

APRIL, 2026

**Natural Products, Heterocyclic Compounds,
Nitrogen Containing Compounds and Polynuclear Hydrocarbons**

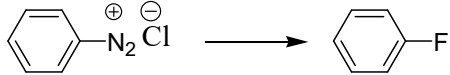
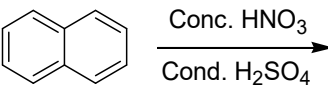
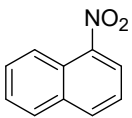
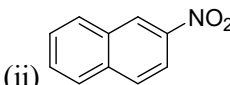
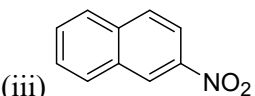
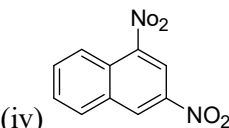
Marks: 100

Time: 3 hr

The figures in the right-hand margin indicate marks

1. Answer all questions.

[10x1=10]

- (a) The order of basicity of among aliphatic amines in aqueous solution is _____
(i) 1^o amines > 2^o amine > 3^o amines (ii) 1^o amines < 2^o amine < 3^o amines
(iii) 2^o amine > 1^o amines > 3^o amines (iv) 2^o amine > 3^o amines > 1^o amines
- (b) The coupling reaction between benzene diazonium salt and phenol reacts best in slightly alkaline medium because _____
(i) It increases the stability of the diazonium ion. (ii) It increases the nucleophilicity of the phenol
(iii) It prevents the formation of by-products. (iv) None of these
- (c) Write the reagent for the reaction. 
(i) KF (ii) CuF (iii) NaCl+HF (iv) HBF₄
- (d) The group that does not produce colour but its presence intensifies the colour of a dye is called _____.
(i) chromophore (ii) auxochrome (iii) primer (iv) mordant
- (e) Which natural dye is present in turmeric?
(i) tartrazine (ii) curcumin (iii) congo red (iv) methyl orange
- (f) Write the product of the reaction. 
(i)  (ii)  (iii)  (iv) 
- (g) The order of aromatic stability among pyrrole, furan and thiophene is _____.
(i) pyrrole > furan > thiophene (ii) furan > pyrrole > thiophene
(iii) furan < pyrrole > thiophene (iv) furan < pyrrole < thiophene
- (h) Which of the following heterocyclic ring is present in DNA and RNA.
(i) Pyrrole (ii) furan (iii) pyridine (iv) pyrimidine
- (i) The class of naturally occurring compounds containing nitrogen containing heterocyclic compounds are called as
(i) alkaloids (ii) terpenoids (iii) steroids (iv) carbohydrates
- (j) Which of the following compound is used as an analgesic agent?
(i) Morphine (ii) quinine (iii) nicotine (iv) isoquinoline

2. Answer all questions.

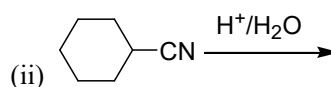
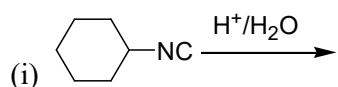
[9x2=18]

- (a) Explain the effect of substituent on the basicity of amines.
- (b) Write the reaction of water with alkyl isocyanates in presence of a base.
- (c) What is Sandmeyer reaction?
- (d) State and explain the role of mordant during dyeing of fabric.
- (e) Comment on the aromaticity of naphthalene. Compare aromatic behaviour of benzene and naphthalene.
- (f) Write the reaction of furan with ammonia in presence of alumina.
- (g) Compare the basicity of pyridine and pyrrole.
- (h) Write the medicinal importance of morphine.
- (i) State and explain isoprene rule.

3. Answer any eight questions.

[8x5=40]

- (a) Write the Hinsberg test used to separate primary, secondary and tertiary amines.
- (b) Write the mechanism of Mannich reaction with a suitable example.
- (c) Write the product of the with mechanism.



- (d) Discuss the synthesis and application of congo red dye.
- (e) Write a note on edible dyes.
- (f) Explain why the electrophilic substitution of anthracene preferably takes place at 9 and 10 position. Give one example.
- (g) Discuss the structure and aromaticity of pyrrole. Write the hybridisation of carbon and nitrogen in pyrrole.
- (h) How can you synthesise furfural from furan? Write any two applications of furfural.
- (i) State and explain Hoffmann's exhaustive methylation. How it is used for structure elucidation of alkaloids.
- (j) Write the synthesis and properties of citral.

4. Answer any four questions.

[4x8=32]

- (a) Write the mechanism of preparation of diazonium salts. Write the coupling reactions of diazonium salt with phenol and aniline.
- (b) Discuss the Paal-Knorr synthesis of thiophene. Explain the electrophilic substitution of thiophene with an example.
- (c) Write the steps involved in dyeing. What are the factors affecting dyeing process?
- (d) Write note on the following.
 - (i) Fischer indole synthesis
 - (ii) Chichibabin reaction
- (e) Write the structure elucidation, synthesis of nicotine. What is the medicinal use of nicotine?

April, 2026

(Conductance, Electrochemistry and Electrical properties of atoms & molecules)

Full Mark: 100

Duration: 3 Hours

(The figures in the right-hand margin indicate marks)

1. All questions are Compulsory.

[10x1=10]

- (a) Define Wien effect.
- (b) State Walden's rule.
- (c) Write down Clausius-Mosotti equation.
- (d) What is the unit of cell constant?
- (e) Write Nernst equation for a single electrode: $M^{n+} + ne^- \rightarrow M$
- (f) At what concentration of ions is $E_{cell} = E_{cell}^0$?
- (g) Define electrochemical equivalent.
- (h) What is the value of 1 Faraday in coulombs?
- (i) The sum of transport numbers of cation and anion is _____.
- (j) The cathode is the electrode at which _____ occurs.

2. All questions are Compulsory.

[9x2=18]

- (a) For the strong electrolytes NaOH, NaCl and BaCl₂, the molar ionic conductances at infinite dilution are 248.1×10^{-4} , 126.5×10^{-4} and 280×10^{-4} S m² mol⁻¹ respectively. Calculate Λ_m^0 for Ba(OH)₂.
- (b) Calculate the pH of a solution for which the [H⁺] is 0.005 gm/lit.
- (c) Explain why E_{cell} becomes zero at equilibrium.
- (d) EMF of cell: Zn | Zn²⁺ (0.01 M) || Cu²⁺ (1.0 M) | Cu is 1.12 V at 25°C. Calculate E_{cell}^0 .
- (e) What is meant by electrochemical series? Explain why Zn reacts with H₂SO₄ to give H₂ but Ag does not?
- (f) Write the cell reaction and calculate E^0 for the cell: Zn | Zn²⁺ (1.0 M) || Fe²⁺ (1.0 M) | Fe³⁺
- (g) The conductivity of 0.20 M solution of KCl at 298 K is 0.0248 S cm⁻¹. Calculate the molar conductivity.
- (h) How much charge is required for the reduction of 1 mol of Al³⁺ to Al?
- (i) Derive the relation between hydrolysis constant K_h , ionisation constant of acid K_a and ionic product of water K_w .

3. Answer any eight of the following questions.

[8x5=40]

- (a) State and explain Kohlrausch law. How this law is used to calculate molar ionic conductance at infinite dilution of weak electrolytes?
- (b) What is potentiometric titration? How do you perform acid-base titration by potentiometrically?
- (c) What is dipole moment? How is dipole moment used to determine geometry and polarisation of molecules?
- (d) What is salt hydrolysis? Derive expressions for hydrolysis constant K_h , degree of hydrolysis h and pH for a salt of strong acid and weak base.
- (e) Distinguish between reversible and irreversible cells with examples.
- (f) Derive an expression of Ostwald's dilution law. Why does this law not hold good for strong electrolytes? The specific conductance of 0.01M CH₃COOH was found to be 0.0163 S m² mol⁻¹ at 25°C. Calculate the degree of dissociation of the acid. (Λ_m^0 of CH₃COOH is 390.7×10^{-4} S m² mol⁻¹).
- (g) How is transport number determined by Hittorf's method. Calculate the transport number of Li⁺ and Br⁻ ions when a current flow an infinite dilute aqueous solution of LiBr at 25°C,

given the ionic mobilities of Li^+ and Br^- ions at infinite dilution are 4.01×10^{-8} and 8.09×10^{-8} $\text{m}^2 \text{V}^{-1} \text{S}^{-1}$ respectively.

- (h) What is the principle of conductometric titration? Discuss the titration curves obtained in the titration of a strong acid with a strong base.
- (i) What is liquid junction potential? Derive an expression for the EMF of electrolyte concentration cell with liquid junction potential. Calculate the liquid junction potential at 25°C between two solutions of HCl having mean ionic activities of 0.01 and 0.001 respectively. (The transference number of H^+ ion (t_+) in HCl is 0.83)
- (j) How is pH determined by using quinhydrone electrode. The cell reaction and EMF for the cell: $\text{Hg}, \text{Hg}_2\text{Cl}_2 \parallel \text{H}^+(\text{Unknown}), \text{Q}, \text{QH}_2$ is 0.26 V at 25°C . Calculate pH of the solution. (Given that $E_{\text{Calomel}}^0 = +0.24$ V and $E_{(\text{H}^+, \text{Q}, \text{QH}_2)}^0 = +0.70$ V)

4. Answer any four of the following questions.

[4x8=32]

- (a) Derive Debye-Huckel Onsager equation for strong electrolytes. Explain the concept of ionic atmosphere, relaxation effect and electrophoretic effect. How does this equation explain the linear decrease of Λ_m with $\sqrt{C}$.

Or

Discuss the variation of molar conductance with dilution for strong and weak electrolytes. Derive the relation $\alpha = \Lambda_m / \Lambda_m^0$ for weak electrolytes. How is dissociation constant of an acid K_a determined conductometrically?

- (b) What are electrolyte concentration cells? Derive expression for the EMFs of electrolyte concentration cells with transference and without transference with suitable example.

Or

What is EMF? How is EMF measurement used to determine ΔG , ΔH and ΔS of a cell reaction and derive the expression $\Delta S = nF(\partial E / \partial T)_P$ & $\Delta H = -nF[E - T(\partial E / \partial T)_P]$.

- (c) What is electrolysis? State and explain Faraday's laws of electrolysis. A solution of molten CaCl_2 is electrolyzed for 5 hours with a current of 2.0 A. Calculate the mass of Ca deposited at the cathode.

Or

What is Nernst equation? Derive an expression for Nernst equation of a Zn-Cu cell. Calculate EMF of the cell $\text{Zn} \mid \text{Zn}^{2+} (0.1\text{M}) \parallel \text{Ag}^+ (0.01\text{M}) \mid \text{Ag}$ at 25°C . Given $E_{\text{Zn}^{2+}/\text{Zn}}^0 = -0.76$ V and $E_{\text{Ag}^+/\text{Ag}}^0 = +0.80$ V. Is the cell reaction spontaneous?

- (d) Define specific, equivalent and molar conductivity. What are their units and how are they related? What is the effect of dilution on them? The resistance of 0.5 N solution of an electrolyte in a conductivity cell was found to be 25 ohms. Calculate the cell constant, conductance, specific conductance and equivalent conductance of the solution, if the electrodes in the cell are 1.6 cm apart and have an area of 3.2 cm^2 .

Or

Describe the electrostatics of dielectric media. Explain the terms dielectric constant, polarization and polarizability. Illustrate with suitable examples.

- (e) Write Notes on (a) Debye-Falkenhagen effect (b) Salt hydrolysis of weak acid and strong base

Or

Write Notes on (a) Polarizability (b) pH by using glass electrode

APRIL, 2026

(Coordination Chemistry, Chemistry of d- and f-block elements, Inorganic Reaction Mechanism and Electron transfer reactions)

Full Mark: 100

Duration: 3 Hours

(The figures in the right-hand margin indicate marks)

1. All questions are Compulsory.

[10x1=10]

- (a) What is the oxidation state of Co in $[\text{Co}(\text{NH}_3)_6\text{Cl}_3]$?
- (b) Define high spin complex.
- (c) What are actinides?
- (d) Give one example of bridging ligand.
- (e) What is meant by labile complex?
- (f) What is the role of conjugate base in $\text{S}_{\text{N}}1\text{CB}$ mechanism?
- (g) Why is $[\text{Ni}(\text{CN})_4]^{2-}$ square planar?
- (h) The number of unpaired electron present in $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$ is _____.
- (i) The metal used as catalyst in the manufacture of H_2SO_4 is _____.
- (j) The most common and stable oxidation state of Lanthanides are _____.

2. All questions are Compulsory.

[9x2=18]

- (a) Write MO configurations of O^2 and N^{2+} . Calculate the bond order of these species.
- (b) Write IUPAC name of: $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]\text{Cl}$ and $\text{K}_3[\text{Fe}(\text{CN})_6]$
- (c) What is EAN rule? Explain with one example.
- (d) How do you synthesize $\text{cis-}[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$ from $[\text{PtCl}_4]^{2-}$?
- (e) Why is $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ colored while $[\text{Ti}(\text{H}_2\text{O})_6]^{4+}$ is colorless?
- (f) Why is $[\text{Ni}(\text{CN})_4]^{2-}$ diamagnetic while $[\text{NiCl}_4]^{2-}$ is paramagnetic?
- (g) What is spectrochemical series? Arrange: H_2O , NH_3 , CN^- , Cl^- in increasing field strength.
- (h) Define ambident ligand with example.
- (i) Among $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ and $[\text{Co}(\text{NH}_3)_6]^{2+}$ which one is more stable and why?

3. Answer any eight of the following questions.

[8x5=40]

- (a) Explain how CFSE affects lattice energy, hydration energy and ionic radii of M^{2+} ions of first transition series.

- (b) Explain the magnetic and spectral properties of $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$ and $[\text{Fe}(\text{CN})_6]^{3-}$ using CFT. Calculate CFSE and magnetic moment for both.
- (c) Draw and explain CFT splitting of d-orbitals in octahedral and tetrahedral fields. Why is $\Delta_t = \frac{4}{9}\Delta_o$.
- (d) Explain Laporte and spin selection rules. Why is d-d transition weak?
- (e) Discuss Jahn-Teller distortion in d^4 high spin and d^7 low spin complexes. Why is $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ tetragonally distorted?
- (f) Discuss S_N1 and S_N2 mechanisms in octahedral substitution reactions.
- (g) What is Lanthanide contraction? What are its consequences?
- (h) Describe the π -bonding theory of trans effect. How does it account for the trans-directing ability of ligands?
- (i) Explain the chelate effect. How does it influence the stability of coordination compounds?
- (j) Explain the role of bridging ligands in electron transfer reactions.

4. Answer any four of the following questions.

[4x8=32]

- (a) Discuss Crystal Field Theory of octahedral and tetrahedral complexes. Compare their crystal field splitting and magnetic properties.

Or

Explain Valence Bond Theory and Crystal Field Theory of coordination compounds. Mention their merits and limitations.

- (b) Discuss the chemistry of Lanthanides, highlighting electronic configuration, oxidation states, magnetic properties and Lanthanide contraction.

Or

Describe the chemistry of Actinides and compare them with Lanthanides.

- (c) Describe the mechanism of substitution reactions in square planar complexes. Discuss associative and dissociative pathways with suitable examples.

Or

Discuss the mechanism of acid hydrolysis of octahedral Co(III) complexes with suitable examples.

- (d) Describe the Marcus-Hush Theory of electron transfer reactions. Discuss the concepts of reorganization energy and activation energy.

Or

Discuss electron transfer reactions in coordination compounds. Explain inner sphere and outer sphere mechanism with suitable examples.

- (e) Write Notes on (a) Anation reaction (b) S_N1CB Mechanism

Or

Write Notes on (a) Complementary redox reaction (b) Magnetic properties of actinides.

APRIL, 2026
FUNDAMENTAL ORGANIC CHEMISTRY

Marks: 100

Time: 3 hr

The figures in the right-hand margin indicate marks

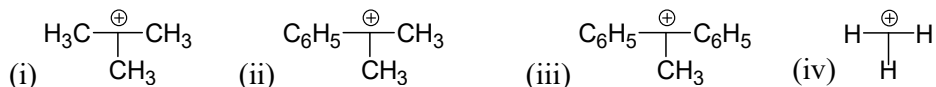
1. Answer all questions.

[10x1=10]

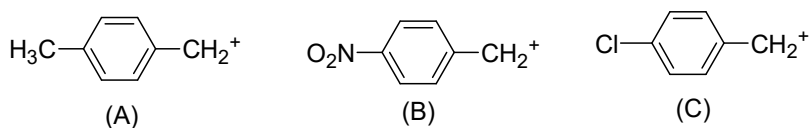
(a) A species that can accept a pair of electrons is called _____

- (i) Free radical (ii) Nucleophile (iii) Electrophile (iv) non-aromatic

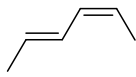
(b) Which of the following carbonium ion is most stable?



(c) The stability order of the following species are given by



- (i) $A > B > C$ (ii) $B < C < A$ (iii) $A < B > C$ (iv) $A < B < C$

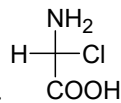
(d) The E & Z configuration of the compound 

- (i) 2 E, 4 E (ii) 2Z, 4Z (iii) 2E, 4Z (iv) 2Z, 4E

(e) Which of the following is not aromatic?

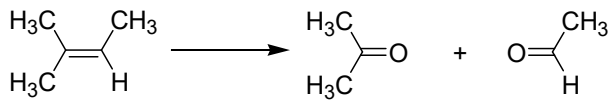


(f) Write the configuration of the compound.



- (i) R (ii) S (iii) Both R & S (iv) E

(g) Write the reagent of the reaction.

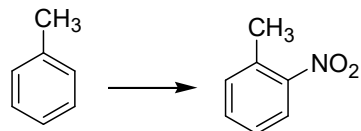


- (i) HNO_3 (ii) $\text{H}^+/\text{H}_2\text{O}$ (iii) $\text{O}_3, \text{Zn}/\text{H}_2\text{O}$ (iv) H_2O_2

(h) The order of stability of carbocation is given by _____.

- (i) $1^\circ > 2^\circ > 3^\circ$ (ii) $1^\circ < 2^\circ > 3^\circ$ (iii) $1^\circ > 2^\circ < 3^\circ$ (iv) $1^\circ < 2^\circ < 3^\circ$

(i) Write the reagent of the following transformation.



- (i) HNO_3 (ii) NaNO_2 (iii) $\text{HNO}_3/\text{H}_2\text{SO}_4$ (iv) None of these

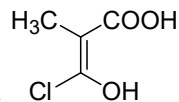
(j) Which of the following is most acidic in nature?

- (i) ClCH_2COOH (ii) Cl_2CHCOOH (iii) Cl_3CCOOH (iv) CH_3COOH

2. Answer all questions.**[9x2=18]**

- (a) Which is stronger acid between phenol and *p*-chloro phenol? Explain.
(b) Discuss the structure and stability of carbocation.

(c)



Write the geometrical configuration of the compounds.

- (d) What are diastereomers?
(e) Write a note on hyperconjugation.
(f) What is Markownikoff's rule? Give one example.
(g) Write one Diels-Alder reaction.
(h) Why benzene undergoes electrophilic reaction although it is an unsaturated compound?
(i) What is role of AlCl_3 in Friedel-craft's reaction?

3. Answer any eight questions.**[8x5=40]**

- (a) Explain SN^1 reaction mechanism with an example.
(b) Explain the structure and stability of carbenes.
(c) State and explain Wurtz-Fittig reaction. Give one example.
(d) Write notes on Bayer strain theory.
(e) The meso compounds do not exhibit optical property although they contain asymmetric carbon. Explain why?
(f) What are the factors affecting E^1 reaction?
(g) Write the hydroxylation of alkenes using alkaline KMnO_4 .
(h) Explain Saytzeff eliminations with a suitable example.
(i) Explain why $-\text{OCH}_3$ group in benzene behave as *ortho* & *para* directing?
(j) What is aromaticity? State and explain Huckel's rule.

4. Answer any four questions.**[4x8=32]**

- (a) Explain the chlorination and nitration of benzene with mechanism.
(b) Explain E^2 reaction mechanism. What are factors influencing E^2 reaction?
(c) Write note on the following.
(i) Electromeric effect
(ii) inductive effect
(d) Define conformational isomer. Explain the conformations and stability of cyclohexane.
(e) (i) State and explain CIP rules.
(ii) Explain cis-trans isomerism with example.
