

Total number of printed pages-8

3 (Sem-4/CBCS) CHE HC 1

2024

CHEMISTRY

(Honours Core)

Paper : CHE-HC-4016

(Inorganic Chemistry-III)

Full Marks : 60

Time : Three hours

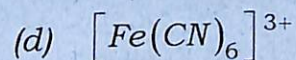
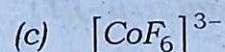
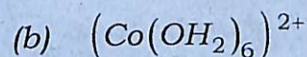
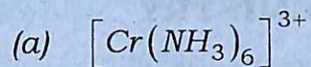
The figures in the margin indicate full marks for the questions.

1. Answer the following : 1×7=7
- (i) In transitional metal complexes the metal acts as
- (a) Lewis acids
 - (b) Lewis bases
 - (c) Neutral compounds
 - (d) Amphoteric compounds
- (Choose the correct answer)*

Contd.

(ii) Which oxidation state of Arsenic is most toxic ?

(iii) In which one of the following species does the transition metal ion have d^3 electronic configuration ?



(Choose the correct answer)

(iv) What are macrocyclic ligands ? Give one example.

(v) Write the general valence shell electronic configuration of group 6 elements of the periodic table.

(vi) In EDTA, total number of chelating rings are

(a) 5

(b) 3

(c) 4

(d) 6

(Choose the correct answer)

(vii) Carbonic anhydrase is a zinc enzyme that catalyses the

(a) hydrolysis of the terminal peptide bond of a peptide chain

(b) hydration of CO_2 and dehydration of carbonic acid

(c) binding of dioxygen to haemoglobin

(d) None of the above processes

(Choose the correct answer)

2. Answer the following :

2×4=8

(i) “ Cu^{2+} ions are coloured and paramagnetic, whereas Zn^{2+} ions are colourless and diamagnetic.” Explain why.

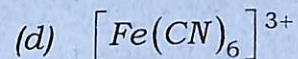
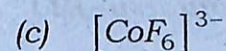
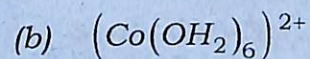
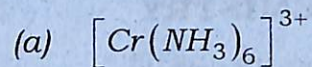
(ii) Draw the geometrical isomers of $[\text{CrCl}_2(\text{en})_2]^{2+}$ and state whether they are optically active or not.

(iii) Write the full name and formula of the ligands whose abbreviations are given below :

dmg, acac, phen, edta

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dmg, acac, phen, edta

(iv) How does Latimer diagram help to examine the thermodynamic feasibility of a species for disproportionation ?

3. Answer **any three** questions from the following : $5 \times 3 = 15$

(i) "Transition metals act as good catalysts". Explain with proper reasons. Write the name of the transition metal which is used as catalyst in the Haber's process for synthesis of ammonia. $4 + 1 = 5$

(ii) Discuss the mechanism of dioxygen binding and release by haemoglobin.

(iii) "Octahedral complexes are more stable and more common than tetrahedral complexes." Explain.

(iv) What is lanthanide contraction ? What causes lanthanide contraction ? Why the lanthanides do not form oxocations ?

(v) Discuss the magnetic character of square planer d^8 complexes with the help of crystal field theory.

4. Answer the following questions : $10 \times 3 = 30$

(i) *Either*

(a) The pairing energy for Mn^{3+} is $28,000 \text{ cm}^{-1}$. The Δ_0 for the complexes $[Mn(H_2O)_6]^{3+}$ and $[Mn(CN)_6]^{3-}$ are $15,800 \text{ cm}^{-1}$ and $38,500 \text{ cm}^{-1}$ respectively. From these values identify the high-spin and low-spin complexes and write the electronic configuration.

3

(b) Describe the preparation of $KMnO_4$ from pyrolusite ore. How does acidified permanganate solution react with the following species ? Write the ionic equation for the reactions. $2 + 3 = 5$

(i) Fe^{2+} ions

(ii) Oxalic acid

(c) "The third ionization enthalpy of manganese is very high." Explain why. 2

Or

(d) Why is the separation of lanthanides difficult? Discuss the ion exchange method for the separation of lanthanides. 2+4=6

(e) "Actinides have greater tendency to form complexes than lanthanides." Explain why. 4

(ii) Either

(a) Explain the origin of Jahn-Teller distortion by crystal field theory. What are the conditions for Jahn-Teller distortion in the tetrahedral and octahedral complexes?

4+1+1=6

(b) Compare the Jahn-Teller distortions in $Ni(II)$ and $Cu(II)$. 2

(c) Explain why

trans- $[Cu(en)_2(H_2O)_2]^{2+}$ is more stable than

cis- $[Cu(en)_2(H_2O)_2]^{2+}$. 2

Or

(d) Write the general mechanisms by which a toxic metal can attack the human body. Give an account of the toxicity due to lead and mercury. 3+2+2=7

(e) "Excess as well deficiency of an essential metal is harmful to human body." Justify the statement with an example. 3

(iii) Either

(a) Assign suitable reasons for the following:

I. The Mn^{2+} compounds are more stable than Fe^{2+} towards oxidation to their +3 state. 2

II. In the 3d series, the enthalpy of atomization of Zn^{2+} is the lowest. 2

III. Sc^{3+} is colourless in aqueous solution whereas Ti^{3+} is coloured. 2

IV. CrO is basic, Cr_2O_3 is amphoteric and CrO_3 is acidic in nature. 2

V. $[Co(NH_3)_6]^{3+}$ is more stable than $[Co(NH_3)_6]^{2+}$. 2

Or

(b) How are essential metals in biological system classified? Mention each class with definition and write the name of each element present in it. 5

(c) What is Na/K pump? Discuss the functioning of Na/K pump. 5

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3 (Sem-4/CBCS) CHE HC 2

2024

CHEMISTRY

(Honours Core)

Paper : CHE-HC-4026

(Organic Chemistry-III)

Full Marks : 60

Time : Three hours

The figures in the margin indicate full marks for the questions.

1. Answer the following questions : $1 \times 7 =$
 - (a) Write *aciform* structure of nitromethane.
 - (b) The aliphatic diazonium compounds are unstable, why ?
 - (c) What is special isoprene rule ?
 - (d) Mention *one* medicinal importance of nicotine.

Cont

- (e) Arrange the following compounds in increasing order of aromatic character :
Thiophene, pyrrole, benzene, furan
- (f) Mention *two* adverse effects of PAN on living organisms.
- (g) What class of alkaloid does nicotine belong to ?

2. Answer **any four** of the following questions :
2×4=8

- (a) Write the products formed in each of the following reactions :
- (i) Cyanoethane is reduced with $LiAlH_4$
- (ii) Nitrobenzene is heated with a mixture of conc. HNO_3 and conc. H_2SO_4
- (b) Mention *two* synthetic applications of diazonium salts with their chemical reactions.
- (c) Explain why Naphthalene gives 1-Naphthalene sulphonic acid at low temperature and 2-Naphthalene sulphonic acid at high temperature.

(d) Write down the different steps involved in Bischler-Napieralski reaction leading to synthesis of isoquinoline.

(e) How can you show that

(i) α -terpineol is a 3° alcohol

(ii) geraniol has *E*-configuration

(f) What product is formed in each case when citral is allowed to react with

(i) $NaOH(aq)$

(ii) $KHSO_4$

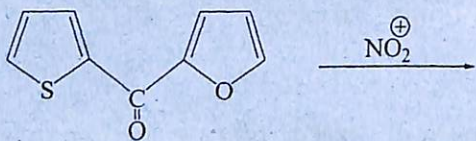
3. Answer **any three** questions from the following :
5×3=15

(a) Mention *two* nitrating agents employed in direct nitration of arenes ? Explain the reaction mechanism of nitration of benzene. The 2,4,6-trinitrophenol is known as Picric acid although it does not contain a carboxyl group — why ?

2+2+1=5

(b) Explain the role of resonance effect on basic properties of aliphatic amines with special reference to isomers of nitroanilines. Explain with appropriate structures, why N,N-dimethylpicramide is more basic than picramide. 3+2=5

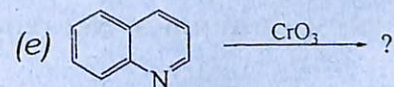
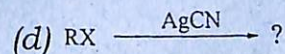
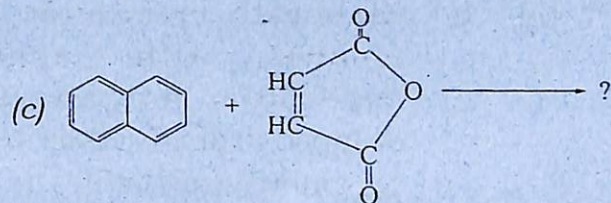
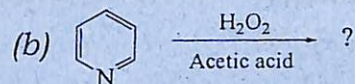
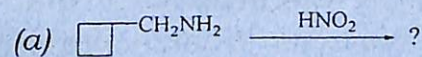
(c) Why does electrophilic substitution of Furan usually take place at C-2 position? Write Paal-Knorr synthesis of Furan. Write the product(s) of the following reaction. (structure and name). 2+2+1=5



(d) Write the different products when anthracene is reacted with the following reactants: 1×5=5

- (i) Sodium in THF
- (ii) Sodium in amyl alcohol
- (iii) Hydrogen gas over Ni
- (iv) $\text{Na}_2\text{Cr}_2\text{O}_7/\text{H}_2\text{SO}_4$
- (v) HNO_3 in glacial acetic acid

(e) Write the product of the following reactions: 1×5=5



4. Answer **any three** questions from the following: 10×3=30

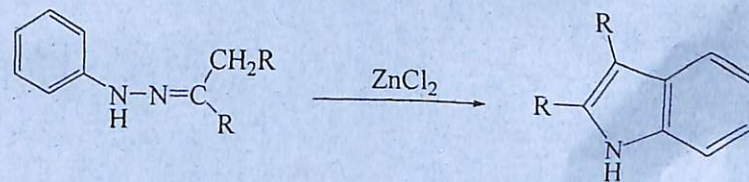
- (a) (i) Discuss the structural difference between nitroalkanes and alkyl nitriles. Discuss how one can be distinguished from the other. Mention *two* chemical tests.

2+3=5

- (ii) Elaborate the mechanism of diazotization of aniline. Mention one application of diazotization reaction. What happens when an aliphatic primary amine is diazotized? $3+1+1=5$
- (b) (i) Elaborate isocyanide test for amines with appropriate mechanism. How can reaction be stopped from further release of poisonous gas? Write the reaction. $3+1+1=5$
- (ii) Why do aliphatic nitro compounds dissolve in aqueous alkali? Write the mechanism of Nef reaction. $2+3=5$
- (c) (i) Explain why the electrophilic substitution in naphthalene takes place mainly at the 1-position? 2
- (ii) How will you prepare 2-nitronaphthalene starting from naphthalene? 2
- (iii) Write Haworth synthesis for phenanthrene. 3

(iv) Explain the peri-hydrogen interaction in particularly in sulphonation of naphthalene. 3

- (d) (i) Give reasons for the following: $2+1+2=5$
- (a) Furan shows Diels-Alder cycloaddition
- (b) Pyrrole readily polymerizes in presence of mineral acids
- (c) Pyridine is less reactive in compare with benzene towards electrophiles.
- (ii) Write the steps involved in the following conversion. Also mention the name of the synthesis. $4+1=5$



- (e) (i) How many carbon atoms are present in sesqui and a diterpene? Write a synthesis of geraniol. What products will be formed on ozonolysis of geraniol? $1+3+1=5$

- (ii) Write *four* general properties of alkaloids. Mention a chemical test that is helpful in structure elucidation of an alkaloid. Draw the structure of nicotine and show how the nature of nitrogen atoms has been established. $2+1+1+1=5$
- (f) (i) Name the type of hygrine alkaloid and its biological source. 2
- (ii) Write *two* medicinal importances each of hygrine and reserpine. $2+2=4$
- (iii) How is cocaine used as medicine? 2
- (iv) What is Emde's modification? 2
-

Total number of printed pages-7

3 (Sem-4/CBCS) CHE HC 3

2024

CHEMISTRY

(Honours Core)

Paper : CHE-HC-4036

(Physical Chemistry-IV)

Full Marks : 60

Time : Three hours

The figures in the margin indicate full marks for the questions.

1. Answer the following questions : $1 \times 7 = 7$

(a) The molar conductance Λ_{NaOAC}° and Λ_{HCl}° at infinite dilution in water at $25^{\circ}C$ are 91.0 and $426.2 \text{ Scm}^2 \text{ mol}^{-1}$ respectively. To calculate Λ_{HOAC}° , the additional value required is

(i) Λ_{NaOH}°

(ii) Λ_{NaCl}°

(iii) $\Lambda_{H_2O}^{\circ}$

(iv) Λ_{KCl}°

(Choose the correct answer)

Contd.

- (b) Define specific conductance.
(c) What is Ostwald's Dilution Law ?
(d) The pH of an aqueous solution is 4. Its

$[OH^-]$ is

- (i) 10
(ii) 10^{-4}
(iii) 10^{-10}
(iv) 10^{-14}

(Choose the correct answer)

- (e) Define Debye-Falkenhagen effect.
(f) Which of the following molecule would have zero dipole moment ?

- (i) NH_3
(ii) *m*-dichlorobenzene
(iii) CH_3Cl
(iv) *p*-dichlorobenzene

(Choose the correct answer)

- (g) The relative permeability $\mu_r > 1$ stands for

- (i) Paramagnetic solids
(ii) Diamagnetic solids
(iii) Ferromagnetic solids

- (iv) None of the above

(Choose the correct answer)

2. Answer the following questions : $2 \times 4 = 8$

(a) Explain the variation of molar conductance with dilution for weak electrolyte.

(b) Name *two* types of concentration cells.

(c) How can dissociation constant of weak acid be determined from the measurement of conductance ?

(d) Differentiate between paramagnetic and diamagnetic substances in terms of magnetic permeability and magnetic susceptibility.

3. Answer **any three** questions from the following : $5 \times 3 = 15$

(a) What is meant by transport number of an ion ? How is it determined by moving boundary method ? $1 + 4 = 5$

(b) Explain saturated calomel electrode with the reactions when it is acting as anode and cathode as well.

- (c) At 25 °C, the specific conductance of carefully distilled water is $58.0 \times 10^{-7} \text{ Sm}^{-1}$ and λ_m° values for H^+ and OH^- ions are 349.8×10^{-4} and $198.5 \times 10^{-4} \text{ Sm}^2 \text{ mol}^{-1}$ respectively. Calculate the ionic product of water at 25°C. [Assume that λ_m differs very little from λ_m°]
- (d) Derive the relation between standard EMF and equilibrium constant of a cell reaction. The standard EMF of the cell $Zn(s) + Cu^{2+}(aq) \rightleftharpoons Zn^{2+}(aq) + Cu(s)$ is 1.10 volts. Calculate the equilibrium constant of the cell reaction. Prove whether the reaction is feasible or not.
- (e) What is magnetic susceptibility? Explain Gouy's method for the measurement of magnetic susceptibility.

$$2+2+1=5$$

$$1+4=5$$

4. Answer **any three** questions from the following: $10 \times 3 = 30$
- (a) Discuss Debye-Hückel theory of strong electrolytes. Explain relaxation effect and electrophoretic effect. How can Debye-Hückel-Onsager equation be utilized in the determination of equivalent conductance at infinite dilution for strong electrolytes. $3+4+3=10$
- (b) Write the principle of conductometric titrations. Draw and explain the titration curves obtained in the conductometric titration of
- (i) HCl with $NaOH$
- (ii) CH_3COOH with $NaOH$
- (iii) CH_3COOH with NH_4OH and
- (iv) $AgNO_3$ with KCl $2+2+2+2=10$
- (c) Explain the construction and working of glass electrode for the determination of pH of a solution using this electrode. What are the limitations of a glass electrode? $8+2=10$

(d) Derive Nernst equation for the measurement of EMF of an electrochemical cell.

Consider an electrochemical cell



- (i) Write the cell reaction
- (ii) Calculate the EMF of the cell
- (iii) Calculate ΔG° value of the cell reaction.

Given that $E^\circ_{Cd^{2+}|Cd} = -0.40V$

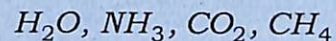
$$E^\circ_{Fe^{2+}|Fe} = -0.44V$$

why does a cell stops working after some time ? Explain with an example.

$$3+1+2+2+2=10$$

- (e) (i) What is molecular polarizability ?
- (ii) Derive the Clausius-Mossotti equation.
- (iii) Define induced molar polarization.

(iv) Which of the following molecules obey Clausius-Mossotti equation ?



$$2+5+1+2=10$$

(f) (i) How can you apply dipole moment of a molecule to calculate percentage ionic character of the molecule and to predict the shapes of molecules ?

(ii) The dipole moment of $NH_3(g)$ is 1.46D and the bond angle HNH is 108° . Calculate the bond moment of the $N-H$ bond.

(iii) How do you explain that the dipole moment of ethylchloride is considerably larger than that of chlorobenzene ?

$$6+2+2=10$$