Date: 27/02/2025

Question Paper Code

56/1/3

Aakash

Medical | IIT-JEE | Foundations

***Corporate Office*:** Aakash Educational Services Limited,
3rd Floor, Incuspaze Campus-2, Plot No. 13, Sector-18, Udyog Vihar, Gurugram, Haryana - 122015

Time: 3 hrs.

Class-XII

Max. Marks: 70

CHEMISTRY (Theory)

(CBSE 2025)

GENERAL INSTRUCTIONS

Read the following instructions very carefully and strictly follow them:

(i) This question paper contains **33** questions. **All** questions are compulsory.

(ii) Question paper is divided into **FIVE** sections – Sections **A**, **B**, **C**, **D** and **E**.

(iii) **In Section – A :** Question Nos. **1** to **16** are Multiple Choice (MCQ) type questions, carrying **1** mark each.

(iv) **In Section – B :** Question Nos. **17** to **21** are Very Short Answer (VSA) type questions, carrying **2** marks each.

(v) **In Section – C :** Question Nos. **22** to **28** are Short Answer (SA) type questions, carrying **3** marks each.

(vi) **In Section – D :** Question Nos. **29** and **30** are Case-Based questions, carrying **4** marks each.

(vii) **In Section – E :** Question Nos. **31** to **33** are Long Answer (LA) type questions, carrying **5** marks each.

(viii) There is no overall choice. However, an internal choice has been provided in few questions in all the sections except Section A.

You have to attempt only one of the choices in such questions.

(ix) Use of calculators is **NOT** allowed.

SECTION-A

Questions No. **1** to **16** are Multiple Choice type questions carrying **1** mark each.

1. Standard electrode potential for Sn^{4+}/Sn^{2+} couple is +0.15 V and that for the Cr^{3+}/Cr couple is –0.74 V. The two couples in their standard states are connected to make a cell. The cell potential will be

(A) +1.19 V (B) +0.89 V

(C) +0.18 V (D) +1.83 V

Answer (B)

Sol. Cell notation $Cr|Cr^{3+}| |Sn^{4+}|Sn^{2+}$

$$E^0_{cell} = E^0_{Cr/Cr^{3+}} + E^0_{Sn^{4+}/Sn^{2+}}$$

$$= 0.74 + 0.15$$

$$= 0.89 \text{ V}$$

2. The magnetic moment is associated with its spin angular momentum and orbital angular momentum. Spin only magnetic moment value of Cr^{3+} ion (Atomic number : Cr = 24) is _____.

(A) 2.87 B.M. (B) 3.87 B.M.

(C) 3.47 B.M. (D) 3.57 B.M.

Answer (B)

Sol. μ, spin angular momentum = $\sqrt{n(n+2)}$. B.M. Electronic configuration of Cr^{3+} = [Ar] $3d^3$

Number of unpaired electrons = 3

$\mu = \sqrt{3\times5} = \sqrt{15}$ B.M. = 3.87 B.M.

3. In case of association, abnormal molar mass of solute will

(A) increase (B) decrease

(C) remain same (D) first increase and then decrease

Answer (A)

Sol. Due to association, molar mass of substance increases

4. Alkyl halides undergoing nucleophilic bimolecular substitution reaction involve

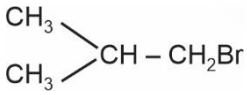
(A) retention of configuration (B) formation of racemic mixture

(C) inversion of configuration (D) formation of carbocation

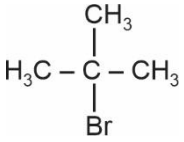
Answer (C)

Sol. In nucleophilic bimolecular substitution reaction inversion of configuration takes place.

5. Arrange the following compounds in increasing order of their boiling points :

(i) 

(ii) $CH_3CH_2CH_2CH_2Br$

(iii) 

The correct order is

(A) (ii) < (i) < (iii) (B) (i) < (ii) < (iii)

(C) (iii) < (i) < (ii) (D) (iii) < (ii) < (i)

Answer (C)

Sol. Among isomeric haloalkenes, with the increase in branching, Vander wall force of attraction decreases and boiling point decreases.

So correct is (iii) < (i) < (ii)

6. The correct IUPAC name of $[Pt(NH_3)_2Cl_2]^{2+}$ is

(A) Diamminedichloridoplatinum (II)

(B) Diamminedichloridoplatinum (IV)

(C) Diamminedichloridoplatinum (0)

(D) Diamminedichloridoplatinate (IV)

Answer (D)

Sol. $[Pt(NH_3)_2Cl_2]^{2+}$

Diamminedichloridoplatinum (IV)

Oxidation state of Pt is +4

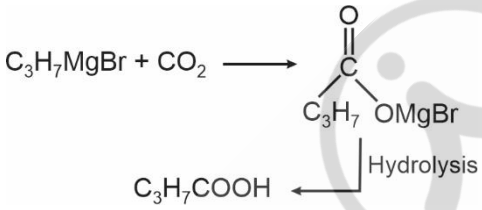
7. The acid formed when propyl magnesium bromide is treated with CO_2 followed by acid hydrolysis is:

(A) C_3H_7COOH (B) C_2H_5COOH

(C) CH_3COOH (D) C_3H_7OH

Answer (A)

Sol.



8. Acidified $KMnO_4$ oxidises sulphite to

(A) $S_2O_3^{2-}$ (B) $S_2O_8^{2-}$

(C) $SO_2(g)$ (D) SO_4^{2-}

Answer (D)

Sol. In acidic medium $KMnO_4$ oxidises SO_3^{2-} to SO_4^{2-}

9. Which is the correct order of acid strength from the following ?

(A) $C_6H_5OH > H_2O > ROH$ (B) $C_6H_5OH > ROH > H_2O$

(C) $ROH > C_6H_5OH > H_2O$ (D) $H_2O > C_6H_5OH > ROH$

Answer (A)

Sol. Phenol is more acidic than water. Aliphatic alcohols are less acidic than water.

So, correct order of acidic strength is $C_6H_5OH > H_2O > ROH$

10. An unripe mango placed in a concentrated salt solution to prepare pickle, shrivels because _____.

(A) it gains water due to osmosis (B) it loses water due to reverse osmosis

(C) it gains water due to reverse osmosis (D) it loses water due to osmosis

Answer (D)

Sol. Concentrated salt solution is hypertonic so unripe mango loses water due to osmosis.

11. The best reagent for converting propanamide into propanamine is _____.

(A) excess H_2

(B) Br_2 in aqueous NaOH

(C) iodine in the presence of red phosphorus

(D) $LiAlH_4$ in ether

Answer (D)

Sol. $CH_3 - CH_2 - \overset{\overset{O}{\|}}{C} - NH_2 \xrightarrow[Ether]{LiAlH_4} CH_3\,CH_2\,CH_2\,NH_2$

12. Which of the following statements is not true about glucose?

(A) It is an aldohexose.

(B) On heating with HI it forms n-hexane.

(C) It exists in furanose form.

(D) It does not give Schiff's test.

Answer (C)

Sol. Glucose exist in pyranose form.

For questions number **13** to **16**, two statements are given - one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below:

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false, but Reason (R) is true.

13. **Assertion (A):** All naturally occurring α-amino acids except glycine are optically active.

Reason (R): Most naturally occurring amino acids have L-configuration.

Answer (B)

Sol. All naturally occurring α-amino acids except glycine are optically active is correct.

Most naturally occurring amino acids have L-configuration is correct.

But Reason is not the correct explanation as optical activity is due to absence of symmetry elements.

14. **Assertion (A):** The boiling point of ethanol is higher than that of methoxymethane.

Reason (R): There is intramolecular hydrogen bonding in ethanol.

Answer (C)

Sol. Ethanol forms intermolecular hydrogen bonding so ethanol has higher boiling point than methoxymethane.

15. **Assertion (A):** The boiling points of alkyl halides decrease in the order:

RI > RBr > RCl > RF.

Reason (R): The boiling points of alkyl chlorides, bromides and iodides are considerably higher than that of the hydrocarbon of comparable molecular mass.

Answer (B)

Sol. RI > RBr > RCl > RF

Order in boiling point is due to decreasing size and mass of halogen atom, the magnitude of Vander wall forces decreases.

16. **Assertion (A):** $[Cr(H_2O)_6]Cl_2$ and $[Fe(H_2O)_6]\,Cl_2$ are examples of homoleptic complexes.

Reason (R): All the ligands attached to the metal are the same.

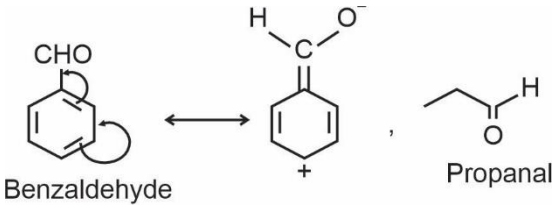
Answer (A)

Sol. Homoleptic complexes have same ligands to the metal.

SECTION-B

17. Would you expect benzaldehyde to be more reactive or less reactive in nucleophilic addition reactions than propanal? Justify your answer. **[2]**

Sol.



Benzaldehyde , Propanal

In benzaldehyde, due to resonance, the carbonyl group is not that much electrophilic. We can say that, in benzaldehyde electrophilicity decreases. Hence, lesser will be the rate of nucleophilic addition reaction in benzaldehyde as compared to propanal.

18. Complete and balance the following chemical equations : **[2]**

(a) $8MnO_4^- + 3S_2O_3^{2-} + H_2O \longrightarrow$

(b) $Cr_2O_7^{2-} + 3\ Sn^{2+} + 14H^+ \longrightarrow$

Sol. (a) $MnO_4^- + S_2O_3^{2-} + H_2O \longrightarrow MnO_2 + SO_4^{2-} + \overline{O}H$

On balancing,

Oxidation half: $\left[\overset{(+2)}{S_2O_3^{2-}} \longrightarrow \overset{(+6)}{2SO_4^{2-}} + 8e^-\right] \times 3$

Reduction half: $\left[\overset{(+7)}{Mn\,O_4^-} + 3e^- \longrightarrow \overset{(+4)}{Mn\,O_2}\right] \times 8$

On adding;

Net reaction: $8MnO_4^- + 3S_2O_3^{2-} + H_2O \longrightarrow 6SO_4^{2-} + 8MnO_2 + 2OH^-$

(b) $Cr_2O_7^{2-} + Sn^{2+} + H^+ \longrightarrow Sn^{4+} + Cr^{3+} + H_2O$

Balancing of reaction:

Oxidation half: $\left[Sn^{2+} \longrightarrow Sn^{4+} + 2e^-\right] \times 3$

Reduction half: $Cr_2O_7^{2-} + 6e^- \longrightarrow 2Cr^{3+}$

On adding, and in acidic medium,

$Cr\,O_7^{2-} + 3Sn^{2+} + 14H^+ \longrightarrow 3Sn^{4+} + 2Cr^{3+} + 7H_2O$

19. (A) Give reasons : **[1 + 1 = 2]**

(a) Cooking is faster in pressure cooker than in an open pan.

(b) On mixing liquid X and liquid Y, volume of the resulting solution decreases. What type of deviation from Raoult's law is shown by the resulting solution ? What change in temperature would you observe after mixing liquids X and Y ?

OR

(B) Define Azeotrope. What type of Azeotrope is formed by negative deviation from Raoult's law? Give an example. **[2]**

Sol. (A) (a) In pressure cooker, cooking is faster because the boiling point of water increases on increase pressure which allow the food to cook at higher temperature in a short period of time.

(b) On mixing liquid X and liquid Y, volume decreases means attraction between X & Y increases so, vapour pressure of XY (resulting solution) is less as compared to individual vapour pressure of X and Y. Hence, resulting solution show negative deviation from Raoult's law and this is exothermic reaction, ΔH = –ve, causing the temperature increase after mixing.

OR

(B) The binary mixture having same composition in liquid and vapour phase and boil at a constant temperature are known as azeotropes.

It is not possible to separate the components by factional distillation.

There are two types of azeotropes

(1) Minimum boiling Azeotrope

(2) Maximum boiling Azeotrope.

The solutions that show large negative deviation from Raoult's law form maximum boiling azeotrope at a specific composition.

Example : 68% HNO_3 and 32% H_2O by mass is an example of maximum boiling azeotrope.

20. Identify A and B in each of the following reaction sequence : **[1 + 1 = 2]**

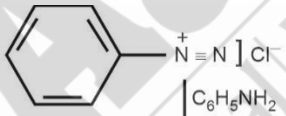
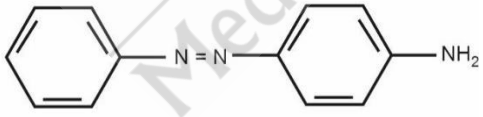
(a) $CH_3CH_2Cl \xrightarrow{NaCN} A \xrightarrow{H_2/Ni} B$

(b) $C_6H_5NH_2 \xrightarrow[0-5°C]{NaNO_2/HCl} A \xrightarrow[H^+]{C_6H_5NH_2} B$

Sol. (a) $CH_3CH_2Cl \xrightarrow{NaCN} \underset{(A)}{CH_3CH_2CN} \xrightarrow{H_2/Ni} \underset{(B)}{CH_3CH_2CH_2NH_2}$

$(A) \equiv CH_3CH_2CN$

$(B) \equiv CH_3CH_2CH_2NH_2$

(b) $C_6H_5NH_2 \xrightarrow[0-5°C]{NaNO_3/HCl}$  $\xrightarrow[H^+]{C_6H_5NH_2}$ 

(p-aminoazobenzene)
(azo – dye)
(Yellow-dye)

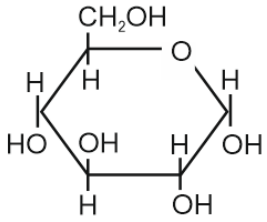
21. What are the hydrolysis products of:

(a) Sucrose

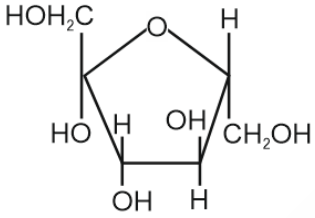
(b) Lactose

Sol. (a) On hydrolysis of sucrose it yields equimolar mixture of D(+)-glucose and D-(–) fructose.

$$\underset{\text{Sucrose}}{C_{12}H_{22}O_{11}} + H_2O \longrightarrow \underset{\text{D(+)-Glucose}}{C_6H_{12}O_6} + \underset{\text{D–(–) fructose}}{C_6H_{12}O_6}$$

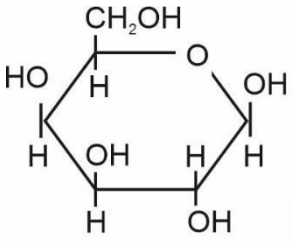


(α-D-Glucose)

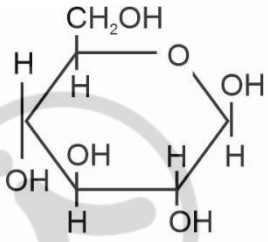


(β-D-Fructose)

(b) On hydrolysis of lactose, it yields β-D-galactose and β-D-glucose



(β-D-Galactose)



(β-D-Glucose)

SECTION-C

22. Henry's law constant for CO_2 in water is 1.67×10^8 Pa at 298 K. Calculate the number of moles of CO_2 in 500 ml of soda water when packed under 2.53×10^5 Pa at the same temperature. **[3]**

Sol. $k_H = 1.67 \times 10^8$ Pa

Moles CO_2 = ?

$P = 2.53 \times 10^5$ Pa

$P = k_H \chi$

$2.53 \times 10^5 = 1.67 \times 10^8 \text{ Pa} \times \chi$

$$\chi = \frac{2.53 \times 10^5 \text{ Pa}}{1.67 \times 10^8 \text{ Pa}} = 1.515 \times 10^{-3}$$

$= 0.00152$

Mass of H_2O = 500 g

$$\text{Moles } H_2O = \frac{500}{18} = 27.78 \text{ moles}$$

Moles of $CO_2 = 0.00152 \times 27.78$

$= 0.042$ moles

23. Calculate $\Delta_r G°$ and K_C of the reaction. **[3]**

$2Cr(s) + 3Cd^{2+}(aq) \rightarrow 2Cr^{3+}(aq) + 3Cd(s)$

Given $E^\circ_{Cr^{3+}/Cr} = -0.74$ V

$E^\circ_{Cd^{2+}/Cd} = -0.40$ V

[R = 8.314 J K^{-1} mol^{-1}, F = 96500 C mol^{-1}]

Sol. $E^{\circ}_{cell} = E^{\circ}_{(Cd^{2+}/Cd)} - E^{\circ}_{(Cr^{3+}/Cr)}$

$= -0.40\ V - (-0.74\ V)$

$= -0.40\ V + 0.74\ V$

$= 0.34\ V$

$\Delta G^{\circ} = -nF\,E^{\circ}_{cell}$

$= -6 \times 96500 \times 0.34$

$= 196.860\ kJ\ mol^{-1}$

$$E^{\circ}_{cell} = \frac{2.303\,RT}{nF}\log k_c$$

$$= \frac{0.059\ V}{n}\log k_c$$

$$0.34\ V = \frac{0.059}{6}\log k_c$$

$$\log k_c = \frac{2.04}{0.059} = 34.5763$$

$k_c = 10^{0.5763} \times 10^{34}$

$= 3.769 \times 10^{34}$

24. The rate of a reaction quadruples when the temperature changes from 293 K to 313 K. Calculate the energy of activation of the reaction assuming that it does not change with temperature. **[3]**

[Given : log 4 = 0.602, log 2 = 0.301, R = 8.314 J K^{-1} mol^{-1}]

Sol. $$\log\frac{k_2}{k_1} = \frac{Ea}{2.303\,R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$

$$\log\frac{r_2}{r_1} = \frac{Ea}{2.3 \times R}\left[\frac{1}{293} - \frac{1}{313}\right]$$

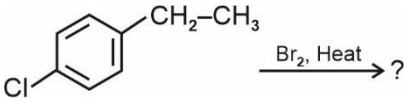
$$\log\frac{4r}{r} = \frac{Ea}{2.3 \times 8.314}\left[\frac{313-293}{313\times 293}\right]$$

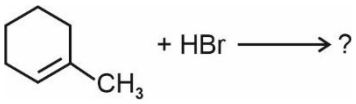
$$0.6020 = \frac{Ea}{19.147}\left[\frac{20}{91709}\right]$$

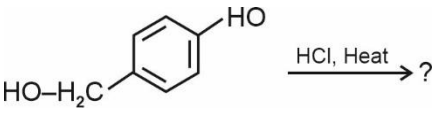
$$Ea = \frac{0.602 \times 19.15 \times 91709}{20}$$

$= 52.862\ kJ$

25. (A) Draw the structure of the major monohalo product for each of the following reaction : **[1 + 1 + 1 = 3]**

(a) 

(b) 

(c) 

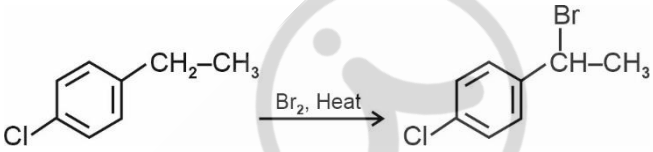
OR

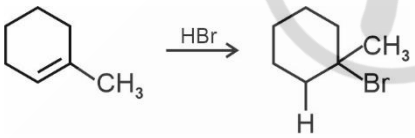
(B) How do you convert : **[3 × 1 = 3]**

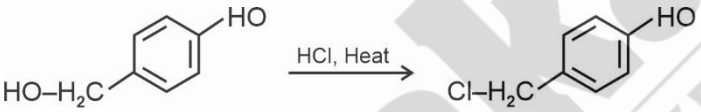
(a) Chlorobenzene to biphenyl

(b) Propene to 1-Iodopropane

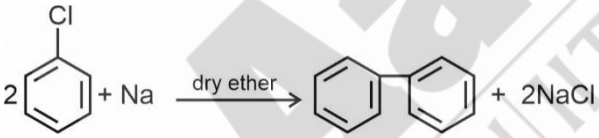
(c) 2-bromobutane to but-2-ene

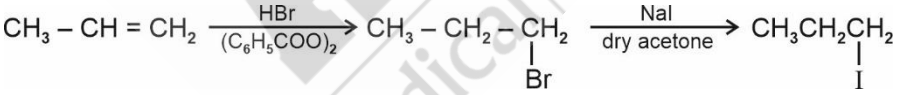
Sol. (A) (a) 

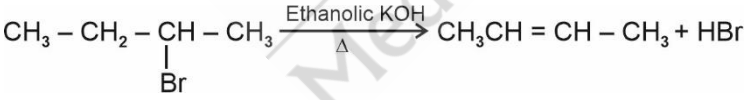
(b) 

(c) 

OR

(B) (a) 

(b) 

(c) 

26. The elements of 3d transition series are given as : **[1 + 1 + 1 = 3]**

Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn

Answer the following :

(a) Copper has exceptionally positive $E^{o}_{M^{2+}/M}$ value, why ?

(b) Which element is a strong reducing agent in +2 oxidation state and why?

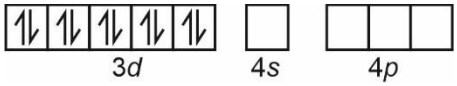
(c) Zn^{2+} salts are colourless. Why?

Sol. (a) Cu^{2+}/Cu has a high positive electrode potential as it has high enthalpy of atomisation (339 kJ mol^{-1}) and very low enthalpy of hydration (–2121 kJ mol^{-1}).

$\therefore$ In (+2) oxidation states it behaves as a good oxidising agent and gets reduced to stable Cu.

(b) Cr^{2+} is a reducing agent as its configuration changes from d^4 to d^3 in Cr^{3+}.

(c) Electronic configuration of Zn^{2+} = $[Ar]3d^{10}4s^0$



No unpaired electrons

$\therefore$ Colourless

27. (a) Arrange the following compounds in increasing order of their boiling point : **[1 + 2 = 3]**

$(CH_3)_2NH$, $CH_3CH_2NH_2$, CH_3CH_2OH

(b) Give plausible explanation for each of the following :

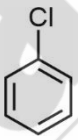
(i) Aromatic primary amines cannot be prepared by Gabriel Phthalimide synthesis

(ii) Amides are less basic than amines

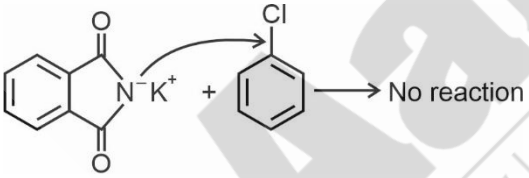
Sol. (a) Order of boiling point of the given compounds :

$CH_3CH_2OH > CH_3CH_2NH_2 > (CH_3)_2NH$

As, Alcohol is having stronger intermolecular hydrogen bonding as compared to amines.

(b) (i) This is because, the substate needed to react must be 

S_N2 reaction is difficult here due to partial double bond character in C–Cl bond



(ii) Amides are less basic than amines because in amides, lone pairs present on the nitrogen is in resonance with the carbonyl group, which decreases the basicity of the group.

28. Define the following terms : **[3]**

(a) Native protein

(b) Nucleotide

(c) Essential amino acid

Sol. (a) Protein found in a biological system with a unique three-dimensional structure and biological activity is called a native protein. **[1]**

(b) A unit formed by the attachment of a base to 1'-position of sugar is known as nucleoside. When nucleoside is linked to phosphoric acid at 5'-position of sugar moiety then nucleotide is formed. **[1]**

(c) The amino acids, which can not be synthesised in the body, and must be obtained through diet, are known as essential amino acids. **[1]**

SECTION-D

The following questions are case based questions. Read the passage carefully and answer the questions that follow.

29. The rate of a chemical reaction is expressed either in terms of decrease in the concentration of reactants or increase in the concentration of a product per unit time. Rate of the reaction depends upon the nature of reactants, concentration of reactants, temperature, presence of catalyst, surface area of the reactants and presence of light. Rate of reaction is directly related to the concentration of reactant. Rate law states that the rate of reaction depends upon the concentration terms on which the rate of reaction actually depends, as observed experimentally. The sum of powers of the concentration of the reactants in the Rate law expression is called order of reaction while the number of reacting species taking part in an elementary reaction which must collide simultaneously in order to bring about a chemical reaction is called molecularity of the reaction.

Answer the following questions :

(a) (i) What is a rate determining step ? **[1 + 1 = 2]**

(ii) Define complex reaction.

(b) What is the effect of temperature on the rate constant of a reaction ? **[1]**

OR

(b) Why is molecularity applicable only for elementary reactions whereas order is applicable for elementary as well as complex reactions ? **[1]**

(c) The conversion of molecule X to Y follows second order kinetics. If concentration of X is increased 3 times, how will it affect the rate of formation of Y? **[1]**

Sol. (a) (i) The overall rate of the reaction is controlled by the slowest step in a reaction called the rate determining step. **[1]**

(ii) Complex reactions are those reactions which involve more than three molecules in the stoichiometric equation and take place in more than one step. **[1]**

(b) For a chemical reaction with rise in temperature by 10°, the rate constant is nearly doubled **[½]**

$k = Ae^{-E_a/RT}$ **[½]**

OR

(b) Molecularity of reaction is the number of reacting species taking part in an elementary reaction, which must collide simultaneously in order to bring about a chemical reaction. **[½]**

While order of reaction is an experimental quantity and it is determined by knowing rate determining step of reaction which is slowest step. **[½]**

(c) $r = k[x]^2$

$r_{New} = k[3x]^2$ **[½]**

$$\frac{r}{r_{New}} = \frac{k[x]^2}{k[9x^2]}$$

Hence, $r_{New} = 9r$ **[½]**

30. Phenols undergo electrophilic substitution reactions readily due to the strong activating effect of OH group attached to the benzene ring. Since, the OH group increases the electron density more to o– and p– positions therefore OH group is ortho, para-directing. Reimer-Tiemann reaction is one of the examples of aldehyde group being introduced on the aromatic ring of phenol, ortho to the hydroxyl group. This is a general method used for the ortho-formylation of phenols.

Answer the following questions:

(a) What happens when phenol reacts with **[2]**

(i) Br_2/CS_2

(ii) Conc. HNO_3

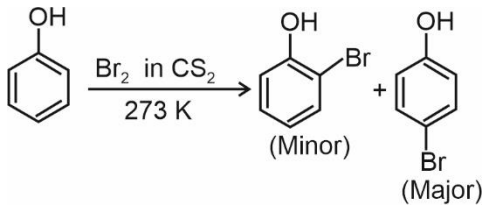
(b) Why phenol does not undergo protonation readily? **[1]**

(c) Which is a stronger acid - phenol or cresol? Give reason. **[1]**

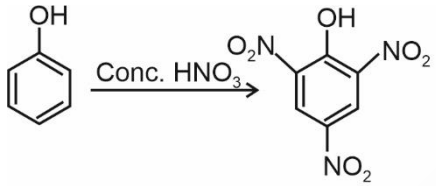
OR

(c) Write the IUPAC name of name of the product formed in the Reimer-Tiemann reaction. **[1]**

Sol. (a) (i)



(ii)



2, 4, 6-Trinitrophenol
(Picric acid)

(b) Phenol does not undergo protonation readily because the lone pair on oxygen atom is in conjugation with benzene ring so it is not available for protonation. **[1]**

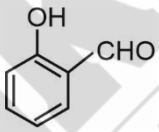
(c) Cresol is less acidic than phenol because methyl group is electron releasing group and it does not favour the formation of phenoxide ion resulting in decrease in acidic strength.

	pK_a value
Phenol	10.0
o-cresol	10.2

[1]

OR

(c) Product formed in Reimer-Tiemann reaction is



[1/2]

It's IUPAC name is 2-Hydroxybenzaldehyde **[1/2]**

SECTION-E

31. (A) (a) Carry out the following conversions: **[2 + 3 = 5]**

(i) Ethanal to But-2-enal

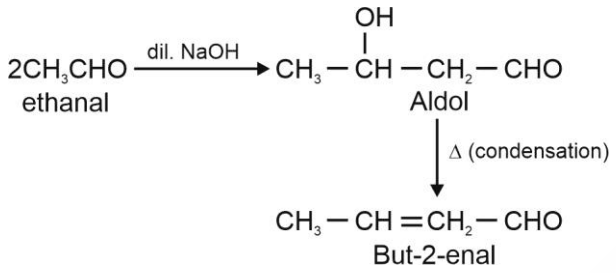
(ii) Propanoic acid to ethane

(b) An alkene A with molecular formula C_5H_{10} on ozonolysis gives a mixture of two compounds B and C. Compound B gives positive Fehling test and also reacts with iodine and NaOH solution. Compound C does not give Fehling solution test but forms iodoform. Identify the compounds A, B and C.

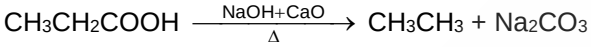
OR

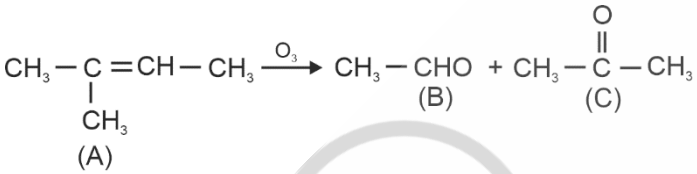
31. (B) An organic compound (A) (molecular formula $C_8H_{16}O_2$) was hydrolysed with dilute sulphuric acid to get a carboxylic acid (B) and an alcohol (C). Oxidation of (C) with chromic acid produced (B). (C) on dehydration gives But-1-ene. Identify (A), (B) and (C) and write chemical equations for the reactions involved. **[5]**

Sol. (A) (a) (i) Ethanal to But-2-enal



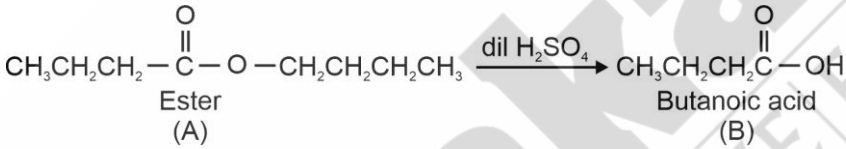
(ii) Propanoic acid to ethane

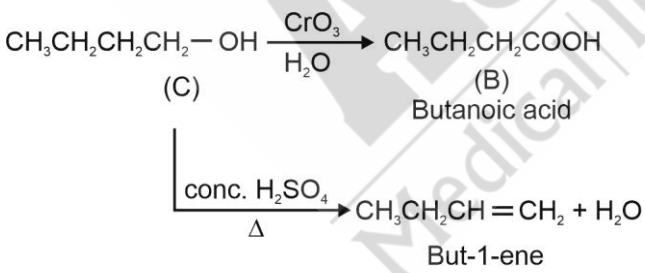


(b) 

- CH_3CHO gives positive Fehling test and also gives iodoform test with I_2 and NaOH
- Acetone CH_3COCH_3 does not give Fehling test but gives iodoform test

OR

(B) 



32. (A) In the following complex ions, explain the type of hybridisation, shape and magnetic property:

[2½ × 2 = 5]

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

(b) $[NiCl_4]^{2-}$

(At. Nos. : Fe = 26, Ni = 28)

OR

32. (B) (a) Write IUPAC names of the following: **[3 + 2 = 5]**

(i) $[Co(H_2O)(CN)(en)_2]^{2+}$

(ii) $[PtCl_4]^{2-}$

(iii) $[Cr(NH_3)_4Cl(ONO)]^{+}$

(b) What is spectrochemical series? Write the difference between a strong field ligand and a weak field ligand.

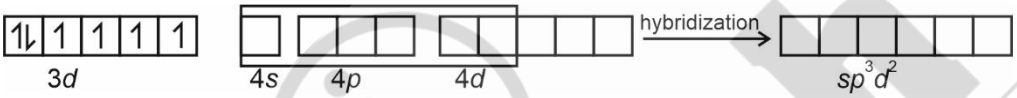
Sol. (A) (a) $[Fe(H_2O)_6]^{2+}$

Oxidation state of Fe = +2

$Fe^{2+} = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6$

H_2O is a weak field ligand.

$3d^6\ 4s^0$



Hybridization → sp^3d^2

Shape → Octahedral

Paramagnetic in nature.

(b) $[NiCl_4]^{2-}$

Oxidation state of Ni = +2

$Ni^{2+} \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^0\ 3d^8$

Cl → Weak field ligand

Hybridization → sp^3

Shape → Tetrahedral

Magnetic nature → Paramagnetic

OR

(B) (a) IUPAC Names

(i) $[Co(H_2O)(CN)(en)_2]^{2+}$

Aquacyanidobis (ethane-1,2-diamine) cobalt (III) ion

(ii) $[PtCl_4]^{2-}$

Tetrachloridoplatinate (II) ion

(iii) $[Cr(NH_3)_4Cl(ONO)]^{+}$

Tetramminechloridonitrito –O chromium (III)ion

(b) Spectrochemical series → Arrangement of ligands in a series in the order of increasing field strength is known as spectrochemical series.

	Strong field ligand		Weak field ligand
1.	Strong field ligand causes more splitting of *d*-orbitals.	1.	Weak field ligand causes less splitting of *d*-orbital.

33. (A) (a) Write the cell reaction and calculate the e.m.f. of the following cell at 298 K: **[3 + 2 = 5]**

$Sn(s)|Sn^{2+}(0.004\ M)\ ||\ H^+(0.02\ M)\ |\ H_2(g)\ (1\ Bar)\ |\ Pt(s)$

(Given $E^0_{Sn^{2+}/Sn} = -0.14\ V, E^0_{H^+|H_2(g),pt} = 0.00\ V$)

(b) Account for the following ;

(i) On the basis of E^0 values, O_2 gas should be liberated at anode but it is Cl_2 gas which is liberated in the electrolysis of aqueous NaCl.

(ii) Conductivity of CH_3COOH decreases on dilution.

OR

33. (B) (a) Write the anode and cathode reactions and the overall cell reaction occurring in a lead storage battery during its use**.** **[2 + 3 = 5]**

(b) Calculate the potential for half-cell containing 0.01 M $K_2Cr_2O_7(aq)$, 0.01 M $Cr^{3+}(aq)$ and 1.0×10^{-4} M $H^+(aq)$.

The half cell reaction is

$$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \longrightarrow 2Cr^{3+}(aq) + 7H_2O(l)$$

and the standard electrode potential is given as $E^0 = 1.33$ V.

[Given : log 10 = 1]

Sol. (A) (a) $Sn(s)|Sn^{2+}(0.004\ M)\ ||\ H^+(0.02\ M)\ |\ H_2(g)\ (1\ Bar)\ |\ Pt(s)$

Reaction at anode

$Sn(s) \longrightarrow Sn^{2+}(aq) + 2e$

Reaction at cathode

$2H^+(aq) + 2e \longrightarrow H_2(g)$

Complete cell reaction $Sn(s) + 2H^+(aq) \longrightarrow Sn^{2+}(aq) + H_2(g)$

$$E^0_{cell} = E^0_{oxidation} + E^0_{reduction}$$

$= 0.14 + 0.00 = 0.14$ V

$$E_{cell} = E^0_{cell} - \frac{0.059}{2}\log\frac{[Sn^{2+}](P_{H_2})}{[H^+]^2}$$

$$= 0.14 - 0.03\log\frac{4\times10^{-3}}{2\times10^{-2}}$$

$= 0.14 - 0.03 \log(2 \times 10^{-1})$

$= 0.161$ V

(b) (i) At the anode the following oxidation reactions are possible in electrolysis of aqueous NaCl

$$Cl^-(aq) \rightarrow \frac{1}{2}Cl_2(g) + e^- \quad E^0 = 1.36\ V$$

$$2H_2O(l) \rightarrow O_2(g) + 4H^+(aq) + 4e^- \quad E^0 = 1.23\ V$$

the reaction at anode with lower value of E^0 is preferred and therefore, water should get oxidised in presence to Cl^-, due to over potential of oxygen.

(ii) Conductivity of weak electrolyte (CH_3COOH) decreases on dilution due to number of ions per unit volume decreases.

OR

(B) (a) Anode reaction

$$Pb(s) + SO_4^{2-}(aq) \longrightarrow PbSO_4(s) + 2e^-$$

Cathode reaction

$$PbO_2(s) + SO_4^{2-}(aq) + 4H^+(aq) + 2e^- \longrightarrow 2PbSO_4(s) + 2H_2O(l)$$

Overall reaction

$$Pb(s) + PbO_2(s) + 2H_2SO_4(aq) \longrightarrow 2PbSO_4(s) + 2H_2O(l)$$

(b) $Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \rightarrow 2Cr^{3+}(aq) + 7H_2O(l)$

$$E = E^0 - \frac{0.06}{6}\log\frac{[Cr^{3+}]^2}{[Cr_2O_7^{2-}][H^+]^{14}}$$

$$= 1.33 - 0.01\log\frac{(10^{-2})^2}{(10^{-2})^2(10^{-4})^{14}}$$

$$= 1.33 - 0.10\log 10^{56}$$

$$= 1.33 - 0.01 \times 56$$

$$= 1.33 - 0.56 = 0.77\ V$$

❑ ❑ ❑