Q.03) Give an account of the theories of colour and constitution?

Q.04) Explain the terms “Chromophore”, “Chromogen” and “Auxochrome”?

Q.05) Discuss the synthesis and chemistry of following dyes

(a) Methyl orange

(b) Malachite green

(c) Indigo

(d) Crystal violet

(e) Phenolphthalein

Q.06) Explain valence bond theory of colour?

**HOTSQ**

Q.07) Describe “Chromophore-Auxochrome theory” of colour and constitution?

Q.08) What is Witts theory of colour and constitution? Illustrate its application with reference to the use of phenolphthalein as an indicator in alkali titration?

## Unit - II

## Natural Dyes

**Very Short Answer Type Questions -**

Q.01) What is a natural dye?

Q.02) Give the types of natural dyes?

Q.03) What is a vegetable dye?

Q.04) What is an animal dye?

Q.05) What is a mineral dye?

Q.06) Give two example of vegetable dyes?

Q.07) Give one example of animal dye?

Q.08) Write an example of mineral dye?

Q.09) Write the name of plant of a yellow colour dye?

Q.10) Write the name of plant of a red colour dye?

**Short Answer Type Questions** -

Q.01) Define natural dyes with examples?

Q.02) Write the name of plants of natural dyes (any five)?

Q.03) Give the classification of natural dyes based on sources?

Q.04) Write the sources of natural dyes?

**HOTSQ**

Q.05) Define extraction of dyes?

Q.06) Give the occurrence of natural dyes?

**Long Answer Type Questions** -

Q.01) Define natural dyes? Give detailed account of the classification of natural dyes?

Q.02) Write short note on following

(a) Natural dyes

(b) Classification of natural dyes

(c) Name of plants of natural dyes

(d) Sources of natural dyes

**HOTSQ**

Q.03) Explain occurrence and extraction of natural dyes?

Q.04) Write the name of plants of natural dyes (any ten)?

## Unit - III

## Soaps

**Very Short Answer Type Questions** -

Q.01) What are soaps?

Q.02) What is saponification?

Q.03) Write the name of two soluble soaps?

Q.04) What is a hard soap?

Q.05) What is a soft soap?

Q.06) What is a transparent soap?

Q.07) What is a marine soap?

**Short Answer Type Questions -**

Q.01) Define soaps with examples?

Q.02) Compare soap with detergent?

Q.03) What are soft and hard soap? Give one example of each type?

Q.04) Draw the diagram of hot process for soap manufacture?

Q.05) Explain cold process of manufacture of soap?

Q.06) How many types of soluble soaps are there?

**HOTSQ**

Q.07) Write short notes on following:

(a) Soluble soaps

(b) Modern process for soap manufacture

(c) Hot process for soap manufacture

**Long Answer Type Questions -**

Q.01) Define soaps. Explain manufacture of soaps?

Q.02) What are soaps. Describe various types of soluble soaps with example?

**HOTSQ**

Q.03) Give the detail account of the liquid soaps?

**Unit - IV**

# Detergents

**Very Short Answer Type Questions -**

Q.1) What are detergents?

Q.2) Give one example of soft detergent?

Q.3) Give one example of hard detergent?

Q.4) Write the formula of sodium perborate?

Q.5) Write an example of synthetic detergents?

Q.6) Give one example of Alkyl sulphonate?

Q.7) Give one example of Aryl sulphonate?

**Short Answer Type Questions -**

Q.1) Write short note on synthetic detergents?

Q.2) Write short note on Alkyl and Aryl sulphonate?

Q.3) What are soft and hard detergents? Give one example of each type?

Q.4) Describe following with one example in each case

(a) Biodegradable detergents

(b) Non biodegradable detergents

Q.5) Write short note on additives of detergents?

Q.6) Write the comparison of soaps and synthetic detergents?

**HOTSQ**

Q.7) What is SDS? How is it prepared.

Q.8) Classify the following detergents as cationic, anionic and non-ionic detergents:

(a) Benzyl dimethyl octyl ammonium chloride

(b) Sodium lauryl sulphate

(c) Sod-p-alkylbenzene sulphonate

(d) Pentaerythrityl palmitate

**Long Answer Type Questions -**

Q.1) What are synthetic detergents. Describe various types of synthetic detergents?

**HOTSQ**

Q.2) Explain Alkyl & Aryl sulphonate?

Q.3) Define detergents? Describe additives of detergents and their types.

## Unit - V

## Action of soaps

**Very Short Answer Type Questions -**

Q.01) What is the non-polar end of soap?

Q.02) What is reason of cleansing action of soap and detergents?

Q.03) Why is detergents better than soap in cleansing action?

Q.04) Draw the diagram of "Micelle formation"?

**Short Answer Type Questions -**

Q.01) Write short note on: "cleansing action of soap"?

Q.02) Define "Micelle"?

**HOTSQ**

Q.03) Write short note on "Dish washer soaps"?

Q.04) Define liquid soaps?

**Long Answer Type Questions -**

Q.01) What are soaps? Explain cleansing action of soap?

Q.02) Describe cleansing action of detergents?

**HOTSQ**

Q.03) Define liquid soap? Explain cleansing action of liquid soap.

Q.04) Give a detailed account of “Dish washer soaps”?

# Questions Bank for B.Sc. III Year (Inorganic Chemistry)

# (According to Bloom's Taxonomy)

## Chapter - I

## MCQS & HOTSQ on Hard and Soft Acid-Base Concept

Q.01) Which of the following is a characteristic of hard acids and bases?

(a) They are typically small and highly charged

(b) They tend to form weak bonds with each other

(c) They prefer to bind to soft acids and bases

(d) They are typically large and have low charge density

Answer: (a) They are typically small and highly charged

Q.02) Which of the following is a characteristic of soft acids and bases?

(a) They are typically small and highly charged

(b) They tend to form weak bonds with each other

(c) They prefer to bind to hard acids and bases

(d) They are typically large and have low charge density

Answer: (d) They are typically large and have low charge density

Q.03) Which of the following is an example of a hard acid?

(a) $Na^+$

(b) $Hg^{2+}$

(c) $Ag^+$

(d) $Pb^{2+}$

Answer: (a) $Na^+$

Q.04) Which of the following is an example of a soft acid?

(a) $Na^+$

(b) $Hg^{2+}$

(c) $Ag^+$

(d) $Pb^{2+}$

Answer: (b) $Hg^{2+}$

Q.05) Which of the following acid-base combinations would form the strongest bond?

(a) Hard acid + hard base

(b) Hard acid + soft base

(c) Soft acid + hard base

(d) Soft acid + soft base

Answer: (d) Soft acid + soft base

Q.06) Which of the following is a characteristic of hard acids?

(a) They are large and polarizable

(b) They have low charge density

(c) They tend to bond with hard bases

(d) They have a higher affinity for soft bases

Answer: (c) They tend to bond with hard bases

Q.07) Which of the following is a characteristic of soft bases?

(a) They are highly charged

(b) They are small and polarizable

(c) They tend to bond with hard acids

(d) They have a higher affinity for hard acids

Answer: (d) They have a higher affinity for hard acids

Q.08) Which of the following is a characteristic of the hard-soft acid base (HSAB) concept?

(a) It explains how acids and bases react with water

(b) It describes the thermodynamics of acid-base reactions

(c) It classifies acids and bases based on their electronic structure

(d) It predicts the strength of acid-base interactions

Answer: (c) It classifies acids and bases based on their electronic structure

Q.09) Which of the following is an example of a hard acid?

(a) $Hg^{2+}$

(b) $Pb^{2+}$

(c) $Ag^{+}$

(d) $Cu^{+}$

Answer: (c) $Ag^{+}$

Q.10) Which of the following is an example of a soft base?

(a) $F^{-}$

(b) $Cl^{-}$

(c) $Br^{-}$

(d) $I^{-}$

Answer: (d) $I^{-}$

Q.11) Which of the following is a characteristic of a hard acid?

(a) Large ionic radius

(b) Low electronegativity

(c) Small ionic radius

(d) High polarizability

Answer: (c) Small ionic radius

Q.12) Which of the following is a characteristic of a soft base?

(a) High electronegativity

(b) Large size

(c) Low polarizability

(d) High ionization energy

Answer: (b) Large size

Q.13) Which acid-base interaction is typically favored for hard acids and bases?

(a) Covalent bond formation

(b) Electrostatic attraction

(c) Hydrogen bond formation

(d) Van der Waals interactions

Answer: (b) Electrostatic attraction

Q.14) Which of the following is an example of a hard acid?

(a) $Hg^{2+}$

(b) $Ag^{+}$

(c) $Fe^{3+}$

(d) $Cu^{+}$

Answer: (d) $Cu^{+}$

Q.15) Which acid-base interaction is typically favored for soft acids and bases?

(a) Covalent bond formation

(b) Electrostatic attraction

(c) Hydrogen bond formation

(d) Van der Waals interactions

Answer: (a) Covalent bond formation

Q.16) Which of the following statements about hard and soft acid base theory is correct?

(a) Hard acids prefer to bind to hard bases, while soft acids prefer to bind to soft bases.

(b) Soft acids prefer to bind to hard bases, while hard acids prefer to bind to soft bases.

(c) Both hard and soft acids can bind to any base, regardless of whether it is hard or soft.

(d) Both hard and soft bases can bind to any acid, regardless of whether it is hard or soft.

Answer: (a) Hard acids prefer to bind to hard bases, while soft acids prefer to bind to soft bases.

Q.17) Which of the following is an example of a hard acid?

(a) $Hg^{2+}$

(b) $Ag^{+}$

(c) $Cu^{+}$

(d) $Pt^{2+}$

Answer: (b) $Ag^{+}$

Q.18) Which of the following is an example of a soft base?

(a) $NH_3$

(b) $H_2O$

(c) $F^-$

(d) $Cl^-$

Answer: (a) $NH_3$

Q.19) Which of the following acid-base interactions is most favored according to the hard and soft acid base theory?

(a) $Hg^{2+}$ with $F^-$

(b) $Ag^+$ with F-

(c) $Hg^{2+}$ with $NH_3$

(d) $Ag^+$ with $NH_3$

Answer: (c) $Hg^{2+}$ with $NH_3$

Q.20) Which of the following statements about the acid-base strength in hard and soft acid base theory is true?

(a) Hard acids are always stronger than soft acids.

(b) Soft bases are always stronger than hard bases.

(c) Acid-base strength cannot be compared in terms of hard and soft acid base theory.

(d) Both hard and soft acids and bases can exhibit a range of strengths.

Answer: (d) Both hard and soft acids and bases can exhibit a range of strengths.

**HOTSQ**

1.Analyze the relationship between the size and charge of an ion and its classification as a hard or soft acid.

2.Evaluate the limitations and strengths of the hard and soft acid-base theory in predicting acid-base interactions in complex chemical systems.

3.Synthesize the concept of hard and soft acid-base theory and explain how it can be used to design more effective catalysts for chemical reactions.

4.Compare and contrast the hard and soft acid-base theory with other acid-base models such as the Lewis acid-base theory.

5.Evaluate the importance of hard and soft acid-base theory in fields such as biochemistry and materials science.

6.Evaluate the effectiveness of the hard and soft acid base theory in predicting acid-base interactions in biological systems.

7.Analyze how the hard and soft acid base theory can be used to explain the reactivity of metal ions with ligands in coordination chemistry.

8.Compare and contrast the hard and soft acid base theory with the Lewis acid-base theory.

9.Synthesize the key features of hard and soft acids and bases and explain how they relate to the stability of metal complexes.

10.Evaluate the applications of the hard and soft acid base theory in materials science and catalysis.

11.Evaluate the effectiveness of the hard and soft acid-base concept in predicting acid-base reactions in organic chemistry.

12.Analyze how the hard and soft acid-base theory can be used to design catalysts for chemical reactions.

13.Compare and contrast the hard and soft acid-base theory with Lewis acid-base theory.

14.Synthesize the principles of hard and soft acid-base theory and explain how they can be applied to explain the solubility of salts in water.

15.Evaluate the potential impact of the hard and soft acid-base concept on the development of new materials with unique properties.

16.Evaluate the applicability of the hard and soft acid base theory in predicting the stability of metal complexes in solution.

17.Analyze the factors that determine whether an acid or a base is classified as hard or soft in the context of the hard and soft acid base theory.

18.Synthesize the key features of the hard and soft acid base theory and explain how they can be used to understand the reactivity of chemical species.

19.Compare and contrast the hard and soft acid base theory with other models of acid-base chemistry, such as the Bronsted-Lowry theory.

20.Critically evaluate the limitations and strengths of the hard and soft acid base theory in predicting the formation of metal complexes in biological systems

# Chapter - II

## MCQS & HOTSQ on Crystal Field Theory

What does the Crystal Field Theory describe?

a) The electronic structure of atoms and molecules

b) The bonding between atoms and molecules

c) The structure and properties of ionic solids

d) The interaction between transition metal ions and ligands

Answer: d) The interaction between transition metal ions and ligands

Which of the following statements about Crystal Field Theory is correct?

a) The theory assumes that the ligands are neutral molecules.

b) The theory assumes that the ligands are point charges.

c) The theory assumes that the ligands are negatively charged ions.

d) The theory assumes that the ligands are positively charged ions.

Answer: b) The theory assumes that the ligands are point charges.

Which of the following is a consequence of applying the Crystal Field Theory to transition metal complexes?

a) The splitting of the d-orbitals into two energy levels.

b) The mixing of the d-orbitals with the s- and p-orbitals.

c) The formation of covalent bonds between the transition metal ion and the ligands.

d) The ionization of the transition metal ion to a higher oxidation state.

Answer: a) The splitting of the d-orbitals into two energy levels.

Which of the following is an example of a high-spin complex?

a) $[Fe(H_2O)_6]^{2+}$

b) $[Fe(CN)_6]^{3-}$

c) $[Fe(NH_3)_6]^{3+}$

d) $[Fe(H_2O)_6]^{3+}$

Answer: d) $[Fe(H_2O)_6]^{3+}$

Which of the following is an example of a low-spin complex?

a) $[Co(CN)_6]^{3-}$

b) $[Co(H_2O)_6]^{2+}$

c) $[Co(NH3)_6]^{3+}$

d) $[Co(H_2O)_6]^{3+}$

Answer: b) $[Co(H_2O)_6]^{2+}$

Which of the following statements best describes the Crystal Field Theory?

a) It describes the distribution of electrons in a molecule based on the repulsion between electrons.

b) It describes the distribution of electrons in a molecule based on the attraction between the metal ion and the surrounding ligands.

c) It describes the distribution of electrons in a molecule based on the strength of the hydrogen bonding.

d) It describes the distribution of electrons in a molecule based on the polarity of the molecule.

Answer: b) It describes the distribution of electrons in a molecule based on the attraction between the metal ion and the surrounding ligands.

Which of the following is a ligand field splitting diagram for an octahedral complex?

a) Tetrahedral field splitting diagram.

b) Square planar field splitting diagram.

c) High spin field splitting diagram.

d) Low spin field splitting diagram.

Answer: d) Low spin field splitting diagram.

Which of the following metal ions would exhibit the largest crystal field splitting in an octahedral complex?

a) $Fe^{3+}$

b) $Ni^{2+}$

c) $Co^{2+}$

d) $Cu^{2+}$

Answer: a) $Fe^{3+}$

Which of the following factors determines the magnitude of the crystal field splitting energy?

a) The size of the metal ion.

b) The oxidation state of the metal ion.

c) The type of ligands surrounding the metal ion.

d) The coordination number of the metal ion.

Answer: c) The type of ligands surrounding the metal ion.

Which of the following statements about the Crystal Field Theory is correct?

a) The theory can explain the color of transition metal complexes.

b) The theory can explain the acidity and basicity of molecules.

c) The theory is only applicable to ionic compounds.

d) The theory cannot explain the magnetic properties of molecules.

Answer: a) The theory can explain the color of transition metal complexes.

Which of the following is a postulate of the crystal field theory?

a) Ligand field theory governs the bonding between metal ions and ligands.

b) The energy levels of d orbitals are modified in the presence of ligands.

c) The magnitude of the splitting of the d orbitals is proportional to the field strength of the ligands.

d) All of the above.

Answer: b) The energy levels of d orbitals are modified in the presence of ligands.

In the crystal field theory, which of the following types of ligands causes the highest energy splitting of d orbitals?

a) Strong-field ligands

b) Weak-field ligands

c) Both strong-field and weak-field ligands cause the same energy splitting of d orbitals

d) The energy splitting of d orbitals is not related to the field strength of ligands

Answer: a) Strong-field ligands

Which of the following coordination geometries causes a larger crystal field splitting of d orbitals?

a) Tetrahedral coordination

b) Octahedral coordination

c) Trigonal bipyramidal coordination

d) Square planar coordination

Answer: b) Octahedral coordination

Which of the following is an example of a strong-field ligand?

a) $NH_3$

b) $H_2O$

c) $F^-$

d) $Cl^-$

Answer: c) $F^-$

Which of the following is an example of a weak-field ligand?

a) $CN^-$

b) $OH^-$

c) $NO2^-$

d) $SCN^-$

Answer: b) $OH^-$

Which of the following statements about Crystal Field Theory is correct?

a) It explains the bonding in covalent compounds.

b) It explains the bonding in ionic compounds.

c) It explains the bonding in transition metal complexes.

d) It explains the bonding in non-metal compounds.

Answer: c) It explains the bonding in transition metal complexes.

Which of the following statements about Crystal Field Theory is false?

a) It considers the ligands to be point charges.

b) It predicts the splitting of the d-orbitals in transition metal complexes.

c) It explains the color of transition metal complexes.

d) It assumes that the metal ion is spherical in shape.

Answer: d) It assumes that the metal ion is spherical in shape.

Which of the following is an example of a strong field ligand?

a) $H_2O$

b) $NH_3$

c) $Cl^-$

d) $CN^-$

Answer: d) $CN^-$

Which of the following is an example of a weak field ligand?

a) CO

b) $H_2O$

c) $NH_3$

d) $F^-$

Answer: b) $H_2O$

Which of the following statements about the splitting of the d-orbitals in Crystal Field Theory is correct?

a) The energy difference between the two sets of d-orbitals is proportional to the electronegativity of the ligand.

b) The energy difference between the two sets of d-orbitals is proportional to the size of the metal ion.

c) The energy difference between the two sets of d-orbitals is proportional to the charge on the metal ion.

d) The energy difference between the two sets of d-orbitals is independent of the ligand and the metal ion.

Answer: a) The energy difference between the two sets of d-orbitals is proportional to the electronegativity of the ligand.

**HOTSQ**

1) Evaluate the limitations of Crystal Field Theory in explaining the bonding in transition metal complexes.
2) Analyze the factors that affect the magnitude of the crystal field splitting energy in transition metal complexes.
3) Synthesize the key features of Crystal Field Theory and explain how they can be used to predict the color of transition metal complexes.
4) Compare and contrast the Crystal Field Theory with other models of bonding in transition metal complexes, such as Molecular Orbital Theory.
5) Critically evaluate the role of Crystal Field Theory in understanding the electronic structure and reactivity of transition metal complexes in biological systems. Analyze the assumptions and limitations of Crystal Field Theory in explaining the electronic and structural properties of transition metal complexes.

6) Evaluate the effectiveness of Crystal Field Theory in predicting the magnetic and spectroscopic properties of transition metal complexes.
7) Synthesize the key features of Crystal Field Theory and explain how it differs from Ligand Field Theory.
8) Compare and contrast the predictions of Crystal Field Theory and Molecular Orbital Theory in explaining the bonding in transition metal complexes.
9) Critically evaluate the applicability of Crystal Field Theory in predicting the reactivity of transition metal complexes in biological systems.
10) Analyze the strengths and limitations of Crystal Field Theory in predicting the properties and behaviors of transition metal complexes.
11) Synthesize the key features of Crystal Field Theory and explain how it can be used to understand the bonding and reactivity of transition metal complexes.
12) Compare and contrast Crystal Field Theory with other models of bonding, such as Molecular Orbital Theory and Valence Bond Theory.
13) Evaluate the role of Crystal Field Theory in explaining the color of transition metal complexes and its applications in chemical analysis and materials science.
14) Critically analyze the assumptions made by Crystal Field Theory and their implications for understanding the behaviour of transition metal complexes in biological systems.
15) Analyze the impact of different ligands on the electronic structure of transition metal complexes in the context of Crystal Field Theory.
16) Evaluate the strengths and limitations of Crystal Field Theory in explaining the properties and behavior of transition metal complexes.

17) Synthesize the key concepts of Crystal Field Theory and explain how they can be applied to predict the color of transition metal complexes.

18) Compare and contrast the predictions of Crystal Field Theory with other models of bonding in transition metal complexes, such as Molecular Orbital Theory.

19) Critically evaluate the role of Crystal Field Theory in understanding the reactivity of transition metal complexes in biological systems.

## Chapter – III

## MCQS & HOTSQ on Magnetic Properties of Transition Metal Complexes

1. Which of the following factors determines the magnetic properties of transition metal complexes?

a) The size of the metal ion.

b) The charge on the metal ion.

c) The electronic configuration of the metal ion.

d) The electronegativity of the ligands.

Answer: c) The electronic configuration of the metal ion.

2. Which of the following is a diamagnetic complex?

a) $[Fe(CN)_6]^{4-}$

b) $[Co(NH_3)_6]^{3+}$

c) $[Cu(H_2O)_6]^{2+}$

d) $[NiCl_4]^{2-}$

Answer: d) $[NiCl_4]^{2-}$

3. Which of the following is a paramagnetic complex?

a) $[Fe(H_2O)_6]^{2+}$

b) $[Zn(H_2O)_6]^{2+}$

c) $[Cu(NH_3)_4(H2O)_2]^{2+}$

d) $[Mn(CN)_6]^{3-}$

Answer: a) $[Fe(H_2O)_6]^{2+}$

4. Which of the following factors increases the magnetic moment of a transition metal complex?

a) Increasing the oxidation state of the metal ion.

b) Increasing the size of the metal ion.

c) Increasing the number of unpaired electrons in the d-orbitals.

d) Increasing the electronegativity of the ligands.

Answer: c) Increasing the number of unpaired electrons in the d-orbitals.

5. Which of the following statements about the magnetic properties of transition metal complexes is true?

a) All transition metal complexes are diamagnetic.

b) The presence of unpaired electrons in the d-orbitals makes a complex diamagnetic.

c) The magnetic properties of a complex are independent of the ligands.

d) The magnetic properties of a complex can be determined experimentally by measuring its UV-Vis spectrum.

Answer: b) The presence of unpaired electrons in the d-orbitals makes a complex diamagnetic.

6. What is the definition of magnetic moment?

a) The amount of energy required to remove an electron from an atom or molecule.

b) The force experienced by a magnetic dipole in a magnetic field.

c) The measure of the magnetic strength of a substance.

d) The number of unpaired electrons in an atom or molecule.

Answer: b) The force experienced by a magnetic dipole in a magnetic field.

7. Which of the following statements about magnetic moment is true?

a) Magnetic moment is a vector quantity.

b) Magnetic moment is a scalar quantity.

c) Magnetic moment is independent of temperature.

d) Magnetic moment is inversely proportional to the strength of the magnetic field.

Answer: a) Magnetic moment is a vector quantity.

8. What is the unit of magnetic moment in the SI system?

a) Tesla (T)

b) Ampere (A)

c) Joule (J)

d) Weber (Wb)

Answer: a) Tesla (T)

Which of the following factors affects the magnetic moment of an atom or molecule?

a) The size of the atom or molecule.

b) The charge on the atom or molecule.

c) The electronic configuration of the atom or molecule.

d) The boiling point of the atom or molecule.

Answer: c) The electronic configuration of the atom or molecule.

9. Which of the following statements about magnetic moment is false?

a) Paramagnetic substances have a net magnetic moment.

b) Diamagnetic substances have no net magnetic moment.

c) Magnetic moment can be measured experimentally by observing the deflection of a substance in a magnetic field.

d) Magnetic moment is always positive.

Answer: d) Magnetic moment is always positive.

10. What is magnetic moment?

a) The force exerted by a magnet.

b) The strength of a magnetic field.

c) The magnetic property of a material.

d) The direction of a magnetic field.

Answer: c) The magnetic property of a material.

11. What is the unit of magnetic moment?

a) Tesla (T)

b) Weber (Wb)

c) Ampere (A)

d) Bohr magneton (μB)

Answer: d) Bohr magneton (μB)

12. Which of the following factors affects the magnetic moment of a substance?

a) The temperature of the substance.

b) The mass of the substance.

c) The shape of the substance.

d) The electronic structure of the substance.

Answer: d) The electronic structure of the substance.

13. Which of the following statements is true regarding the magnetic moment of an atom?

a) It is always zero.

b) It is always positive.

c) It can be positive, negative, or zero.

d) It is determined by the shape of the atom.

Answer: c) It can be positive, negative, or zero.

14. What is the relationship between the magnetic moment and the number of unpaired electrons in an atom?

a) The magnetic moment increases with the number of unpaired electrons.

b) The magnetic moment decreases with the number of unpaired electrons.

c) The magnetic moment is not affected by the number of unpaired electrons.

d) The magnetic moment is only affected by the total number of electrons in the atom.

Answer: a) The magnetic moment increases with the number of unpaired electrons.

15. What is L-S coupling?

a) A method for calculating the electronic structure of molecules.

b) A model for describing the interaction between an electron and a magnetic field.

c) A model for describing the interaction between the spin and orbital angular momentum of electrons.

d) A theory for explaining the magnetic properties of materials.

Answer: c) A model for describing the interaction between the spin and orbital angular momentum of electrons.

16. What is the total angular momentum quantum number (J) in L-S coupling?

a) The sum of the spin quantum number (S) and the orbital angular momentum quantum number (L).

b) The difference between the spin quantum number (S) and the orbital angular momentum quantum number (L).

c) The product of the spin quantum number (S) and the orbital angular momentum quantum number (L).

d) The square of the spin quantum number (S) plus the square of the orbital angular momentum quantum number (L).

Answer: a) The sum of the spin quantum number (S) and the orbital angular momentum quantum number (L).

17. Which of the following statements is true regarding L-S coupling?

a) It is only applicable to atoms with a low atomic number.

b) It predicts the same energy levels as Russell-Saunders coupling.

c) It is only applicable to molecules with a high degree of symmetry.

d) It predicts energy level splittings due to spin-orbit coupling.

Answer: d) It predicts energy level splittings due to spin-orbit coupling.

18. Which of the following factors affects the strength of spin-orbit coupling in an atom?

a) The atomic number.

b) The magnetic field strength.

c) The size of the atom.

d) The shape of the electron orbitals.

Answer: a) The atomic number.

19. What is the significance of the term "fine structure" in the context of L-S coupling?

a) It refers to the splitting of energy levels due to the interaction between the electron spin and magnetic field.

b) It refers to the splitting of energy levels due to the interaction between the electron orbitals and magnetic field.

c) It refers to the splitting of energy levels due to the interaction between the electron spin and electron-electron repulsion.

d) It refers to the splitting of energy levels due to the interaction between the electron orbitals and electron-electron repulsion.

Answer: a) It refers to the splitting of energy levels due to the interaction between the electron spin and magnetic field.

20. What is L-S coupling?

a) The interaction between the magnetic moments of electrons and the external magnetic field.

b) The interaction between the spin and orbital angular momentum of electrons in an atom.

c) The interaction between the electric dipole moment of an atom and an external electric field.

d) The interaction between the electronic and nuclear spins in an atom.

Answer: b) The interaction between the spin and orbital angular momentum of electrons in an atom.

21. What is the primary effect of L-S coupling on the energy levels of an atom?

a) It splits the energy levels into multiple levels.

b) It causes the energy levels to converge.

c) It shifts the energy levels to higher energy.

d) It has no effect on the energy levels.

Answer: a) It splits the energy levels into multiple levels.

22. Which of the following statements is true regarding the splitting of energy levels due to L-S coupling?

a) The energy splitting is equal for all levels.

b) The energy splitting is proportional to the spin quantum number.

c) The energy splitting is proportional to the orbital quantum number.

d) The energy splitting is different for different levels.

Answer: d) The energy splitting is different for different levels.

23. Which of the following is an example of a system where L-S coupling is important?

a) A hydrogen atom.

b) A helium atom.

c) A lithium atom.

d) A lanthanide ion.

Answer: d) A lanthanide ion.

24. Which of the following is an example of a transition that is allowed by L-S coupling?

a) Singlet-singlet transition.

b) Triplet-singlet transition.

c) Spin-forbidden transition.

d) Electric-dipole allowed transition.

Answer: d) Electric-dipole allowed transition.

**HOTSQ**

1. What is meant by "spin-only" magnetic moment of a transition metal complex?
2. What are the factors affecting the magnetic properties of transition metal complexes?
3. Explain the origin of magnetic moment in octahedral high-spin and low-spin complexes.
4. How does the nature of ligands affect the magnetic properties of transition metal complexes?
5. Why do some transition metal complexes exhibit antiferromagnetic behavior?
6. Explain the concept of "exchange interaction" in the context of magnetic properties of transition metal complexes.
7. What is the difference between paramagnetism and ferromagnetism?

8. How can magnetic susceptibility measurements be used to determine the number of unpaired electrons in a transition metal complex?
9. What is meant by "superexchange" interaction in the context of magnetic properties of transition metal complexes?
10. How does the oxidation state of the central metal ion affect the magnetic properties of a transition metal complex?
11. Explain the difference between diamagnetism, paramagnetism, and ferromagnetism.
12. How is the magnetic moment of a substance affected by temperature?
13. Why does the magnetic moment of an atom depend on the number of unpaired electrons?
14. What is meant by "spin-only" magnetic moment?
15. Explain how the magnetic moment of a substance can be measured experimentally.
16. How does the external magnetic field affect the magnetic moment of a substance?
17. What is meant by Larmor frequency in the context of magnetic moment?
18. Why do some substances exhibit antiferromagnetic behavior?
19. What is the relationship between the magnetic moment and the magnetic susceptibility of a substance?
20. Explain how the magnetic moment can be used to determine the electronic structure of a substance.
21. Explain the origin of L-S coupling and how it relates to the spin and orbital angular momentum of electrons.
22. What is the significance of the Russell-Saunders coupling scheme in L-S coupling?
23. How does L-S coupling affect the energy levels of an atom or ion?

24. What is the difference between a singlet and a triplet state in the context of L-S coupling?
25. How do transitions between different energy levels affected by L-S coupling manifest themselves in spectroscopy?
26. What is the impact of the strength of the magnetic field on the energy levels of a system under L-S coupling?
27. Explain how the splitting of energy levels due to L-S coupling can be used to determine the electronic configuration of a transition metal ion.
28. What are some limitations of the L-S coupling model?
29. How does the size and shape of a ligand affect the strength of L-S coupling in transition metal complexes?
30. Explain how L-S coupling is used in the interpretation of magnetic properties of transition metal complexes.

## Chapter -IV

## MCQS & HOTSQ On Transition Metals & Metal Complexes

1. Which of the following is NOT a characteristic of the first transition metals series?

A) They have partially filled d-orbitals.

B) They exhibit a wide range of oxidation states.

C) They form coloured compounds.

D) They are all good conductors of electricity.

Answer: D) They are all good conductors of electricity.

2. Which element in the first transition metals series is the most electronegative?

A) Scandium

B) Titanium

C) Vanadium

D) Chromium

Answer: A) Scandium

3. Which of the following elements in the first transition metals series has the highest melting point?

A) Titanium

B) Vanadium

C) Chromium

D) Iron

Answer: C) Chromium

4. Which of the following elements in the first transition metals series has the highest atomic radius?

A) Scandium

B) Titanium

C) Vanadium

D) Manganese

Answer: A) Scandium

5. Which of the following elements in the first transition metals series has the highest ionization energy?

A) Chromium

B) Manganese

C) Iron

D) Cobalt

Answer: D) Cobalt

6. Which of the following is the first element in the first transition metals series?

a) Scandium

b) Titanium

c) Vanadium

d) Chromium

7. What is the maximum oxidation state of manganese in its compounds?

a) +2

b) +4

c) +6

d) +7

8. Which of the following is a common alloy of copper and zinc?

a) Brass

b) Bronze

c) Steel

d) Sterling silver

9. Which of the following elements is commonly used in the production of stainless steel?

a) Chromium

b) Iron

c) Copper

d) Zinc

10. Which of the following elements is used in the manufacture of nickel-cadmium batteries?

a) Cobalt

b) Copper

c) Zinc

d) Nickel

11. What is the electronic configuration of the first transition metal series?

A) [Ar] $3d^{1-10}$ $4s^{1-2}$

B) [Kr] $4d^{1-10}$ $5s^{1-2}$

C) [Ne] $3s^{1-2}$ $3p^{1-6}$

D) [Xe] $5d^{1-10}$ $6s^{1-2}$

Answer: A) [Ar]$3d^{1-10}$ $4s^{1-2}$

12. Which element in the first transition metal series has the highest melting point?

A) Iron (Fe)

B) Cobalt (Co)

C) Nickel (Ni)

D) Copper (Cu)

Answer: A) Iron (Fe)

13. Which of the following elements in the first transition metal series is not a ferromagnetic material?

A) Iron (Fe)

B) Cobalt (Co)

C) Nickel (Ni)

D) Zinc (Zn)

Answer: D) Zinc (Zn)

14. Which element in the first transition metal series has the highest ionization energy?

A) Scandium (Sc)

B) Titanium (Ti)

C) Vanadium (V)

D) Chromium (Cr)

Answer: A) Scandium (Sc)

15. Which of the following elements in the first transition metal series has the lowest density?

A) Iron (Fe)

B) Cobalt (Co)

C) Nickel (Ni)

D) Copper (Cu)

Answer: D) Copper (Cu)

16. Which of the following is not a first transition metal?

a) Scandium

b) Titanium

c) Iron

d) Copper

Answer: d) Copper

17. Which of the following elements has the highest melting point in the first transition metal series?

a) Vanadium

b) Chromium

c) Manganese

d) Iron

Answer: b) Chromium

18. Which of the following transition metals has the highest oxidation state?

a) Titanium

b) Vanadium

c) Chromium

d) Manganese

Answer: c) Chromium

19. Which of the following elements in the first transition metal series has the most unpaired electrons in its ground state?

a) Titanium

b) Vanadium

c) Iron

d) Cobalt

Answer: b) Vanadium

20. Which of the following transition metals is the most reactive with water?

a) Titanium

b) Iron

c) Manganese

d) Zinc

Answer: b) Iron

11. Which of the following is the first transition metal series?

a) Scandium series

b) Titanium series

c) Vanadium series

d) All of the above

Answer: d) All of the above

12. The electronic configuration of the first transition series is:

a) $(n-1)d^{1-10}\ ns^{1-2}$

b) $(n-1)d^{1-10}\ ns^{2-3}$

c) $(n-1)d^{0-9}\ ns^{1-2}$

d) $(n-1)d^{0-9}\ ns^{2-3}$

Answer: c) $(n-1)d^{0-9}\ ns^{1-2}$

13. Which of the following elements is not a part of the first transition series?

a) Cobalt

b) Zinc

c) Iron

d) Chromium

Answer: b) Zinc

14. The melting and boiling points of the first transition series:

a) Decrease from Sc to Mn and then increase from Fe to Cu

b) Increase from Sc to Mn and then decrease from Fe to Cu

c) Increase from Sc to Cu

d) Decrease from Sc to Cu

Answer: b) Increase from Sc to Mn and then decrease from Fe to Cu

15. Which of the following is the most stable oxidation state for the first transition series?

a) +1

b) +2

c) +3

d) +4

Answer: b) +2

16. Which of the following elements is not a part of the first transition metals series?

A) Scandium

B) Vanadium

C) Iron

D) Cobalt

E) Copper

Answer : E) Copper

Explanation: The first transition metals series includes the elements from Scandium (Sc) to Zinc (Zn) on the periodic table. Copper (Cu) is a part of the second transition metals series.

**HOTSQ**

1. The complex $[Co(NH_3)_5Cl]^{2+}$ exhibits a difference in the energy between its d-orbitals, which results in the absorption of light in the visible region. What causes this difference in energy and how does it relate to the absorption of light?

Answer: The difference in energy between the d-orbitals in the complex is caused by the crystal field splitting that occurs when the ligands (NH3 and Cl) surround the central cobalt (Co) ion. This splitting results in two sets of d-orbitals, with one set of orbitals (eg) at a higher energy level and the other set (t2g) at a lower energy level.

When light in the visible region is absorbed by the complex, an electron in one of the lower-energy t2g orbitals is excited to a higher-energy eg orbital. This causes the complex to appear colored, as the absorbed light corresponds to the energy difference between the two sets of d-orbitals. The color of the complex is related to the wavelength of light that is absorbed, with shorter wavelengths (higher energy) corresponding to higher-energy transitions and colors appearing more violet or blue, while longer wavelengths (lower energy) correspond to lower-energy transitions and colors appearing more red or orange.

2. Explain why transition metal complexes are often colorful.

Answer: The colors of transition metal complexes arise due to the absorption of visible light by the metal ions in the complexes. When visible light strikes a transition metal complex, the electrons in the d-orbitals of the metal ion can

absorb specific wavelengths of light, depending on their energy levels. The absorbed light energy promotes the electrons to higher energy levels, and the complex appears colored because the unabsorbed wavelengths of light are transmitted or reflected.

The energy required to promote electrons to higher energy levels depends on the electronic configuration of the metal ion, which in turn depends on the ligands surrounding the metal ion. The type and arrangement of the ligands can affect the energy required to promote electrons to higher energy levels, leading to variations in the absorption of visible light and the color of the complex. Hence, the color of a transition metal complex can provide information about its electronic structure and the nature of the ligands surrounding the metal ion.

3. How do ligands affect the electronic and optical properties of transition metal complexes, and what are some practical applications of these effects?

Answer: The electronic and optical properties of transition metal complexes can be dramatically influenced by the choice of ligands. Ligands can donate or accept electron density from the metal center, and can modify the geometry and coordination number of the metal ion. This can affect the color, stability, and reactivity of the complex.

For example, ligands that donate electron density to the metal ion can cause a shift in the energy levels of the metal's d orbitals, resulting in changes in the absorption spectrum of the complex. This is known as the ligand field effect, and it is the basis for the color of many transition metal complexes. For instance, Cu(II) complexes are typically blue due to the d-d transition, while Fe(II)

complexes are usually green because of the strong absorption in the yellow-red region of the spectrum.

The optical properties of transition metal complexes have many practical applications. For example, transition metal complexes are used as dyes in the textile industry, as pigments in paints and coatings, and as biological probes and sensors. The ligand field effect can also be used to tune the reactivity of transition metal catalysts for various applications, such as in industrial chemical synthesis or environmental remediation.

Overall, the ability of ligands to influence the electronic and optical properties of transition metal complexes is a powerful tool for controlling the properties and behavior of these compounds for a variety of practical applications.

4. A student prepared a complex by reacting [Co(NH3)6]Cl3 with silver nitrate. The precipitate formed was filtered and washed with water. When the complex was analyzed, it was found to have the formula [Co(NH3)5(NO2)]Cl2.

a) Write the complete ionic equation for the reaction that occurred.

b) Explain the formation of the precipitate.

c) Identify the oxidation state of cobalt in the complex and explain the changes that occurred during the reaction.

d) Draw the structure of the complex, showing the coordination geometry and the position of the nitrite ligand.

Possible answer:

a) $AgNO3(aq) + 3[Co(NH_3)_6]Cl^3(aq) \rightarrow AgCl(s) + 3Co(NH_3)63(aq)$

b) The precipitate formed is silver chloride (AgCl), which is insoluble in water. The silver ions ($Ag^+$) from silver nitrate react with the chloride ions ($Cl^-$) from the $[Co(NH_3)_6]Cl^3$ complex, forming a solid precipitate of AgCl.

c) The oxidation state of cobalt in the complex is +3. During the reaction, the nitrate ions (NO3-) from the $[Co(NH_3)_{6]}Cl_3$ complex were replaced by nitrite ions ($NO^{2-}$), resulting in the formation of $[Co(NH_3)5(NO_2)]Cl_2$ complex. The oxidation state of cobalt remains +3 before and after the reaction.

d) The structure of the complex is octahedral, with five ammonia ligands and one nitrite ligand. The nitrite ligand ($NO^{2-}$) occupies one of the six coordination sites of the cobalt ion ($Co^{3+}$), forming a five-coordinate complex. The nitrite ligand is bonded to the cobalt ion through the nitrogen atom (N) and one of the oxygen atoms (O). The remaining oxygen atom (O) of the nitrite ligand is not bonded to the cobalt ion, but it is coordinated to a hydrogen bond donor from one of the ammonia ligands.

## Chapter - IV

## MCQS & HOTSQ On Organometallic Chemistry

1. Which of the following is not a common ligand in organometallic chemistry?

a) CO

b) $H_2O$

c) $PR_3$

d) $NH_3$

2. What is the most common oxidation state for transition metal atoms in organometallic complexes?

a) 0

b) +1

c) +2

d) +3

3. What is meant by the term "piano stool" in organometallic chemistry?

a) A type of ligand with a shape similar to a piano stool

b) A metal center with four ligands arranged in a square planar geometry

c) A metal center with one ligand above and four ligands below arranged in a trigonal bipyramidal geometry

d) A metal center with three ligands arranged in a triangular planar geometry

4. Which of the following statements about metallocenes is true?

a) They have a sandwich-like structure with a metal atom sandwiched between two cyclopentadienyl rings.

b) They are only stable in the presence of air and moisture.

c) They are typically prepared using a ligand exchange reaction.

d) They are generally used as solvents in organic synthesis.

5. Which of the following is not a common reaction pathway in organometallic chemistry?

a) Ligand substitution

b) Redox reactions

c) Isomerization

d) Polymerization

6. What is the most common type of bond between a metal center and a ligand in organometallic complexes?

a) Ionic bond

b) Covalent bond

c) Coordinate covalent bond

d) Metallic bond

7. Which of the following is not a common application of organometallic complexes?

a) Catalysis

b) Medicinal chemistry

c) Materials science

d) Agriculture

8. Which of the following ligands is commonly used in transition metal-catalyzed cross-coupling reactions?

a) $H_2O$

b) CO

c) $PPh_3$

d) MeOH

9. Which of the following is not a common type of organometallic reaction?

a) Oxidative addition

b) Reductive elimination

c) Cyclization

d) Halogenation

10. Which of the following is not a common organometallic reagent?

a) Grignard reagents

b) Lithium aluminum hydride ($LiAlH_4$)

c) Sodium borohydride ($NaBH_4$)

d) Hydrogen peroxide ($H_2O_2$)

11. Which of the following elements is commonly found in organometallic compounds?

a) Carbon

b) Hydrogen

c) Oxygen

d) Nitrogen

12. What is the general structure of a metallocene compound?

a) M-X-M

b) M-X-Y

c) M-Cp

d) $M-Cp_2$

13. What is the role of a ligand in an organometallic compound?

a) It provides electrons to the metal center.

b) It stabilizes the metal center by donating electrons.

c) It stabilizes the metal center by accepting electrons.

d) It provides a bridge between two metal centers.

14. Which of the following is an example of a transition metal carbonyl complex?

a) Ferrocene

b) Zeise's salt

c) Grignard reagent

d) Tetracarbonylnickel

15. What is the oxidation state of the metal in the compound $Cp_2Fe$?

a) 0

b) +1

c) +2

d) -1

16. What is the function of a catalyst in an organometallic reaction?

a) It stabilizes the reactants.

b) It promotes the formation of the product.

c) It provides a source of energy for the reaction.

d) It inhibits the reaction.

17. Which of the following is a common reaction of organometallic compounds?

a) Addition to a double bond

b) Elimination of a leaving group

c) Substitution of a ligand

d) All of the above

18. Which of the following is an example of a chiral organometallic compound?

a) Ferrocene

b) Zeise's salt

c) Bis(acetylacetonato)copper(II)

d) Triphenylphosphinegold(I) chloride

19. Which of the following is a common application of organometallic compounds?

a) As catalysts in industrial processes

b) As anti-cancer drugs

c) As fuels for rockets

d) As food additives

20. What is the role of pi bonding in organometallic compounds?

a) It provides a bridge between two metal centers.

b) It stabilizes the metal center by donating electrons.

c) It stabilizes the metal center by accepting electrons.

d) It provides a source of electrons for the metal center.

**HOTSQ**

1. What is the difference between a metallocene and a sandwich compound?

Answer: A metallocene is a type of sandwich compound in which a metal atom is sandwiched between two cyclopentadienyl ligands, whereas a sandwich compound can refer to any compound in which a metal atom is sandwiched between two aromatic ligands.

2. How does the electron density of a ligand affect the reactivity of an organometallic compound?

Answer: Ligands with high electron density, such as phosphines, can stabilize the metal center and make it more nucleophilic, while ligands with low electron density, such as alkyls, can make the metal center more electrophilic.

3. What is the role of d-orbitals in organometallic chemistry?

Answer: D-orbitals are involved in the bonding between the metal center and the ligands in an organometallic compound.

4. What is the difference between a sigma bond and a pi bond in organometallic chemistry?

Answer: A sigma bond is a covalent bond in which the electron density is distributed symmetrically around the internuclear axis, while a pi bond is a covalent bond in which the electron density is concentrated above and below the internuclear axis.

5. How does the electronic structure of a transition metal ion affect the reactivity of its organometallic compounds?

Answer: The electronic structure of a transition metal ion determines its oxidation state, which in turn affects the reactivity of its organometallic compounds.

6. What is the difference between a homogeneous and a heterogeneous organometallic reaction?

Answer: A homogeneous organometallic reaction takes place in solution, where both the metal catalyst and the reactants are in the same phase, while a heterogeneous organometallic reaction takes place on a solid surface, where the metal catalyst and the reactants are in different phases.

7. What is the mechanism of a migratory insertion reaction in organometallic chemistry?

Answer: A migratory insertion reaction involves the insertion of a ligand into a metal-ligand bond, resulting in the formation of a new metal-carbon bond.

8. What is the role of ligand exchange reactions in organometallic chemistry?

Answer: Ligand exchange reactions can be used to modify the electronic and steric properties of organometallic compounds, and they are often used to synthesize new compounds.

9. What is the significance of the metal-ligand bond strength in organometallic chemistry?

Answer: The strength of the metal-ligand bond affects the reactivity and stability of organometallic compounds.

10. How do organometallic compounds contribute to sustainable chemistry?

Answer: Organometallic compounds can be used as catalysts in sustainable chemical processes, such as the production of renewable fuels and the reduction of carbon dioxide emissions.

11. What are some common methods for synthesizing organometallic compounds?

Answer: Common methods for synthesizing organometallic compounds include direct metal-carbon bond formation, substitution reactions of metal halides with organometallic reagents, and oxidative addition reactions.

12. How do ligand properties affect the reactivity of organometallic compounds?

Answer: The properties of ligands such as size, shape, and charge can affect the reactivity of organometallic compounds. For example, small and electron-rich ligands can lead to increased reactivity and easier access to metal centers.

13. What is the role of organometallic catalysts in chemical synthesis?

Answer: Organometallic catalysts can be used to increase reaction rates, selectivity, and efficiency in chemical synthesis. They can also help activate substrates and promote challenging bond-forming reactions.

14. What are some common applications of organometallic compounds in industry?

Answer: Organometallic compounds are widely used as catalysts in industrial processes such as polymerization, hydrogenation, and oxidation. They are also used in the production of fine chemicals, pharmaceuticals, and agrochemicals.

15. How do organometallic compounds contribute to the field of homogeneous catalysis?

Answer: Organometallic compounds are important catalysts in homogeneous catalysis due to their ability to activate and transform substrates in solution-phase reactions. They can also help control the stereochemistry and regiochemistry of reactions.

16. What is the significance of the discovery of ferrocene in the field of organometallic chemistry?

Answer: The discovery of ferrocene in 1951 opened up a new field of organometallic chemistry and led to the development of metallocene catalysts. Ferrocene also played a significant role in the development of modern electrochemistry and materials science.

17. What is the difference between a classical and non-classical carbocation in organometallic chemistry?

Answer: A classical carbocation has a linear arrangement of three atoms, while a non-classical carbocation has a bridged arrangement of three or more atoms. Non-classical carbocations are important intermediates in organometallic reactions and can exhibit unique reactivity and selectivity.

18. What is the role of d-orbitals in the reactivity of transition metal organometallic compounds?

Answer: D-orbitals in transition metal organometallic compounds can participate in pi bonding with ligands, which can affect the reactivity and stability of the compound. D-orbitals can also play a role in the activation of substrates in catalytic reactions.

19. How do organometallic compounds contribute to the development of sustainable energy technologies?

Answer: Organometallic compounds can be used as catalysts in reactions related to sustainable energy technologies such as fuel cells, solar cells, and carbon dioxide reduction. They can also help improve the efficiency and selectivity of these reactions.

20. What are some challenges in the synthesis and application of organometallic compounds?

Answer: Some challenges in the synthesis and application of organometallic compounds include air and moisture sensitivity, toxicity, and cost. The stability and reactivity of organometallic compounds can also be affected by the choice of ligands, solvents, and reaction conditions.

## Chapter - V

## MCQS & HOTSQ On Bio-Inorganic Chemistry

1. What is the primary function of heme in the human body?

a) Oxygen transport

b) Iron storage

c) Energy production

d) DNA replication

Answer: a) Oxygen transport

2. Which of the following is a common cofactor found in many enzymes?

a) Sodium

b) Potassium

c) Magnesium

d) Calcium

Answer: c) Magnesium

3. What is the role of copper in the human body?

a) Energy production

b) Muscle contraction

c) Bone formation

d) Oxygen transport

Answer: d) Oxygen transport

4. Which of the following metals is essential for the function of vitamin B12?

a) Iron

b) Zinc

c) Cobalt

d) Copper

Answer: c) Cobalt

5. Which metal is essential for the function of superoxide dismutase?

a) Iron

b) Zinc

c) Copper

d) Manganese

Answer: d) Manganese

6. What is the primary function of cytochromes in the electron transport chain?

a) ATP synthesis

b) Oxygen transport

c) Carbon dioxide transport

d) Electron transfer

Answer: d) Electron transfer

7. Which metal ion is required for the function of carbonic anhydrase?

a) Zinc

b) Iron

c) Copper

d) Calcium

Answer: a) Zinc

8. Which of the following is a common iron-containing protein found in red blood cells?

a) Myoglobin

b) Hemoglobin

c) Cytochrome c

d) Ferritin

Answer: b) Hemoglobin

9. What is the function of vanadium in marine organisms?

a) Oxygen transport

b) Energy production

c) Defense against predators

d) Pigmentation

Answer: c) Defense against predators

10. Which metal ion is required for the function of nitrogenase?

a) Iron

b) Zinc

c) Molybdenum

d) Copper

Answer: c) Molybdenum

11. Which metal ion is found in the active site of carbonic anhydrase?

a. Zinc

b. Copper

c. Iron

d. Calcium

Answer: a. Zinc

12. What is the function of the heme group in hemoglobin and myoglobin?

a. To bind oxygen

b. To transport carbon dioxide

c. To catalyze redox reactions

d. To stabilize protein structure

Answer: a. To bind oxygen

13. Which metal ion is involved in the oxygen-evolving complex of photosystem II?

a. Manganese

b. Iron

c. Zinc

d. Copper

Answer: a. Manganese

14. What is the function of the iron-sulfur clusters in the electron transport chain?

a. To transfer electrons

b. To bind oxygen

c. To stabilize protein structure

d. To catalyze redox reactions

Answer: a. To transfer electrons

15. What is the role of magnesium in chlorophyll?

a. To bind oxygen

b. To transport carbon dioxide

c. To transfer electrons

d. To act as a central atom in the porphyrin ring

Answer: d. To act as a central atom in the porphyrin ring

16. What is the function of the copper ion in cytochrome c oxidase?

a. To transfer electrons

b. To bind oxygen

c. To catalyze redox reactions

d. To stabilize protein structure

Answer: b. To bind oxygen

17. Which metal ion is involved in the active site of the enzyme nitrogenase?

a. Iron

b. Copper

c. Zinc

d. Molybdenum

Answer: d. Molybdenum

18. What is the function of the iron-sulfur cluster in the nitrogenase enzyme?

a. To transfer electrons

b. To bind oxygen

c. To stabilize protein structure

d. To catalyze redox reactions

Answer: a. To transfer electrons

19. Which metal ion is involved in the active site of the enzyme catalase?

a. Iron

b. Copper

c. Zinc

d. Manganese

Answer: c. Zinc

20. What is the function of the copper ion in the enzyme dopamine beta-hydroxylase?

a. To transfer electrons

b. To bind oxygen

c. To catalyze redox reactions

d. To stabilize protein structure

Answer: c. To catalyze redox reactions

**HOTSQ**

1. How does the binding of oxygen to the heme group in hemoglobin and myoglobin affect the structure of the protein?

Answer: The binding of oxygen to the heme group causes a conformational change in the protein, resulting in a more compact structure and a decrease in the size of the central cavity.

2. How is the oxygen-evolving complex of photosystem II able to catalyze the water-splitting reaction?

Answer: The oxygen-evolving complex contains four manganese ions and a calcium ion, which work together to carry out the water-splitting reaction by oxidizing water and releasing oxygen.

3. What is the function of the iron-sulfur clusters in the nitrogenase enzyme?

Answer: The iron-sulfur clusters are involved in the transfer of electrons during the reduction of nitrogen to ammonia.

4. How does the copper ion in cytochrome c oxidase facilitate the reduction of oxygen to water?

Answer: The copper ion facilitates the transfer of electrons from cytochrome c to oxygen, which allows the oxygen to be reduced to water.

5. What is the role of zinc in the active site of the enzyme carbonic anhydrase?

Answer: Zinc acts as a Lewis acid, coordinating with the substrate and facilitating the transfer of a proton from water to carbon dioxide.

6. How does the iron-sulfur cluster in the electron transport chain facilitate the transfer of electrons?

Answer: The iron-sulfur cluster acts as a redox center, cycling between its oxidized and reduced forms and facilitating the transfer of electrons from one carrier to another.

7. What is the function of the molybdenum ion in the active site of the enzyme nitrogenase?

Answer: Molybdenum coordinates with the nitrogen molecule and facilitates its reduction to ammonia.

8. How does the copper ion in the enzyme dopamine beta-hydroxylase catalyze the oxidation of dopamine to norepinephrine?

Answer: The copper ion facilitates the transfer of electrons from dopamine to oxygen, allowing for the oxidation of dopamine to norepinephrine.

9. What is the role of magnesium in the structure of chlorophyll?

Answer: Magnesium acts as a central atom in the porphyrin ring, allowing chlorophyll to absorb light energy and participate in photosynthesis.

10. What is the function of the iron ion in the active site of the enzyme catalase?

Answer: The iron ion coordinates with the hydrogen peroxide molecule and facilitates its decomposition to water and oxygen.

11. How does the heme group in hemoglobin change its conformation upon binding oxygen?

Answer: The iron ion in the heme group moves towards the plane of the porphyrin ring, causing the porphyrin ring to deform and the heme group to change its conformation. This change in conformation facilitates the binding of oxygen to the iron ion.

12. What is the mechanism of action of carbonic anhydrase in catalyzing the hydration of carbon dioxide?

Answer: Carbonic anhydrase contains a zinc ion in its active site, which coordinates with a water molecule. The coordinated water molecule is activated by the zinc ion and becomes a stronger nucleophile, attacking the carbon dioxide molecule to form bicarbonate ion and a hydrogen ion.

13. What is the role of the iron-sulfur clusters in the nitrogenase enzyme in nitrogen fixation?

Answer: The iron-sulfur clusters in the nitrogenase enzyme serve as electron carriers, transferring electrons to the nitrogen molecule to reduce it to ammonia. The reduced nitrogen is then used by plants to synthesize amino acids and other nitrogen-containing compounds.

14. How does the copper ion in cytochrome c oxidase facilitate the reduction of oxygen to water?

Answer: The copper ion in cytochrome c oxidase undergoes a series of redox reactions, accepting electrons from cytochrome c and donating them to oxygen to form water. The copper ion serves as an electron transfer center, facilitating the reduction of oxygen to water.

15. How do metalloproteins such as hemoglobin and myoglobin selectively bind oxygen over other gases such as nitrogen and carbon dioxide?

Answer: The heme group in metalloproteins such as hemoglobin and myoglobin contains a specific binding site for oxygen, which allows for selective binding of oxygen over other gases such as nitrogen and carbon dioxide. This binding site

is created by the conformational changes in the heme group upon binding oxygen, which allows for tighter binding of the oxygen molecule.

## B.Sc. III Year

## SATQ & HOTSQ on Organic Chemistry

**(According to Bloom's Taxonomy)**

### SATQ

Q.1 Write notes on

(a) Chemical Shift

(b) Splitting of signals and coupling constant

(c) Spin-Spin coupling

(d) Shielding and deshielding

Q.2 Write equations for reactions between ethyl magnesium bromide and

(a) $CO_2$

(b) HCHO

(c) $HCOOC_2H_5$

(d) $CH_3OH$

(e) $CH_3COCH_3$

(f) $CH3CONH_2$

Q.3) Write short notes on

(a) Rubber

(b) Teflon

(c) Polythene

(d) PVC

(e) Condensation polymer

Q.4) Prove that D-glucose has pyranose structure?

Q.5) What is **α** and **β** glycosidic linkage?

Q.6) Write short notes on

(a) Mutarotation

(b) Epimerization

(c) Invert sugar

Q.7) Write notes on

(a) Saponification

(b) Hydrolysis of fat

(c) Hydrogenation of oil

(d) Cleansing action of soap

Q.8) Explain acid base behavior of amino acids?

Q.9) What are nucleic acids? Give names with structure, sugars and bases present in them?

Q.10) Explain electrocyclic reactions?

Q.11) How will you distinguish between inter and intra molecular H-bonding on basis of NMR, spectroscopy?

Q.12) What in the role of ether in Grignard's reagents?

Q.13) Using Grignard's reagent how will you obtain the following

(a) $CH_3Br \longrightarrow$ C2H6

(b) $CH_3CHO \longrightarrow$ $CH_3COCH3$

(c) (CH3)2CO $\longrightarrow$ isobutyl alcohol

(d) Acetone $\longrightarrow$ tert. butyl alcohol

(e) $CH_3OH \longrightarrow C_2H_5OH$

Q.14) What are mercaptans? What is the action of the following on it?

(a) Mercuric chloride

(b) Strong nitric acid

(c) Na

(d) RCOOH

Q. 15) What happens when ethylene glycol reacts with dimethyl terephthalate?

Q.16) Explain the following

(a) In absence of aldehydic group fructose reduces Fehling's solution or Tollens's reagent

(b) Despite different functional group glucose and fructose form the same osazone?

(c) Mechanism of osazone formation from glucose.

Q.17) What is the difference between iodine value and acid value?

Q.18) Explain effect of heat on amino acids?

Q.19) What is isoelectric point of amino acids? How it is used in separation of amino acids from their mixture.

Q.20) Write a note on components of nucleic acids?

Q.21) Discuss with examples

(a) Chromophore

(b) Auxochrome

(c) Batho chromic

(d) Hypochromic shifts

**HOTSQ**

Q.1) Explain with e.g., how IR spectra helps in identifying functional group?

Q.2) Discuss $^{1}$HNMR Spectrum of

(a) Ethyl alcohol

(b) Acetophenone

Q.3) Give preparation and nucleophilic addition reaction of ethyl magnesium bromide?

Q.4) Justify D-glucose has a pyranose structure?

Q.5) What are soaps? Explain cleansing action of soap?

Q.6) Describe dipolar ionic structure of amino acids? How does the dipolar ionic structure of amino acids affect their physical properties?

Q.7) Explain double helical structure of DNA?

Q.8) Give preparation and uses of the following:

(a) Methyl orange

(b) Malachite green

Q.9) Explain [2+2] and [4+2] cycloaddition reactions in detail?

Q.10) Explain electrocyclic reaction in detail?

## B.Sc. III Year

## SATQ & HOTSQ on Physical Chemistry

**SATQ**

Q.1 Discuss formation of $H_2^+$ ion from LCAO method?

Q.2 Why is **π** bond weaker than **σ** bond?

Q.3) write a note on Born-Oppenheimer approximation?

Q.4) Explain briefly various regions of dectro magnetic radiation or spectrum?

Q.5) Discuss Stokes and Antistokes lines?

Q.6) Write short notes on

(a) Overtones and fundamental frequency

(b) Modes of vibration

(c) Force constant

Q.7) Write a note on frank condor principle?

Q.8) Give one term for the following

(a) No. of wavelengths per centimeter

(b) Distance travelled by wave in one complete cycle

(c) Vibration in which two atoms oscillate along the internuclear distance

(d) Electrons which form **σ** bond

(e) Those orbitals to which no anti-bonding orbital corresponds?

(f) Spectroscopy which describes only electronic transitions?

Q.9) Write applications of ultraviolet spectroscopy?

Q.10) Differentiate fluorescence and phosphorescence?

Q.11) Explain Norrish Type I and II reactions?

Q.12) Why combination of $H_2$ & $Br_2$ has low quantum field?

Q.13) Difference between ferro and diamagnetic substances?

**HOTSQ**

Q.1) Derive an expression for de-Broglie equation?

Q.2) How is Compton effect be explained on basis of quantum theory?

Q.3) Explain why carbon shows tetravalency?

Q.4) What do you understand by energy conversion factor?

Q.5) Write notes on

(a) Rigid rotator

(b) Maxwell-Boltzmann distribution

Q.6) Deduce an expression for energy of harmonic oscillator?

Q.7) Explain concept of polarizability?

Q.8) Give the qualitative description of π, σ and η molecular orbitals, their energy values and their respective transitions?

Q.9) Explain different electronic transitions taking place in UV spectroscopy?

Q.10) Write an account on conjugated system in organic chemistry?

Q.11) Draw and explain Jablonski diagram predicting various physical processes occurring in the electronic excited state of the molecule?

Q.12) What is photosensitization? How is energy transferred in photosensitization?

Q.13) Explain Clausius Mossoti equation?