

# Sample Question Paper (Solved)–2025

(Issued by Central Board of Secondary Education, New Delhi)

## CLASS—12th CHEMISTRY

Time Allowed : 3 Hours]

[Maximum Marks : 70

### General Instructions :

Read the following instructions carefully.

- There are 33 questions in this question paper with internal choice.
- SECTION A consists of 16 multiple-choice questions carrying 1 mark each.
- SECTION B consists of 5 short answer questions carrying 2 marks each.
- SECTION C consists of 7 short answer questions carrying 3 marks each.
- SECTION D consists of 2 case-based questions carrying 4 marks each.
- SECTION E consists of 3 long answer questions carrying 5 marks each.
- All questions are compulsory.
- Use of log tables and calculators is not allowed.

### SECTION—A

The following questions are multiple-choice questions with one correct answer. Each question carries 1 mark. There is no internal choice in this section.

**Q. 1. Ammonolysis of ethyl chloride followed by reaction of the amine so formed with 1 mole of methyl chloride gives an amine that :** 1

- reacts with Hinsberg reagent to form a product soluble in an alkali.
- on reaction with Nitrous acid, produced nitrogen gas.
- reacts with Benzenesulphonyl chloride to form a product that is insoluble in alkali
- does not react with Hinsberg reagent.

**Ans.** (c) reacts with Benzenesulphonyl chloride to form a product that is insoluble in alkali.

**Hint :** 2° amine will be formed which will react with benzene sulphonyl chloride to form a product insoluble in alkali.

**Q. 2. Which one of the following has the highest dipole moment ?** 1

- CH<sub>3</sub>F
- CH<sub>3</sub>Cl
- CH<sub>3</sub>I
- CH<sub>3</sub>Br.

**Ans.** (b) CH<sub>3</sub>Cl

**Hint :** The dipole moment of haloalkane decreases from Cl to Br to I because of decrease in polarity of C – X bond as :

CH<sub>3</sub>Cl > CH<sub>3</sub>Br > CH<sub>3</sub>I. The dipole moment of CH<sub>3</sub>F is less than that of CH<sub>3</sub>Cl because of small size of F atom as compared to Cl atom.

**Q. 3. Match the properties given in column I with the metals in column II :** 1

Column I	Column II
(i) Actinoid having configuration [Rn] 5f <sup>7</sup> 6d <sup>1</sup> 7s <sup>2</sup>	(A) Ce
(ii) Lanthanoid which has 4f <sup>14</sup> electronic configuration in + 3 oxidation state.	(B) Lu
(iii) Lanthanoid which show + 4 Oxidation state	(C) Cm

(a) (i)–(C), (ii)–(B), (iii)–(A)

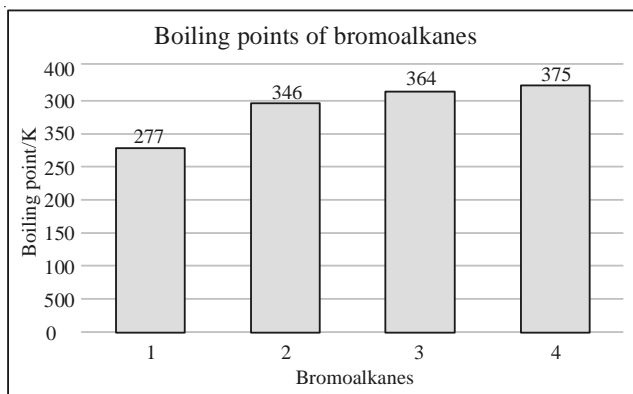
(b) (i)–(C), (ii)–(A), (iii)–(B)

(c) (i)–(A), (ii)–(B), (iii)–(C)

(d) (i)–(B), (ii)–(A), (iii)–(C)

**Ans.** (a) (i)–(C), (ii)–(B), (iii)–(A)

**Q. 4. Study the graph showing the boiling points of bromoalkanes and identify the compounds.** 1



- (a) 1 = Bromomethane, 2 = 2-Bromobutane, 3 = 1-Bromobutane, 4 = 2-Bromo-2-methylpropane
- (b) 1 = 1-Bromobutane, 2 = 2-Bromo-2-methylpropane, 3 = 2-Bromobutane, 4 = Bromomethane
- (c) 1 = Bromomethane, 2 = 1-Bromobutane, 3 = 2-Bromo-2-methylpropane, 4 = 2-Bromobutane,
- (d) 1 = Bromomethane, 2 = 2-Bromo-2-methylpropane, 3 = 2-Bromobutane, 4 = 1-Bromobutane.

Ans. (d) 1 = Bromobutane.

Hint : 1 = Bromomethane, 2 = 2-Bromo-2-methylpropane, 3 = 2-Bromobutane; 4 = 1-Bromobutane.

**Q. 5. The initial concentration of R in the reaction  $R \rightarrow P$  is  $4.62 \times 10^{-2}$  mol/L. What is the half life for the reaction if  $k = 2.31 \times 10^{-2}$  mol L<sup>-1</sup>s<sup>-1</sup> ?** 1

- (a) 30 s (b) 3 s  
(c) 1 s (d) 10 s.

Ans. (c) 1 s

Hint : Since the unit of  $k$  is mol L<sup>-1</sup>s<sup>-1</sup>, the order of reaction is zero,

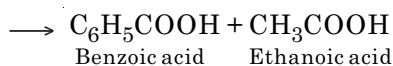
$$t_{1/2} = \frac{[R]_0}{2k} = \frac{4.62 \times 10^{-2}}{2 \times 2.31 \times 10^{-2}} = 1s.$$

**Q. 6. When  $C_6H_5COOCOCH_3$  is treated with  $H_2O$ , the product obtained is :** 1

- (a) Benzoic acid and ethanol  
(b) Benzoic acid and ethanoic acid  
(c) Acetic Acid and phenol  
(d) Benzoic anhydride and methanol.

Sol. (b) Benzoic anhydride and methanol.

Hint :  $C_6H_5COOCOCH_3 + H_2O$



**Q. 7. Formulation of Cobalt(III) Chloride-Ammonia Complexes** 1

Colour	Formula	Solution conductivity corresponds to
Yellow	$[Co(NH_3)_6]^{3+}3Cl^-$	Y
Purple	$[CoCl(NH_3)_5]^{2+}2Cl^-$	1 : 2 electrolyte
Green	X	1 : 1 electrolyte

'X' and 'Y' in the above table are :

- (a)  $X = [Co(NH_3)_6]^{2+}3Cl^-$ ,  $Y = 1 : 3$   
(b)  $X = [Co(NH_3)_4Cl_2]^+Cl^-$ ,  $Y = 1 : 3$   
(c)  $X = [Co(NH_3)_4Cl_2]^+Cl^-$ ,  $Y = 1 : 1$   
(d)  $X = [Co(NH_3)_4Cl_2]^{3+}3Cl^-$ ,  $Y = 1 : 1$

Ans. (b)  $X = [Co(NH_3)_4Cl_2]^+Cl^-$ ,  $Y = 1 : 3$ .

**Q. 8. Which of the following contains only  $\beta$ -D-glucose as its monosaccharide unit :** 1

- (a) Sucrose (b) Cellulose  
(c) Starch (d) Maltose.

Ans. (b) Cellulose

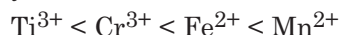
Hint : Cellulose is polymer of  $\beta$ -D-glucose.

**Q. 9. Which one of the following sets correctly represents the increase in the paramagnetic property of the ions ?** 1

- (a)  $Ti^{3+} < Fe^{2+} < Cr^{3+} < Mn^{2+}$   
(b)  $Ti^{3+} < Mn^{2+} < Fe^{2+} < Cr^{3+}$   
(c)  $Mn^{2+} < Fe^{2+} < Cr^{3+} < Ti^{3+}$   
(d)  $Ti^{3+} < Cr^{3+} < Fe^{3+} < Mn^{2+}$ .

Ans. (d)  $Ti^{3+} < Cr^{3+} < Fe^{3+} < Mn^{2+}$ .

Hint : Paramagnetism depends upon the number of unpaired electrons :  $Ti^{3+}$  (1),  $Cr^{3+}$  (3),  $Fe^{2+}$  (4) and  $Mn^{2+}$  (5). Therefore, increasing order of paramagnetic property is :



**Q. 10. A first-order reaction is found to have a rate constant,  $k = 5.5 \times 10^{-14}$  s<sup>-1</sup>. The time taken for completion of the reaction is :** 1

- (a)  $1.26 \times 10^{13}$  s (b)  $2.52 \times 10^{13}$  s  
(c)  $0.63 \times 10^{13}$  s  
(d) It never goes to completion.

Ans. (d) It never goes to completion.

Hint : First order reaction never goes to completion.

For a first order reaction,

$$[R] = [R]_0 e^{-kt}$$

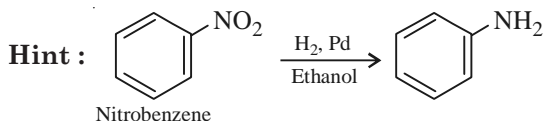
If  $[R] = 0$ , then

$$e^{-kt} = 0, \text{ which is only possible when } t = \infty.$$

**Q. 11. A student was preparing aniline in the lab. She took a compound 'X' and reduced it in the presence of Ni as a catalyst. What could be the compound 'X'.** 1

- (a) Nitrobenzene      (b) 1-Nitrohexane  
 (c) Benzonitrile      (d) 1-Hexanenitrile. 1

Ans. (a) Nitrobenzene



**Q. 12. Which of the following compound gives an oxime with hydroxylamine :** 1

- (a)  $\text{CH}_3\text{COCH}_3$       (b)  $\text{CH}_3\text{COOH}$   
 (c)  $(\text{CH}_3\text{CO})_2\text{O}$       (d)  $\text{CH}_3\text{COCl}$ .

Ans. (a) :  $\text{CH}_3\text{COCH}_3$ .

**Hint :** Only aldehydes and ketones give nucleophilic addition reactions and form oximes.

**Q. 13. Assertion (A) :**  $[\text{Mn}(\text{CN})_6]^{3-}$  has a magnetic moment of two unpaired electrons while  $[\text{MnCl}_6]^{3-}$  has a paramagnetic moment of four unpaired electrons.

**Reason [R] :**  $[\text{Mn}(\text{CN})_6]^{3-}$  is inner orbital complexes involving  $d^2sp^3$  hybridisation, on the other hand,  $[\text{MnCl}_6]^{3-}$  is outer orbital complexes involving  $sp^3d^2$  hybridisation. 1

**Select the most appropriate answer from the options given below :**

- (a) Both A and R are true and R is the correct explanation of A  
 (b) Both A and R are true but R is not the correct explanation of A.  
 (c) A is true but R is false  
 (d) A is false but R is true.

Ans. (a) : Both A and R are true and R is the correct explanation of A.

**Q. 14. Assertion (A) :** For strong electrolytes, there is a slow increase in molar conductivity with dilution and can be represented by the equation. 1

$$\Lambda_m^\circ = \Lambda_m - Ac^{1/2}$$

**Reason (R) :** The value of the constant 'A' for NaCl,  $\text{CaCl}_2$ , and  $\text{MgSO}_4$  in a given solvent and at a given temperature is different.

**Select the most appropriate answer from the options given below :**

- (a) Both A and R are true and R is the correct explanation of A  
 (b) Both A and R are true but R is not the correct explanation of A.  
 (c) A is true but R is false  
 (d) A is false but R is true.

Ans. (d) A is false but R is true.

**Hint :** Correct assertion is  $\Lambda_m = \Lambda_m^\circ - Ac^{1/2}$

**Q. 15. Assertion (A) :** Glucose does not form the hydrogensulphite addition product with  $\text{NaHSO}_3$ .

**Reason (R) :** Glucose exists in a six-membered cyclic structure called pyranose structure. 1

**Select the most appropriate answer from the options given below :**

- (a) Both A and R are true and R is the correct explanation of A  
 (b) Both A and R are true but R is not the correct explanation of A.  
 (c) A is true but R is false  
 (d) A is false but R is true.

Ans. (b) Both A and R are true but R is not the correct explanation of A.

**Q. 16. Assertion (A) :** The half-life for a zero order reaction is independent of the initial concentration of the reactant.

**Reason (R) :** For a zero order reaction, Rate =  $k$ . 1

**Select the most appropriate answer from the options given below :**

- (a) Both A and R are true and R is the correct explanation of A  
 (b) Both A and R are true but R is not the correct explanation of A.  
 (c) A is true but R is false  
 (d) A is false but R is true.

Ans. (d) A is false but R is true.

**Hint :**  $t_{1/2} = \frac{[\text{R}]_0}{2k}$  and depends on initial concentration of the reactant.

## SECTION-B

*The section contains 5 questions with internal choice in one question. The following questions are very short answer type and carry 2 marks each.*

**Q. 17. (a)** Nitrogen gas is soluble in water. At temperature 293 K, the value of  $K_H$  is 76.48 k bar. How would the solubility of nitrogen vary (increase, decrease or remain the same) at a temperature above 293 K, if the value of  $K_H$  rises to 88.8 k bar. 1

**(b)** Chloroform (b.p. 61.2 °C) and acetone (b.p. 56°C) are mixed to form an azeotrope. The mole fraction of acetone in this mixture is 0.339. Predict whether the boiling point of the azeotrope formed will be (i) 60°C (ii) 64.5°C or (iii) 54 °C. Defend your answer with reason. 1

Ans. (a) Solubility of a gas is inversely proportional to  $K_H$ . On increasing temperature nitrogen gas becomes less soluble because its  $K_H$  value increases.

(b) (ii) 64.5°C chloroform and acetone mixture shows negative deviation from Raoult's law and therefore, they form maximum boiling azeotrope at a specific composition. The boiling point of the mixture so formed will be higher than the individual components.

Or

(a) A soda bottle will go flat (lose its fizz) faster in Srinagar than in Delhi. Is this statement correct? Why or why not? 1

(b) How does sugar help in increasing the shelf life of the product? 1

Ans. (a) At higher altitudes (i.e. in Srinagar) the atmospheric pressure is less than that at Delhi. The solubility of a gas is directly proportional to the partial pressure of the gas over the solution and therefore, the carbon dioxide dissolved in water will be lesser at Srinagar. Hence, the soda bottle will go flat faster.

(b) Preservation of fruits by adding sugar protects against bacterial action. Through osmosis, a bacterium in canned fruits loses water, shrivels and dies.

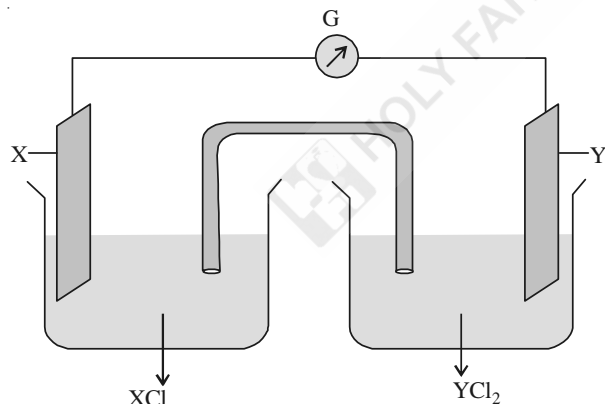
Q. 18. (a) Write the IUPAC name of the following complex:  $K[Cr(H_2O)_2(C_2O_4)_2] \cdot H_2O$ . 1

(b) Name the metal present in the complex compound of (i) Haemoglobin (ii) Vitamin B-12. 1/2 + 1/2

Ans. (a) Potassium diaquadioxalatochromate(II) hydrate.

(b) (i) Iron, (ii) Cobalt.

Q. 19. Observe the following cell and answer the questions that follow:



(a) Represent the cell shown in the figure. 1

(b) Name the carriers of the current in the salt bridge. 1/2

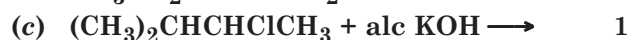
(c) Write the reaction taking place at the anode. 1/2

Ans. (a)  $Y(s) | Y^{2+}(aq) || X^+(aq) | X(s)$

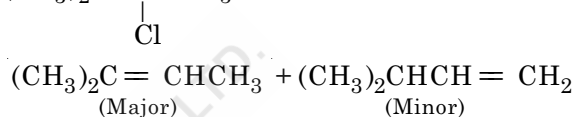
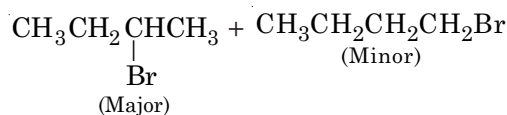
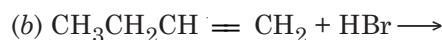
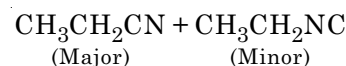
(b) Ions are carrier of current in salt bridge.

(c)  $Y(s) \rightarrow Y^{2+}(aq) + 2e^-$

Q. 20. Complete the following reactions by writing the major and minor product in each case (any 2)

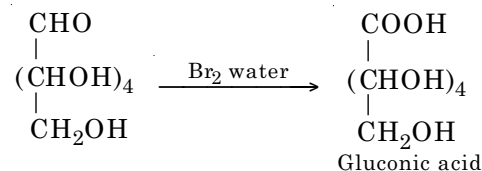


Ans. (a)  $CH_3CH_2Br + KCN \rightarrow$



Q. 21. The presence of Carbonyl group in glucose is confirmed by its reaction with hydroxylamine. Identify the type of carbonyl group present and its position. Give a chemical reaction in support of your answer. 1+1

Ans. The carbonyl group present in glucose aldehyde at  $C_1$  atom. Glucose on oxidation with mild oxidising agent like  $Br_2$  water gives gluconic acid containing same number of C atoms (six) as are present in glucose.



This indicates that the carbonyl group present in an aldehydic ( $-CHO$ ) group.

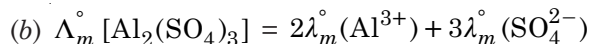
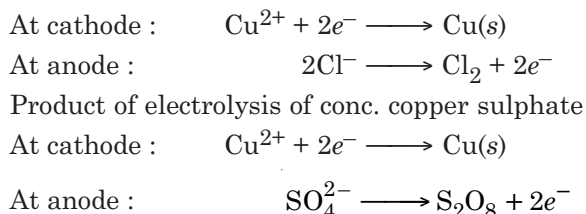
### SECTION-C

This section contains 7 questions with internal choice in one question. The following questions are short answer type the carry 3 marks each.

Q. 22. (a) Write down the reaction occurring on two inert electrodes when electrolysis of copper chloride is done. What will happen if a concentrated solution of copper sulphate is replaced with copper chloride? 2

(b) Write an expression for the molar conductivity of aluminium sulphate at infinite dilution according to Kohlrausch law. 1

Ans. (a) Product of electrolysis of copper chloride:



**Q. 23. Account for the following :**

(a) The lowest oxide of transition metal is basic, and the highest is acidic. 1

(b) Chromium is a hard metal while mercury is a liquid metal. 1

(c) The ionisation energy of elements of the 3d series does not vary much with increasing atomic number. 1

**Ans. (a)** In case of lower oxide of transition metals, the metal atom has same electrons present in its valence shell which are involved in bonding. As a result, it can donate electrons and behaves as a base. In case of higher oxide of transition metal, the metal atom does not have electrons in its valence shells for donation. As a result, it can accept electrons and behave as an acid.

(b) Chromium has unpaired electrons which results in strong metallic bonding and is therefore, hard solid. Mercury does not have unpaired electrons and therefore, does not form strong metallic bonding. Hence, it is a liquid.

(c) The increase in effective nuclear charge in the elements of 3d series responsible for increase in ionisation energy is counter balanced by shielding effect of  $(n-1)$  d electrons. Therefore, the ionisation energy does not vary much in 3d series with increase in atomic number.

**Q. 24. (a)** Give the chemical reaction involved when p-nitrotoluene undergoes Etard reaction. 1

(b) Why does Benzoic acid exist as a dimer in an aprotic solvent ? 1

(c) Benzene on reaction with methylchloride in the presence of anhydrous  $\text{AlCl}_3$  forms toluene. What is the expected outcome if benzene is replaced by benzoic acid ? Give a reason for your answer. 1

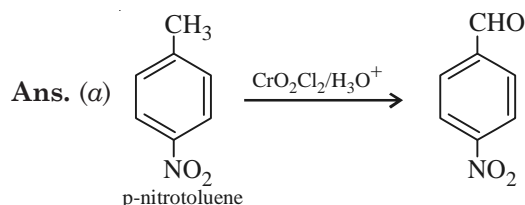
**Or**

An organic compound 'X' does not undergo aldol condensation. However 'X' with compound 'Y' in the presence of a strong base react to give the compound 1, 3-diphenylprop-2-en-1-one.

(a) Identify 'X' and 'Y' 1

(b) Write the chemical reaction involved. 1

(c) Give one chemical test to distinguish between X and Y. 1

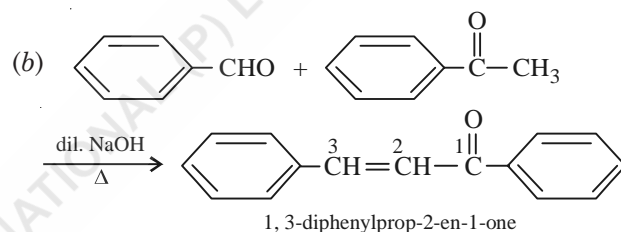


(b) Benzoic acid undergoes extensive intermolecular hydrogen bonding and therefore, exists as dimer.

(c) Benzoic acid does not undergo Friedel Crafts reaction because the carboxyl group is strongly deactivating group and the catalyst  $\text{AlCl}_3$  (Lewis acid) gets bonded to the carboxyl group strongly.

**Or**

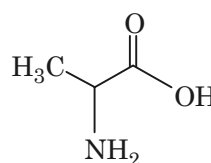
(a) Compound X is benzaldehyde and Y is acetophenone.



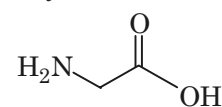
(c) **Test to distinguish between X and Y :** With Tollens' reagent X (benzaldehyde) gives silver mirror test forming silver mirror. But Y (acetophenone) does not react with Tollens' reagent.

**Q. 25. (a)** Give the structure of all the possible dipeptides formed when the following two amino acids form a peptide bond. 2

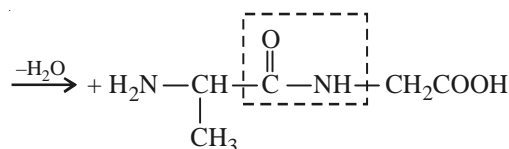
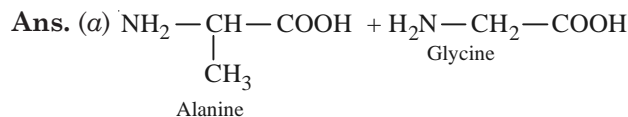
Alanine

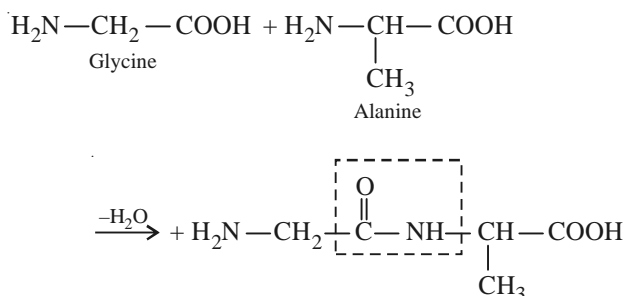


Glycine



(b) Keratin, insulin, and myosin are a few examples of proteins present in the human body. Identify which type of protein is keratin and insulin and differentiate between them based on their physical properties. 1





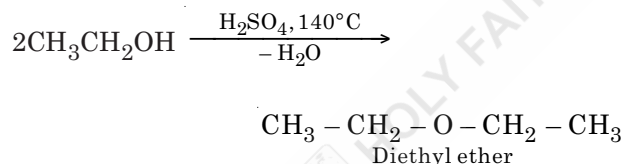
(b) Keratin is a fibrous protein. It has fibre like structure. These types of proteins are insoluble in water. Insulin is a globular protein. This type of structure is formed when the chains of polypeptides coil around to give a spherical shape. These are generally soluble in water.

**Q. 26.** Neeta was experimenting in the lab to study the chemical reactivity of alcohols. She carried out a dehydration reaction of propanol at 140°C to 180°C. Different products were obtained at these two temperatures.

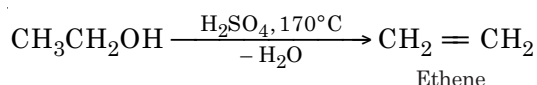
(a) Identify the major product formed at 140°C and the substitution mechanism followed in this case. 1 + ½

(b) Identify the major product formed at 180°C and the substitution mechanism followed in this case. 1½

**Ans. (a)** At 140°C, ethanol undergoes dehydration reaction and diethyl ether is formed. The formation of diethyl ether is a S<sub>N</sub>2 nucleophilic substitution, bimolecular reaction.



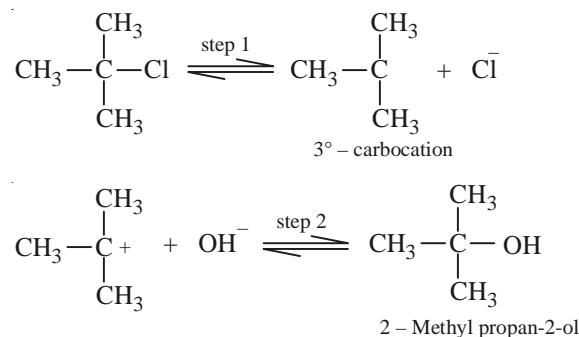
(b) When temperature is 170°C, ethene is formed as the major product. This is S<sub>N</sub>1, nucleophilic substitution unimolecular reaction.



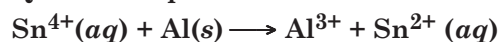
**Q. 27.** Various isomeric haloalkanes with the general formula C<sub>4</sub>H<sub>9</sub>Cl undergo hydrolysis reaction. Among them, compound "A" is the most reactive through S<sub>N</sub>1 mechanism. Identify "A" citing the reaction for your choice. Write the mechanism for the reaction. 3

**Ans.** 'A' is (CH<sub>3</sub>)<sub>3</sub>CCl. This is most reactive because the 3° carbocation formed is most stable of all the possible isomers.

**Mechanism :**



**Q. 28.** The equilibrium constant of cell reaction :



is 4.617 × 10<sup>184</sup>, at 25°C

(a) Calculate the standard emf of the cell. 2

(Given : log 4.617 × 10<sup>184</sup> = 184.6644)

(b) What will be the E° of the half cell Al<sup>3+</sup>/Al, if E° of half cell Sn<sup>4+</sup>/Sn<sup>2+</sup> is 0.15V. 1

**Ans. (a)**  $E = E^\circ - \frac{0.059}{n} \log K_c$  at 298 K

$$E = 0, n = 6$$

$$E^\circ = \frac{0.059}{n} \log K_c$$

$$= \frac{0.059}{6} \log 4.617 \times 10^{184}$$

$$= \frac{0.059}{6} (184 + \log 4.617)$$

$$= \frac{0.059}{6} (184 + 0.664)$$

$$= \frac{0.059}{6} \times 184.664 = 1.815$$

(b)  $E^\circ_{\text{cell}} = E^\circ(\text{Sn}^{4+}/\text{Sn}^{2+}) - E^\circ(\text{Al}^{3+}/\text{Al})$

$$1.81 = 0.15 - E^\circ(\text{Al}^{3+}/\text{Al})$$

$$\therefore E^\circ(\text{Al}^{3+}/\text{Al}) = -1.81 + 0.15 = -1.66 \text{ V}$$

### SECTION-D

The following questions are case-based questions. Each question has an internal choice and carries 4 (2 + 1 + 1) marks each. Read the passage carefully and answer the questions that follow.

**Q. 29.** Dependence of the rate of reaction on the concentration of reactants, temperature, and other factors is the most general method for weeding out unsuitable reaction mechanisms. The term mechanism means all the individual collisional or elementary

processes involving molecules (atoms, radicals, and ions included) that take place simultaneously or consecutively to produce the observed overall reaction. For example, when hydrogen gas reacts with bromine, the rate of the reaction was found to be proportional to the concentration of  $H_2$  and to the square root of the concentration of  $Br_2$ . Furthermore, the rate was inhibited by increasing the concentration of  $HBr$  as the reaction proceeded. These observations are not consistent with a mechanisms involving bimolecular collisions of a single molecule of each kind. The currently accepted mechanism is considerably more complicated, involving the dissociation of bromine molecules into atoms followed by reactions between atoms and molecules :

It is clear from this example that the mechanism cannot be predicted from the overall stoichiometry.

(source : Moore, J.W. & Pearson, R, G. (1981). *Kinetics and mechanism*. John Wiley & Sons.)

(a) Predict the expression for the rate of reaction and order the the following :



What are the units of rate constant for the above reaction ? 1

(b) How will the rate of reaction be affected if the concentration of  $Br_2$  is tripled ? 1

Or

What change in the concentration of  $H_2$  will triple the rate of reaction ?

(c) Suppose a reaction between A and B, was experimentally found to be first order with respect to both A and B. So the rate equation is :

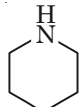
$$\text{Rate} = k [A] [B]$$

Which of these two mechanisms is consistent with this experimental finding ? Why ?

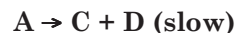
**Q. 30.** Amines are basic in nature. The  $pK_b$  value is a measure of the basic strength of an amine. Lower the value of  $pK_b$ , more basic is the amine. The effect of substituent on the basic strength of amines in aqueous solution was determined using titrations. The substituent "X" replaced "-  $CH_2$ " group in piperidine (compound 1) and propylamine  $CH_3CH_2CH_2NH_2$ , (compound 2).



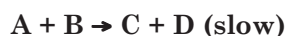
The experimental data is tabulated below :

Substituent "X"	Electro-negativity of X	Substituted piperidine compound	$pK_a$	Substituted propylamine compound	$pK_a$
$CH_2$	2.55		11.13	$CH_3CH_2CH_2NH_2$	10.67

### Mechanism-1



### Mechanism 2



Ans. (a)  $\text{Rate} = k [H_2] [Br_2]^{1/2}$  1

$$\text{Order} = 1 + \frac{1}{2} = \frac{3}{2}$$

Unit of  $k$  :  $k = \frac{\text{mol L}^{-1} \text{s}^{-1}}{(\text{mol L}^{-1})^{3/2}}$   
 $= \frac{\text{mol L}^{-1}}{\text{mol}^{3/2} \text{L}^{-3/2}} = \text{mol}^{-1/2} \text{L}^{1/2} \text{s}^{-1}$

(b)  $\text{Rate} = k [H_2] [Br_2]^{1/2}$

When conc. of  $Br_2$  is tripled,

$$\text{Rate}' = k [H_2] [3Br_2]^{1/2}$$

$$\text{Rate}' = \sqrt{3} k [H_2] [Br_2]^{1/2}$$

$$\text{Rate}' = \sqrt{3} \text{Rate}$$

Rate becomes  $\sqrt{3}$  times.

Or

$$\text{Rate} = k [H_2] [Br_2]^{1/2}$$

When  $[H_2]$  is tripled

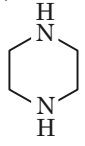
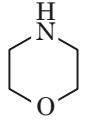
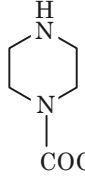
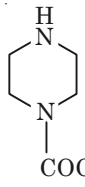
$$\text{Rate}' = k [3H_2] [Br_2]^{1/2}$$

$$\text{Rate}' = 3k [H_2] [Br_2]^{1/2}$$

Rate becomes 3 times.

(c) Slowest step is rate determining step. Mechanism 2 is consistent with experimental results.

$$\text{Rate} = k [A] [B].$$

Substituent "X"	Electronegativity of X	Substituted piperidine compound	$pK_a$	Substituted propylamine compound	$pK_a$
NH	3.12		9.81	$\text{NH}_2\text{CH}_2\text{CH}_2\text{NH}_2$	10.08
O	3.44		8.36	$\text{HOCH}_2\text{CH}_2\text{NH}_2$	9.45
$\text{CH}_3\text{CON}$	3.6		7.94	$\text{CH}_3\text{CONHCH}_2\text{CH}_2\text{NH}_2$	9.28
$\text{C}_6\text{H}_5\text{CON}$	3.7		7.78	$\text{C}_6\text{H}_5\text{CONHCH}_2\text{CH}_2\text{NH}_2$	-

(source : Hall Jr, H.K. (1956). Field and inductive effects on the base strengths of amines. *Journal of the American Chemical Society*, 78(11), 2570-2572).

Study the above data and answer the following questions :

(a) Plot a graph between the electronegativity of the substituent vs  $pK_b$  value of the corresponding substituted propyl amine (given that  $pK_a + pK_b = 14$ ). Is there any relation between the electronegativity of the substituent and its basic strength ? 2

(b) The electronegativity of the substituent " $\text{C}_6\text{H}_5\text{CON}$ " is 3.7, what is the expected  $pK_a$  value of compound  $\text{C}_6\text{H}_5\text{CONHCH}_2\text{CH}_2\text{NH}_2$  ? 1

(i) 9.9 (ii) 9.5 (iii) 9.3 (iv) 9.1

(c) The  $pK_a$  value of the substituted piperidine formed with substituent "X" is found to be 8.28. What is the expected electronegativity of "X".

(i) 3.5 (ii) 3.4 (iii) 3.8 (iv) 3.1. 1

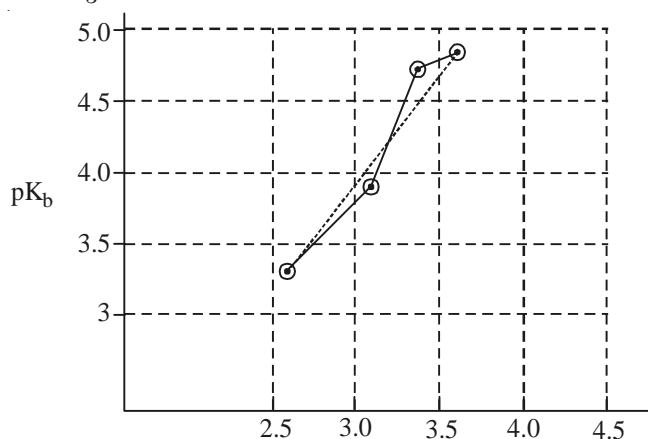
Or

What is the most suitable  $pK_a$  value of the substituted propylamine formed with substituent "X" with electronegativity 3.0

(i) 10.67 (ii) 10.08 (iii) 10.15 (iv) 11.10.

Ans. (a) Plot of graph between electronegativity of substituent vs  $pK_b$

Substituent	Electronegativity	$pK_a$	$pK_b$
$-\text{CH}_2$	2.55	10.67	3.33
$-\text{NH}$	3.12	10.08	3.92
O	3.44	9.45	4.55
$\text{CH}_3\text{CON}$	3.6	9.28	4.72



..... line is the best fit. The  $pK_b$  value increases with an increase in the electronegativity of the substituent. Therefore, the basic strength decreases with an increase in the electronegativity of the substituent.



(b) (iv)  $pK_a = 9.1$  (less than 9.28)

(c) (i) 3.5

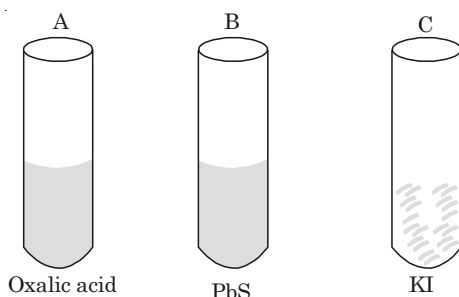
Or

(iii) 10.15 (between 10.67 and 10.08)

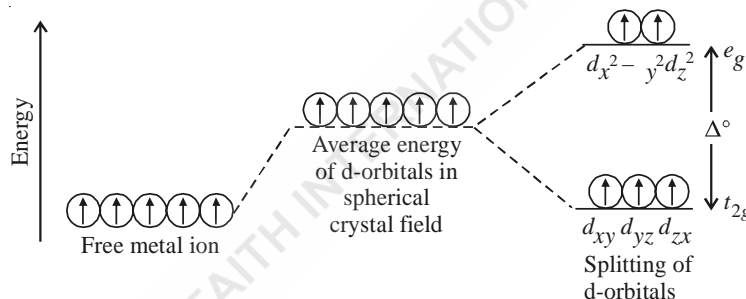
### SECTION-E

The following questions are long answer types and carry 5 marks each. All questions have an internal choice.

Q. 31. (a) A purple colour compound A, which is a strong oxidising agent and used for bleaching of wool, cotton, silk and other textile fibres was added to each of the three tubes along with  $H_2SO_4$ . It was followed by strong heating.



(b) (i)



The configuration is :  $t_{2g}^3 e_g^2$

(ii) Since  $\Delta_o < P$ , it will form outer orbital complex as the electrons in  $3d$  orbitals will not pair up.

Hybridisation :  $sp^3d^2$

(iii) Optical isomerism

Or

(a) Using, Valence Bond Theory identify A, B, C, D, E and F in the following table

S.No.	Complex	Central metal	Configuration of metal ion	Hybridization of Metal ion	Geometry of the Complex	Number of Unpaired Electron	Magnetic Behaviour
(i)	$[CoF_4]^{2-}$	A	$3d^7$	$sp^3$	tetrahedral	B	Paramagnetic
(ii)	$[Cr(H_2O)_2(C_2O_4)_2]$	$Cr^{3+}$	$3d^3$	C	octahedral	3	D
(iii)	$[Ni(CO)_4]$	Ni	$3d^3 4s^2$	E	F	0	Diamagnetic

(b) Write the ionic equations for the reaction of acidified  $K_2Cr_2O_7$  with (i)  $H_2S$  and (ii)  $FeSO_4$ . 2

Ans. (a) A =  $Co^{2+}$   
B = 3  
C =  $d^2sp^3$

D = Paramagnetic  
E =  $sp^3$   
F = tetrahedral

In which of the above test tubes; A, B or C :

(i) Violet vapours will be formed 1

(ii) The bubbles of gas evolved will extinguish a burning matchstick. Write an equation for each of the above observations. 1

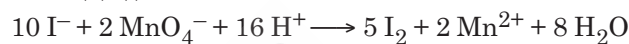
(b) A metal ion  $M^{n+}$  of the first transition series having  $d^5$  configuration combines with three didentate ligands. Assuming  $\Delta_o < P$  :

(i) Draw the crystal field energy level diagram for the  $3d$  orbital of this complex. 1

(ii) What is the hybridisation of  $M^{n+}$  in this complex and why ? 1

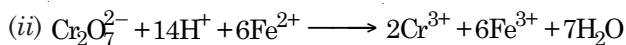
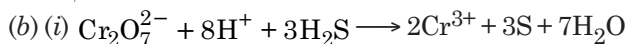
(iii) Name the type of isomerism exhibited by this complex. 1

Ans. (a) (i) Test tube C



(ii) Test tube A





**Q. 32. (a) Give reasons for the following :**

(i) The reaction of ethanol with acetyl chloride is carried out in the presence of pyridine. 1

(ii) Cresols are less acidic than phenol. 1

(b) Williamson's process is used for the preparation of ethers from alkyl halide identify the alkyl bromide and sodium alkoxide used for the preparation of 2-Ethoxy-3-methylpentane 1

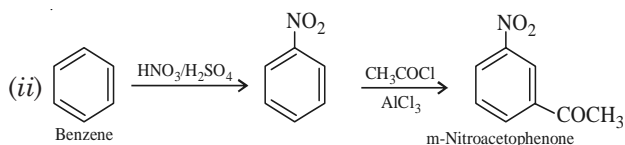
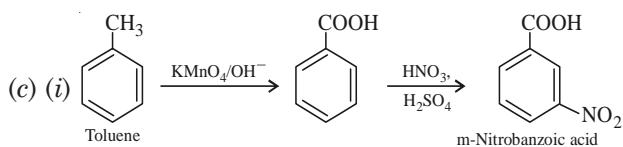
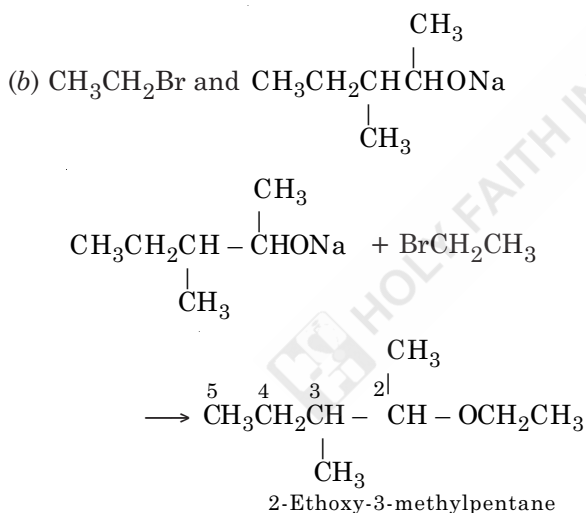
(c) Convert :

(i) Toluene to 3-nitrobenzoic acid. 1

(ii) Benzene to *m*-nitroacetophenone. 1

**Ans. (a) (i)** The reaction of ethanol and acetyl chloride is carried out in the presence of pyridine. This is because pyridine is a strong base and it remains HCl formed in the reaction.

(ii) Methyl group is electron releasing group and it intensify the negative charge on the phenoxide ion. Therefore methyl group destabilizes the phenoxide ion relative to phenol. Thus, cresols are weaker acids than phenol.



Or

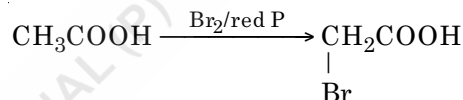
(a) Out of formic acid and acetic acid, which one will give the HVZ reaction? Give a suitable reason in support of your answer and write the chemical reaction involved. 2

(b) Alcohols are acidic but they are weaker acids than water. Arrange various isomers of butanol in the increasing order of their acidic nature. Give a reason for the same. 1

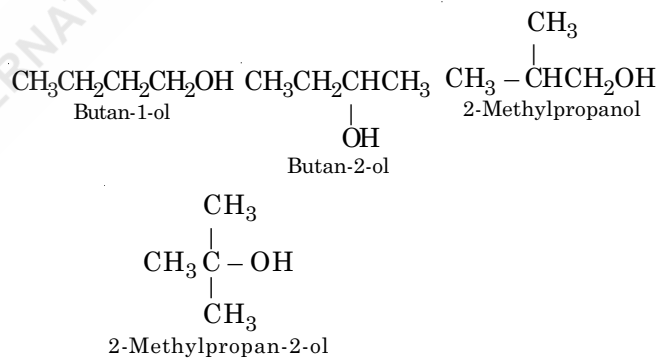
(c) An organic compound A which is a Grignard reagent is used to obtain 2-methylbutan-2-ol on reaction with a carbonyl compound 'B'. Identify 'A' and 'B'. Write the equation for the reaction between A and B. 2

**Ans. (a)** Acetic acid will give HVZ reaction.

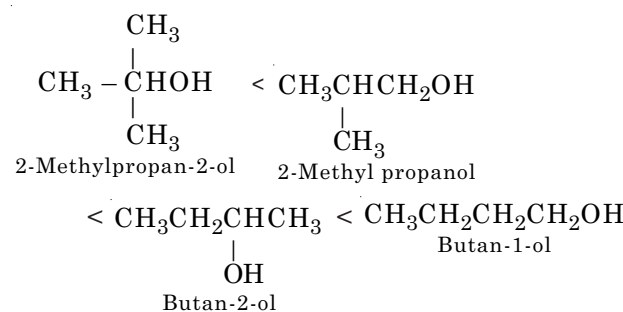
Carboxylic acids having  $\alpha$ -hydrogen are halogenated at the  $\alpha$ -position on treatment with  $\text{Cl}_2$  or  $\text{Br}_2$  in the presence of red phosphorus to give  $\alpha$ -halo carboxylic acids.

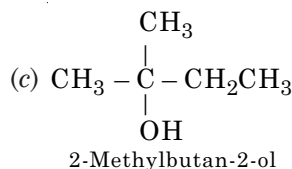


(b) Isomers of butanol are :

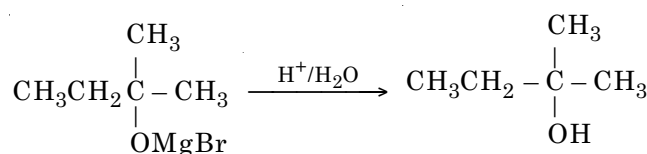
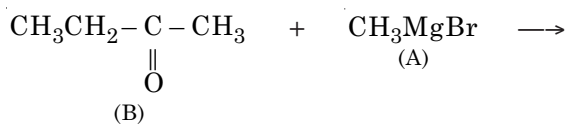
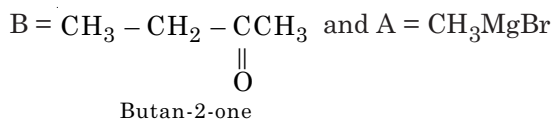


The acidic character of alcohols is due to the polar nature of O-H bond. An electron releasing group such as  $-\text{CH}_3$ ,  $-\text{C}_2\text{H}_5$  etc; increases electron density as oxygen tending to decrease the polarity of O-H bond. Therefore, alcohols are weaker acids than water. Among isomeric butanols, the polarity of O-H bond or acidic character decreases.

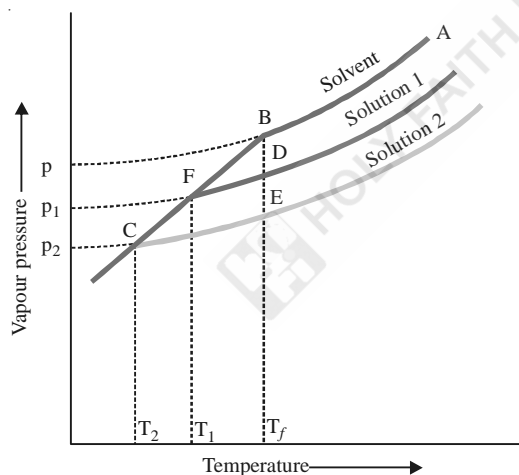




Ketones form tertiary alcohols. Therefore, B is a ketone.



Q. 33. (a) An experiment was carried out in the laboratory, to study depression in freezing point. 1 M aqueous solution of  $\text{Al}(\text{NO}_3)_3$  and 1 M aqueous solution of glucose were taken. From the given figure identify solution 1 and solution 2. Give a plausible reason for your answer. 2

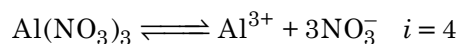


(b) The osmotic pressure of a solution of cane sugar was found to be 2.46 atm at 300 K. If the solution was diluted five times, calculate the osmotic pressure the same temperature.

How can the osmotic pressure of the given cane sugar solution be decreased without changing its volume? Give a reason for your answer. 3

Ans. (a) Depression in freezing point ( $\Delta T_f$ ) is a colligative property. In dilute solutions,  $\Delta T_f$  is directly proportional to the molal concentration of solute, i.e.,

$$\Delta T_f \propto m$$



$\text{C}_6\text{H}_{12}\text{O}_6$  does not ionise and  $i = 1$ .

Since solution 2 has higher depression in freezing point, solution 2 is 1 M  $\text{Al}(\text{NO}_3)_3$  and solution 1 is 1 M glucose.

(b) Osmotic pressure,  $\pi = CRT$

$$\text{or} \quad \pi = \frac{n_2 RT}{V}$$

Let  $V_1 = V, V_2 = 5V$  (on dilution to 5 times)

$$\frac{\pi_1}{\pi_2} = \frac{n_2/V_1}{n_2/V_2}$$

$$\frac{2.64}{\pi_2} = \frac{n_2/V}{n_2/5V}$$

$$\therefore \frac{2.64}{\pi_2} = 5$$

$$\text{or} \quad \pi_2 = \frac{2.64}{5} = 0.528 \text{ atm}$$

Osmotic pressure is directly proportional to temperature.

Therefore osmotic pressure of cane sugar can be decreased by decreasing temperature without changing its volume.

Or

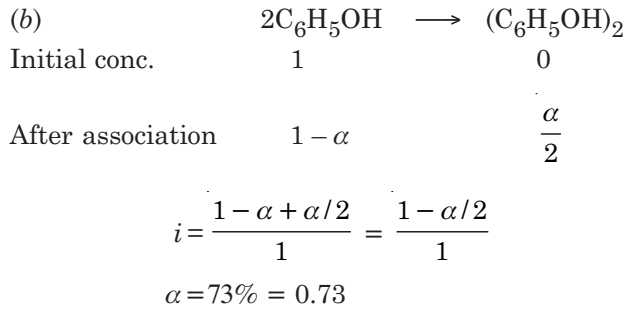
(a) While giving intravenous injections to the patients, the doctors take utmost care of the concentration of the solution used. Why is it necessary to check the concentration of the solution? 2

(b) A solution of phenol was obtained by dissolving  $2 \times 10^{-2}$  kg of phenol in 1 kg of benzene. Experimentally it was found to be 73% associated. Calculate the depression in the freezing point recorded. 3

Ans. (a) While giving intravenous injection to patients, utmost care of concentration of the solution is to be taken. The solution must have same concentration as that of blood cells.

If the solution is more concentrated than the concentration of blood cells, it will lead to the shrinkage of blood cells and the fluid will start flowing out of cells because of endosmosis.

If the solution is less concentrated than the concentration of blood cells, it will lead to swelling of blood cells. Both these conditions are threatening to life.



$$\therefore i = 1 - \frac{0.73}{2} = 0.635$$

Depression in freezing point,

$$\Delta T_f = \frac{i \times K_f \times w_2 \times 1000}{M_2 \times w_1}$$

$$M_2 = 94 \text{ g mol}^{-1}, w_2 = 2 \times 10^{-2} \text{ kg}$$

$$= 20 \text{ g}, w_1 = 1000 \text{ g}$$

$$\Delta T_f = \frac{0.635 \times 5.12 \times 20 \times 1000}{94 \times 1000}$$

$$= \mathbf{0.692 \text{ K.}}$$

# MODEL ANSWERS

## Holy Faith New Style Sample Paper-1

(Based on the Latest Design & Syllabus Issued by CBSE)

CLASS-12th  
CHEMISTRY

Time Allowed : 3 Hours

Maximum Marks : 70

### General Instructions :

Read the following instructions carefully :

- There are 33 questions in this question paper with internal choice.
- Section A consists of 16 multiple-choice questions carrying 1 mark each.
- Section B consists of 5 short answer questions carrying 2 marks each.
- Section C consists of 7 short answer questions carrying 3 marks each.
- Section D consists of 2 case-based questions carrying 4 marks each.
- Section E consists of 3 long answer questions carrying 5 marks each.
- All questions are compulsory.
- Use of log tables and calculators is not allowed.

### SECTION—A

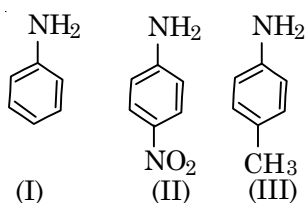
The following questions are multiple-choice questions with one correct answer. Each question carries 1 mark. There is no internal choice in this section.

1. Which of the following statement is true ?

- Molecularity of reaction can be zero or a fraction.
- Molecularity has no meaning for complex reactions.
- Molecularity of a reaction is a experimental quantity
- Reactions with the molecularity three are very rare but are fast.

Ans. (b) Molecularity has no meaning for complex reactions, is a true statement.

2. The correct increasing order of basic strength for the following compounds is :



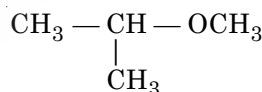
- $II < III < I$
- $III < I < II$
- $III < II < I$
- $II < I < III$

Ans. (d)  $II < I < III$

Hint : Electron donating group ( $-CH_3$ ) increase the basicity of amines while

electron-withdrawing group ( $-NO_2$ ) decrease the basicity.

3. IUPAC name of the compound is :



- 1-methoxy-1-methylethane
- 2-methoxy-2-methylethane
- 2-methoxypropane
- isopropylmethyl ether

Ans. (c) 2-methoxypropane.

4. Which of the following reagent may be used to distinguish between phenol and benzoic acid ?

- Aqueous NaOH
- Tollen's reagent
- Molisch reagent
- Neutral  $FeCl_3$

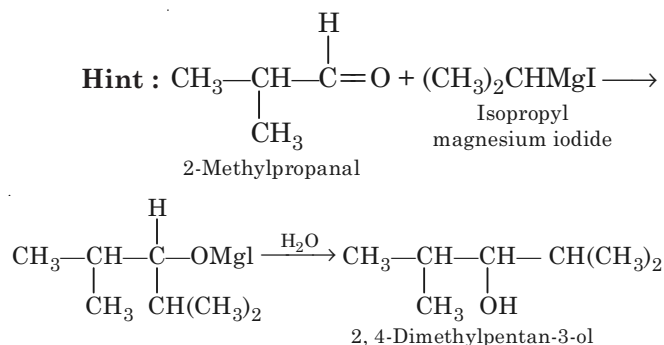
Ans. (d) Neutral  $FeCl_3$

Hint : Phenol gives violet colour with neutral  $FeCl_3$  but benzoic acid gives buff coloured precipitate.

5. What would be the reactant and reagent used to obtain 2, 4-dimethylpentan-3-ol ?

- Propanal and propyl magnesium bromide
- 3-methylbutanal and 2-methyl magnesium iodide
- 2-dimethylpropanone and methyl magnesium iodide
- 2-methylpropanal and isopropyl magnesium iodide

Ans. (d) 2-methylpropanal and isopropyl magnesium iodide



6. Two liquids P and Q have vapour pressures 450 and 200 torr respectively at certain temperature. In an ideal solution of the two, the mole fraction of P at which two liquids have equal partial pressures is :

- (a) 0.80                      (b) 0.308  
(c) 0.444                      (d) 0.154

Ans. (b) 0.308

Hint : Let the mole fraction of P be  $x$

Mole fraction of Q =  $1 - x$

$$450x = 200(1 - x)$$

$$650x = 200$$

$$\therefore x = \frac{200}{650} = 0.308.$$

7.  $\text{K}_3[\text{Al}(\text{C}_2\text{O}_4)_3]$  is named as :

- (a) potassium trioxalatoaluminate(III)  
(b) potassium trisoxalatoaluminate(III)  
(c) potassium aluminium(III) oxalate  
(d) potassium trioxalatoaluminate(II)

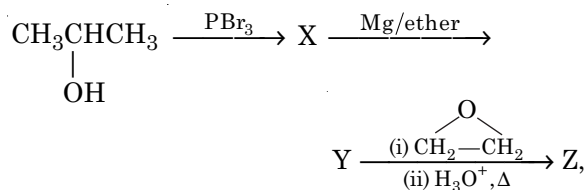
Ans. (a) potassium trioxalatoaluminate(III).

8. Low concentration of  $\text{O}_2$  in the blood of people living at high altitude is due to :

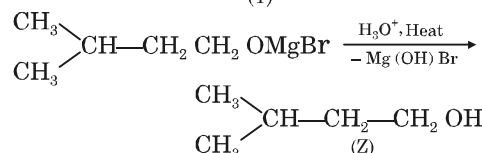
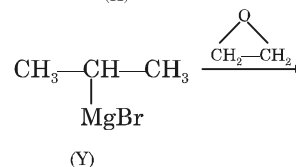
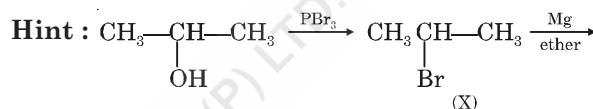
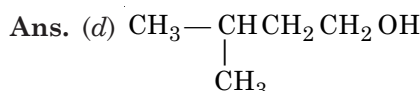
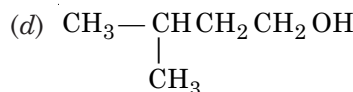
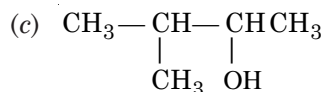
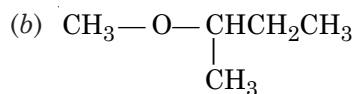
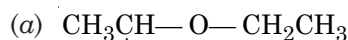
- (a) low temperature  
(b) low atmospheric pressure  
(c) high atmospheric pressure  
(d) None of the above.

Ans. (b) low atmospheric pressure.

9. In the reaction:



the final product Z is :

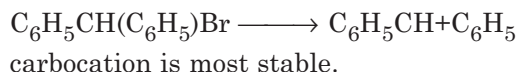


10. Which one of the following compounds is more reactive towards  $\text{S}_{\text{N}}1$  reaction ?

- (a)  $\text{CH}_2 = \text{CHCH}_2\text{Br}$  (b)  $\text{C}_6\text{H}_5\text{CH}_2\text{Br}$   
(c)  $\text{C}_6\text{H}_5\text{CH}(\text{C}_6\text{H}_5)\text{Br}$  (d)  $\text{C}_6\text{H}_5\text{CH}(\text{CH}_3)\text{Br}$

Ans. (c)  $\text{C}_6\text{H}_5\text{CH}(\text{C}_6\text{H}_5)\text{Br}$

Hint :  $\text{S}_{\text{N}}1$  reaction proceeds through the formation of carbocation.



11. Match the solution (column I) with its van't Hoff factor (i) value (column II).

(Column I)	(Column II)
(i) KCl	(A) 3
(ii) Urea	(B) 2
(iii) $\text{K}_4[\text{Fe}(\text{CN})_6]$	(C) 5
(iv) $\text{CaCl}_2$	(D) 1
(a) (i) (B), (ii) (A), (iii) (C), (iv) (A)	
(b) (i) (B), (ii) (D), (iii) (C), (iv) (A)	
(c) (i) (D), (ii) (B), (iii) (D), (iv) (A)	
(d) (i) (B), (ii) (C), (iii) (D), (iv) (A)	

Ans. (b) (i) (B), (ii) (D), (iii) (C), (iv) (A).

## 12. Match the reaction with its example.

Reaction	Example
(i) Raschig reaction	(A) $\text{CH}_3\text{Br} + \text{AgF} \longrightarrow \text{CH}_3\text{F} + \text{AgBr}$
(ii) Finkelstein reaction	(B) $\text{C}_6\text{H}_5\text{N}_2^+\text{Cl}^- \xrightarrow{\text{Cu}_2\text{Cl}_2} \text{C}_6\text{H}_5\text{Cl}$
(iii) Sandmeyer's reaction	(C) $\text{CH}_3\text{CH}_2\text{Cl} + \text{NaI} \xrightarrow{\text{Acetone}} \text{CH}_3\text{CH}_2\text{I} + \text{NaCl}$
(iv) Swarts reaction	(D) $2\text{C}_6\text{H}_6 + 2\text{HCl} + \text{O}_2 \xrightarrow{\text{CuCl}_2} 2\text{C}_6\text{H}_5\text{Cl} + 2\text{H}_2\text{O}$

(a) (i) (D), (ii) (A), (iii) (B), (iv) (C)

(b) (i) (D), (ii) (B), (iii) (C), (iv) (A)

(c) (i) (D), (ii) (C), (iii) (B), (iv) (A)

(d) (i) (D), (ii) (B), (iii) (A), (iv) (C)

Ans. (c) (i) (D), (ii) (C), (iii) (B), (iv) (A).

The questions given below consist of an assertion and a reason. Use the following key to choose the appropriate answer.

(a) Both Assertion (A) and Reason (R) are correct statements, and Reason (R) is the correct explanation of the Assertion (A).

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

(c) Assertion (A) is correct, Reason (R) is wrong statement.

(d) Assertion (A) is wrong, but Reason (R) is correct statement.

13. **Assertion :** N-Ethylbenzene sulphonamide is soluble in alkali.

**Reason :** Hydrogen attached to nitrogen in sulphonamide is strongly acidic.

Ans. (d) Assertion (A) is wrong, but Reason (R) is correct statement.

14. **Assertion :** Order of the reaction can be zero or fractional.

**Reason :** We cannot determine order from balanced chemical equation.

Ans. (b) Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).

15. **Assertion :** According to Kohlrausch's law the molar conductance of an electrolyte at infinite dilution is sum of molar conductances of its ions.

**Reason :** The current carried by cation and anion is always equal at infinite dilution.

Ans. (c) Assertion (A) is correct, Reason (R) is wrong statement.

16. **Assertion :**  $\text{C}_2\text{H}_5\text{OH}$  is a weaker base than phenol but is a stronger nucleophile than phenol.

**Reason :** In phenol the lone pair of electrons on oxygen is withdrawn towards the ring due to resonance.

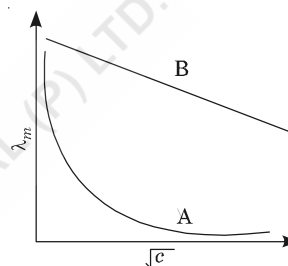
Ans. (d) Assertion (A) is wrong, but Reason (R) is correct statement.

## SECTION-B

This section contains 5 questions with internal choice in one question. The following questions are very short answer type and carry 2 marks each.

17. Solutions of two electrolytes 'A' and 'B' are diluted. The  $\Lambda_m$  of 'B' increases 1.5 times while that of A increases 25 times. Which of the two is a strong electrolyte? Justify your answer. Graphically show the behavior of 'A' and 'B'.

Ans. B is a strong electrolyte. The molar conductivity of strong electrolytes increase slowly with dilution because there is no increase in number of ions on dilution as these are completely dissociated.



Or

Out of the following pairs, predict with reason which pair will allow greater conduction of electricity :

(a) 0.1M  $\text{CH}_3\text{COOH}$  solution or 1M  $\text{CH}_3\text{COOH}$  solution.

(b) KCl solution at  $20^\circ\text{C}$  or KCl solution at  $50^\circ$

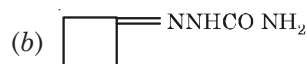
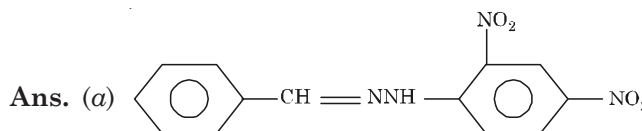
Ans. (a) 0.1M acetic acid because, with dilution, dissociation increases and therefore, conductivity increases.

(b) KCl solution at  $50^\circ\text{C}$  because, with increase in temperature, ionic mobilities of strong electrolytes increase.

18. Draw the structures of the following derivatives :

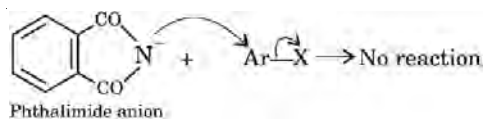
(a) 2,4-dinitrophenylhydrazone of benzaldehyde

(b) Semicarbazone of cyclobutanone



19. Why aromatic primary amines cannot be prepared by Gabriel phthalimide synthesis?

**Ans.** The main reaction in the Gabriel phthalimide synthesis is the nucleophilic substitution reaction of phthalimide anion with haloalkane to form N-alkylphthalimide in which halogen of haloalkane is substituted by phthalimide anion. Since the cleavage of C—X bond in haloalkane (C<sub>6</sub>H<sub>5</sub>Cl or C<sub>6</sub>H<sub>5</sub>Br) is difficult and therefore, the reaction between aryl halide and phthalimide anion does not occur to form N-aryl phthalimide.



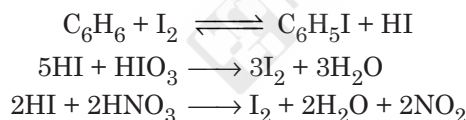
Therefore, aromatic primary amines cannot be prepared by Gabriel phthalimide reaction.

**20. What is the effect of denaturation on the structure of proteins ?**

**Ans.** During denaturation, the protein molecule uncoils from an ordered and specific conformation into a more random conformation. Denaturation does not change the primary structure of protein but results from a rearrangement of secondary and tertiary structures.

**21. Aryl chlorides and bromides can be easily prepared by electrophilic substitution of arenes with chlorine and bromine respectively in the presence of Lewis acid catalysts. But why does preparation of aryl iodides requires presence of an oxidising agent ?**

**Ans.** Iodination reactions are reversible in nature. Therefore, to carry out the reaction in the forward direction, HI formed during iodination is removed by oxidation with iodic acid (HIO<sub>3</sub>) or nitric acid (HNO<sub>3</sub>).



### SECTION-C

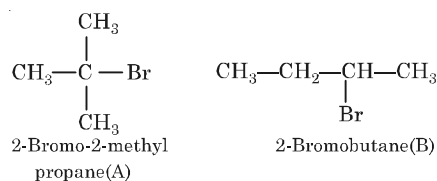
This section contains 7 questions with internal choice in one question. The following questions are short answer type and carry 3 marks each.

**22. Compound 'A' with molecular formula C<sub>4</sub>H<sub>9</sub>Br is treated with aq. KOH solution. The rate of this reaction depends upon the concentration of the compound 'A' only. When another optically active isomer 'B' of this compound was treated with aq. KOH solution, the rate of reaction was found to be dependent on concentration of compound and KOH both.**

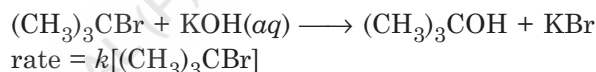
**(i) Write down the structural formula of both compounds 'A' and 'B'.**

**(ii) Out of these two compounds, which one will be converted to the product with inverted configuration.**

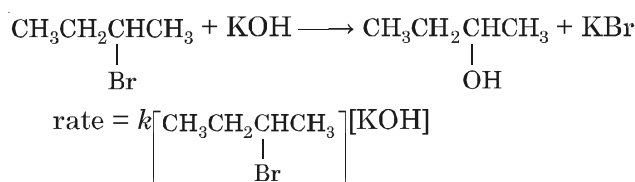
**Ans.** (i) The structural formulae of isomers of C<sub>4</sub>H<sub>9</sub>Br are



(ii) Since the rate of reaction of compound 'A' (C<sub>4</sub>H<sub>9</sub>Br) with aqueous KOH depends upon the concentration of compound 'A' only, therefore, the reaction occurs by S<sub>N</sub>1 mechanism and compound 'A' is tertiary bromide i.e., 2-bromo-2-methylpropane.



Since compound 'B' is optically active and is an isomer of compound 'A' (C<sub>4</sub>H<sub>9</sub>Br), therefore, compound 'B' must be 2-bromobutane. Since the rate of reaction of compound 'B' with aqueous KOH depends upon the concentration of compound 'B' and KOH, therefore, the reaction occurs by S<sub>N</sub>2 mechanism and product of hydrolysis will have inverted configuration.



Compound 'B' will be converted with inverted configuration.

**23. Define the following as related to proteins:**

**(i) Peptide linkage**

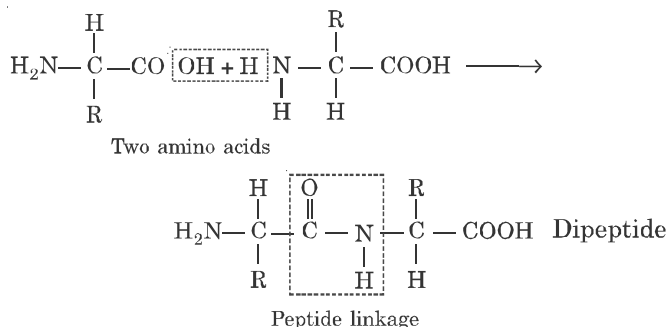
**(ii) Primary structure**

**(iii) Denaturation.**

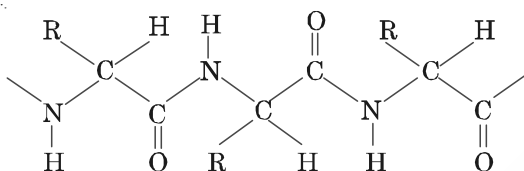
**Ans.** (i) **Peptide linkage :** Peptide bond is formed by the condensation of two or more, same or different α-amino acids. The condensation occurs between amino acids with the elimination of water. In this case, the carboxyl group of one amino acid and amino group of another amino acid get condensed with the elimination of water molecule.



The resulting  $\text{—}\overset{\text{O}}{\parallel}{\text{C}}\text{—NH—}$  linkage is called **peptide linkage** : The formation of a dipeptide and the peptide linkage is shown below :

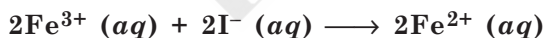


(ii) **Primary structure** : The primary structure of proteins gives the sequence in which the amino acids are linked in one or more polypeptide chains of proteins. This is shown below :



(iii) **Denaturation** : A process that changes the physical and biological properties of proteins without affecting the chemical composition of a protein is called **denaturation**. The denaturation is caused by certain physical or chemical treatments such as changes in pH, temperature, presence of some salts or certain chemical agents.

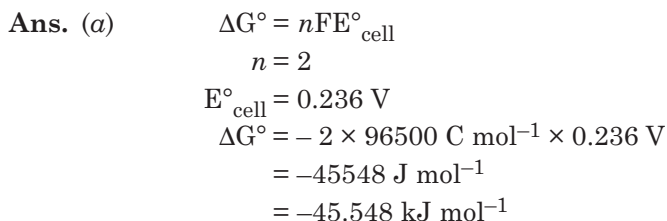
24. (a) The cell in which the following reaction occurs :



+  $\text{I}_2 (\text{s})$  has  $E_{\text{cell}}^{\circ} = 0.236 \text{ V}$  at 298 K. Calculate the standard Gibbs energy of the cell reaction. (Given:  $1\text{F} = 96,500 \text{ C mol}^{-1}$ )

(b) How many electrons flow through a metallic wire if a current of 0.5 A is passed for 2 hours ?

(Given :  $1\text{F} = 96500 \text{ C mol}^{-1}$ )



$$\begin{aligned} (b) \quad Q &= I \times t \\ &= 0.5 \times 2 \times 60 \times 60 \\ &= 3600 \text{ C} \end{aligned}$$

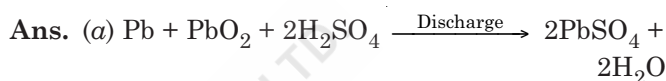
$$\text{Now, } 96500 \text{ C} = 6.022 \times 10^{23} \text{ electrons}$$

$$\begin{aligned} 3600 \text{ C} &= \frac{6.022 \times 10^{23}}{96500} \\ &= 2.25 \times 10^{22} \text{ electrons.} \end{aligned}$$

Or

(a) Write the cell reaction of a lead storage battery when it is discharged. How does the density of the electrolyte change when the battery is discharged ?

(b) How will the pH of brine (aq. NaCl solution) be affected when it is electrolysed ?



Density of electrolyte decreases because water is formed and sulphuric acid is consumed as the product during discharge of the battery.

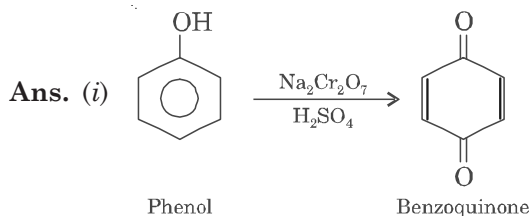
(b) Since NaOH is formed during electrolysis, pH of the brine solution will increase.

25. How would you convert the following :

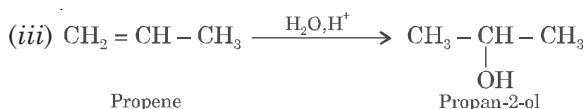
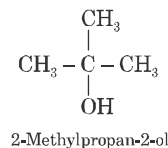
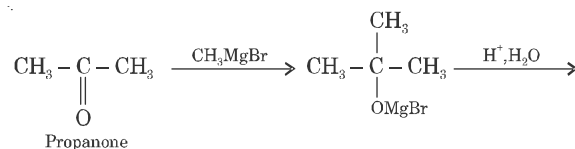
(i) Phenol to benzoquinone

(ii) Propanone to 2-methylpropan-2-ol

(iii) Propene to propan-2-ol



(ii)



26. Nickel forms three complexes  $[\text{Ni}(\text{CO})_4]$  (A),  $[\text{Ni}(\text{CN})_4]^{2-}$  (B) and  $[\text{NiCl}_4]^{2-}$  (C).

(i) Which of these is/are paramagnetic ?

(ii) Which of these is/are involve  $sp^3$  hybridisation ?

(iii) Which of these is / are square planar ?

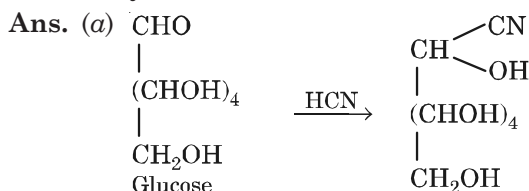
Ans. (i)  $[\text{NiCl}_4]^{2-}$

(ii)  $[\text{NiCl}_4]^{2-}$ ,  $[\text{Ni}(\text{CO})_4]$

(iii)  $[\text{Ni}(\text{CN})_4]^{2-}$

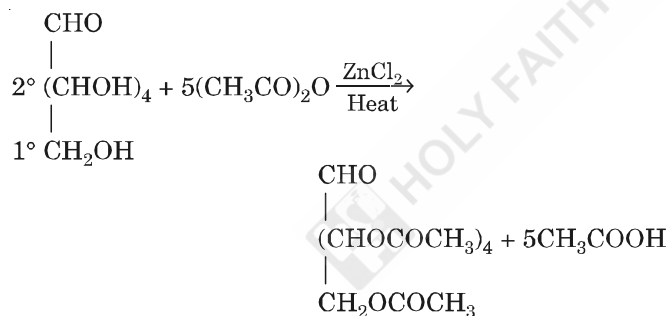
27. (a) Write a balanced equation for the reaction between glucose and hydrogen cyanide. What inference can we draw from it ?

(b) Samta reacted glucose with acetic anhydride. Will the reaction help her to determine the number of secondary alcoholic groups and the number of primary alcoholic groups that are present in a glucose molecule ? Justify your answer.



This infers that glucose contains an aldehydic or carbonyl group.

(b) Both primary and secondary alcohols in glucose molecule undergo acetylation with acetic anhydride



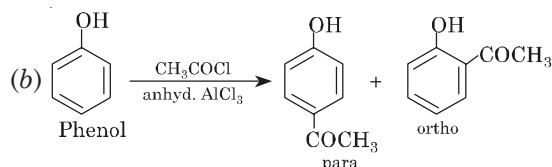
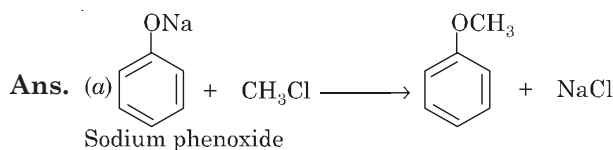
The formation of penta-acetyl derivative suggests the presence of 5-OH groups ( $1^\circ$  and  $2^\circ$ ). Therefore, the reaction will not help Samta to determine the number of secondary alcoholic groups and the number of primary alcoholic groups in glucose molecule.

28. What happens when

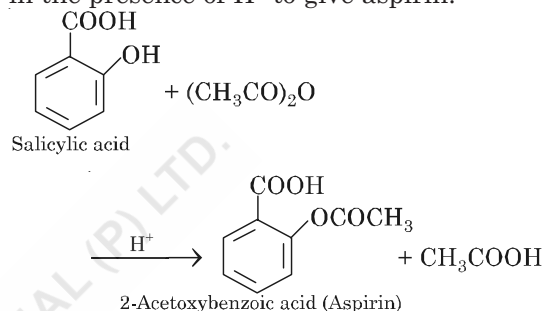
(a) Sodium phenoxide is treated with  $\text{CH}_3\text{Cl}$  ?

(b) Phenol is treated with  $\text{CH}_3\text{COCl}$ / anhydrous  $\text{AlCl}_3$  ?

(c) Salicylic acid is treated with  $(\text{CH}_3\text{CO})_2\text{O}$ /  $\text{H}^+$  ?



(c) Salicylic acid is treated with acetic anhydride in the presence of  $\text{H}^+$  to give aspirin.



#### SECTION-D

The following questions are case-based questions. Each question has an internal choice and carries 4 (1+1+2) marks each.

Read the passage carefully and answer the questions that follow :

29. Svante Arrhenius showed that the dependence of the rate constant of a reaction on temperature can be expressed by the following equation known as the Arrhenius equation.

$$k = A e^{-E_a/RT}$$

where  $E_a$  is the activation energy of the reaction,  $A$  represents collision frequency and is called the frequency factor. It can be assumed to be constant for a reaction over a fairly wide temperature range. The Arrhenius equation is useful in studying reactions involving simple species. But for complex reactions the frequency factor  $A$  in the equation does not depend mainly on the collision frequency. For these reactions, orientation of reactant molecules when they collide also becomes important. Therefore, to account for effective collisions, another factor, called the orientation factor is also introduced. Thus, in the collision theory, activation energy and proper orientation of the molecules determine the criteria for an effective collision and hence the rate of a chemical reaction.

(i) In the Arrhenius equation, what does the factor  $e^{-E_a/RT}$  correspond to ?

(ii) A reaction X has low activation energy while reaction Y has higher activation energy. Which of these X or Y will be fast reaction ?

(iii) The rate constant for the first order decomposition of a reactant is given by

$$\log k = 13.6 - \frac{1.0 \times 10^3}{T}$$

What is the value of  $E_a$  for the reaction? ( $R = 8.3 \text{ JK}^{-1} \text{ mol}^{-1}$ )

Or

A catalyst lowers the activation energy of a reaction at  $27^\circ\text{C}$  from 70 kJ. to 35.5 kJ. What is the ratio of rate constant of catalysed and uncatalysed reaction ?

Ans. (a)  $e^{-E_a/RT}$  corresponds to the fraction of molecules having kinetic energy greater than  $E_a$ .

(b) X

(c)  $\log k = \log A - \frac{E_a}{2.303RT}$

Comparing,

$$\log k = 13.6 - \frac{1.0 \times 10^3}{T}$$

$$\therefore \frac{E_a}{2.303R} = 1.0 \times 10^3$$

$$E_a = 1.0 \times 10^3 \times 2.303 \times 8.3 \\ = 19.11 \times 10^3 \text{ J mol}^{-1} \\ \text{or } 19.11 \text{ kJ mol}^{-1}$$

Or

$$k_1 = Ae^{-E_a/RT}$$

$$k_2 = Ae^{-E_a/RT}$$

for catalysed reaction

$$\log \frac{k_2}{k_1} = \frac{E_a - E_a(c)}{2.303 \times 8.314 \times 300} \\ = \frac{(70 - 35.5) \times 10^3}{2.303 \times 8.314 \times 300} = 10^6$$

$$\therefore \frac{k_2}{k_1} = 10^6.$$

30. Read the passage carefully and answer the questions that follow :

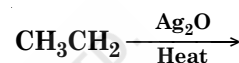
Alkyl halides have polar C-X bond and undergo nucleophilic substitution reactions. These give

a variety of products with nucleophiles such as  $-\text{OH}^-$ ,  $-\text{OR}$ ,  $-\text{NH}_2$ ,  $-\text{CN}$ ,  $-\text{NC}$ ,  $-\text{NO}_2^-$ ,  $-\text{ONO}^-$ ,  $\text{RCOO}^-$ , etc. They undergo mainly two types of nucleophilic substitution reactions;  $\text{S}_{\text{N}}1$  and  $\text{S}_{\text{N}}2$ .  $\text{S}_{\text{N}}1$  reactions are two steps reactions which proceed through the formation of carbocations while  $\text{S}_{\text{N}}2$  reactions are one step reaction which proceeds through the formation of transition state. The stability of carbocation and transition state determine the reactivity of alkyl halides.

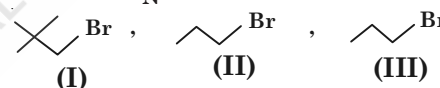
(a) Write the main products A and B in the following reaction.



(b) Complete the reaction :



(c) (i) Arrange the following in the increasing order of reactivity towards  $\text{S}_{\text{N}}2$  reaction:



(ii) Which out of  $\text{S}_{\text{N}}1$  or  $\text{S}_{\text{N}}2$  results into inversion of configuration ?

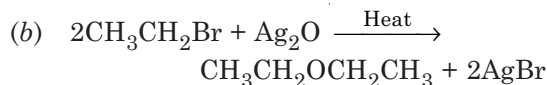
Or

How will you convert the following:

(i) 1-Bromopropane to 2-bromopropane

(ii) 2-Chlorobutane to 3, 4-dimethylhexane.

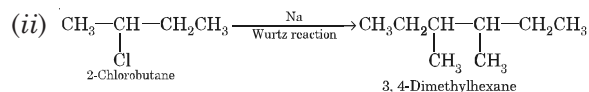
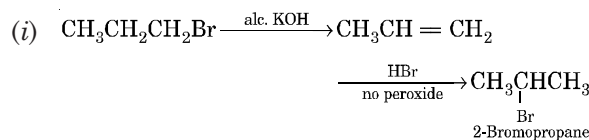
Ans. (i) (a) A :  $\text{CH}_3\text{CH}_2\text{---O---N=O}$  (Ethyl nitrite)  
B :  $\text{CH}_3\text{CH}_2\text{NO}_2$  (Nitroethane)



(c) (i) (I) < (III), < (II)

(ii)  $\text{S}_{\text{N}}2$

Or

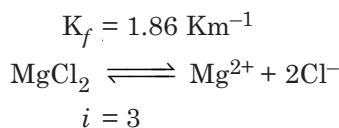


## SECTION-E

The following questions are long answer type and carry 5 marks each. Two questions have an internal choice.

31. (a) (i) Write the reaction involved in Cannizzaro's reaction.





$$\Delta T_f = \frac{3 \times 1.86 \times 1.9 \times 1000}{95 \times 50} = 2.232 \text{ K.}$$

Freezing point of solution =  $273 - 2.232 = 270.768 \text{ K}$

(b) (i) The elevation in boiling point is a colligative property and depends upon the number of moles of solute added. Higher the concentration of solute added, higher will be the elevation in boiling point. Thus, 2M glucose solution has higher boiling point than 1M glucose solution.

(ii) When the external pressure applied becomes more than the osmotic pressure of the solution, then the solvent molecules from the solution pass through the semi-permeable membrane to the solvent side. This process is called reverse osmosis.

Or

(a) When 2.56 g of sulphur was dissolved in 100 g of  $\text{CS}_2$ , the freezing point lowered by 0.383 K. Calculate the formula of sulphur ( $\text{S}_x$ ).

( $K_f$  for  $\text{CS}_2 = 3.83 \text{ K kg mol}^{-1}$ , Atomic mass of sulphur =  $32 \text{ g mol}^{-1}$ )

(b) Blood cells are isotonic with 0.9% sodium chloride solution. What happens if we place blood cells in a solution containing

(i) 1.2% sodium chloride solution ?

(ii) 0.4% sodium chloride solution ?

Ans. (a) 
$$M_B = \frac{K_f \times 1000 \times w_B}{w_A \times \Delta T_f}$$

$w_B = 2.56 \text{ g}$ ,  $w_A = 100 \text{ g}$ ,  $\Delta T_f = 0.383 \text{ K}$ ,  
 $K_f = 3.83 \text{ Km}^{-1}$

$$M_B = \frac{3.83 \times 1000 \times 2.56}{100 \times 0.383} = 256$$

Let the molecular formula of sulphur =  $\text{S}_x$

$$32 \times x = 256$$

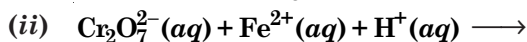
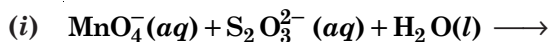
$$x = \frac{256}{32} = 8$$

$\therefore$  Molecular formula =  $\text{S}_8$

(b) (i) 1.2% sodium chloride solution is hypertonic with respect to 0.9% sodium chloride solution or blood cells. When red blood cells are placed in this solution, water flows out of the cell and they shrink due to loss of water by osmosis.

(ii) 0.4% sodium chloride solution is hypertonic with respect to 0.9% sodium chloride solution or blood cells. When red blood cells are placed in this solution, water flows into the cells and they swell.

33. (a) Complete the following chemical equations :

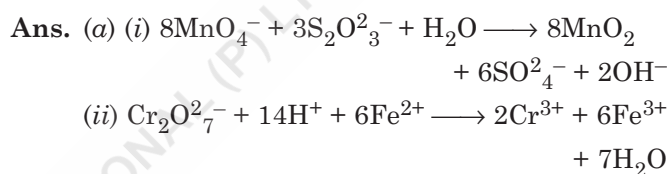


(b) Explain the following observations :

(i)  $\text{La}^{3+}$  ( $Z = 57$ ) and  $\text{Lu}^{3+}$  ( $Z = 71$ ) do not show any colour in solutions.

(ii) Among the divalent cations in the first series of transition elements, manganese exhibits the maximum paramagnetism.

(iii)  $\text{Cu}^+$  ion is not known in aqueous solutions.



(b) (i) In  $\text{La}^{3+}$  there are no  $f$ -electrons and in  $\text{Lu}^{3+}$  the  $4f$  sub-shell is complete ( $4f^{14}$ ). Therefore, there are no unpaired electrons and consequently,  $d-d$  transitions are not possible. Hence,  $\text{La}^{3+}$  and  $\text{Lu}^{3+}$  do not show any colour in solutions.

(ii) Among the divalent cations in the first transition series, Mn ( $Z = 25$ ) exhibits the maximum paramagnetism because it has maximum number of unpaired electrons ( $3d^5$ ); five unpaired electrons.

(iii) In aqueous solution,  $\text{Cu}^+$  undergoes disproportionation changing to  $\text{Cu}^{2+}$  ion.



Or

How would you account for the following :

(i) Among lanthanoids, Ln(III) compounds are predominant. However, occasionally in solutions or in solid compounds, +2 and +4 ions are also obtained.

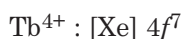
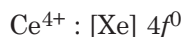
(ii) The  $E^\circ_{\text{M}^{2+}|\text{M}}$  for copper is positive (0.34 V). Copper is the only metal in the first series of transition elements showing this behaviour.

(iii) The metallic radii of the third (5d) series of transition metals are nearly the same as

those of the corresponding members of the second series.

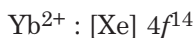
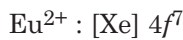
**Ans.** (i) All lanthanoids exhibit a common stable oxidation state of +3. In addition some lanthanoids show +2 and +4 oxidation states also in solution or in solid compounds. These are shown by those elements which by doing so attain the stable  $f^0$  (empty  $f$ -subshell),  $f^7$  (half filled  $f$ -subshell) and  $f^{14}$  (filled  $f$ -subshell) configurations. For example,

(a) Ce and Tb exhibit +4 oxidation states. Cerium (Ce) and terbium (Tb) attain  $f^0$  and  $f^7$  configurations respectively when they get +4 oxidation state, as shown below:



(b) Eu and Yb exhibit + 2 oxidation states.

Europium and ytterbium get  $f^7$  and  $f^{14}$  configurations in +2 oxidation state as shown below:



(ii) The  $E^\circ_{\text{M}^{2+}|\text{M}}$  value for copper is positive and this shows that it is least reactive metal out of first transition series. This is because copper has high enthalpy of atomisation and enthalpy of ionisation. Therefore, the high energy required to convert  $\text{Cu(s)}$  to  $\text{Cu}^{2+}(\text{aq})$  is not balanced by its hydration enthalpy.

(iii) The metallic radii of third transition series elements are virtually same as those of corresponding members of the second transition series because of the lanthanoid contraction. Due to the presence of lanthanoids between second and third transition series, the expected increase in radii vanishes. Consequently, the pairs of elements Zr-Hf, Nb-Ta, Mo-W, etc have almost similar sizes.

# Holy Faith New Style Sample Paper-2

(Based on the Latest Design & Syllabus Issued by CBSE)

CLASS—12th  
CHEMISTRY

Time Allowed : 3 Hours

Maximum Marks : 70

General Instructions : Same as in Holy Faith New Style Sample Paper-1

## SECTION—A

The following questions are multiple-choice questions with one correct answer. Each question carries 1 mark. There is no internal choice in this section.

1. The rate constant of a first order reaction is  $4.33 \times 10^{-2} \text{ mol L}^{-1} \text{ min}^{-1}$ . If the initial concentration is  $0.25 \text{ mol L}^{-1}$ , the half life period is

- (a) 960 s (b) 1200 s  
(c) 693 s (d) 16 s.

Ans. (a) 960 s

$$\text{Hint : } t_{1/2} = \frac{0.693}{4.33 \times 10^{-2}} = 16 \text{ min} = 16 \times 60 = 960 \text{ s.}$$

2. Pressure does not have any significant effect on solubility of solids in liquids because :

- (a) Solids are highly compressible  
(b) Liquids are highly compressible  
(c) Solubility of solid in liquid is directly proportional to partial pressure  
(d) Solids and liquids are highly incompressible

Ans. (d) Solids and liquids are highly incompressible

Hint : Solids and liquids are highly incompressible and practically remain unaffected by changes in pressure. Therefore, pressure does not have any effect on solubility of solids in liquids.

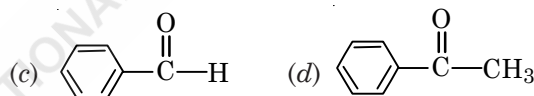
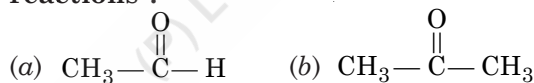
3. Reaction  $A + B \longrightarrow C + D + 38 \text{ k cal}$ , has activation energy  $20 \text{ k cal}$ . Activation energy for reaction  $C + D \longrightarrow A + B$  is :

- (a) 20 k cal (b) -20 k cal  
(c) 58 k cal (d) 18 k cal.

Ans. (c) 58 k cal

$$\text{Hint : } E_a(\text{backward}) = \Delta E + E_a(\text{forward}) \\ = 38 + 20 = 58 \text{ k cal.}$$

4. Which of the following compound is most reactive towards nucleophilic addition reactions ?



Ans. (a)  $\text{CH}_3-\overset{\text{O}}{\parallel}{\text{C}}-\text{H}$ .

5. Glucose on reaction with HI and red P gives n-hexane. This suggests the presence of :

- (a) one primary—OH group  
(b) straight chain of six C atoms  
(c) one aldehydic group  
(d) one double bond

Ans. (b) straight chain of six C atoms.

6. The amount of solute (molar mass  $60 \text{ g mol}^{-1}$ ) that must be added to  $180 \text{ g}$  of water so that the vapour pressure of water is lowered by 10% is :

- (a) 30 g (b) 60 g  
(c) 120 g (d) 12 g.

Ans. (b) 60 g

$$\text{Hint : } \frac{p_1 - p_1}{p_1} = \frac{w_2 M_1}{w_1 M_2}$$

$$\therefore \frac{10}{100} = \frac{w_2 \times 18}{180 \times 60}$$

$$\therefore w_2 = \frac{10}{100} \times \frac{180 \times 60}{18} = 60 \text{ g.}$$

7. The e.m.f. of the following daniell cell at 298 K is  $E_1$ .



When concentration of  $\text{ZnSO}_4$  is 1.0 M and that

of  $\text{CuSO}_4$  is 0.01 M, the e.m.f. changed to  $E_2$ . What is the relationship between  $E_1$  and  $E_2$ ?

- (a)  $E_1 > E_2$                       (b)  $E_1 < E_2$   
(c)  $E_1 = E_2$                       (d)  $E_2 = 0 \neq E_1$

Ans. (a)  $E_1 > E_2$

Hint : For the given cell,  $\text{Zn} + \text{Cu}^{2+} \rightleftharpoons \text{Zn}^{2+} + \text{Cu}$

$$E = E^\circ - \frac{0.059}{2} \log \frac{[\text{Zn}^{2+}]}{[\text{Cu}^{2+}]} \therefore E_1 = E^\circ - \frac{0.059}{2} \log \frac{0.01}{1.0}$$

$$= E^\circ + 0.059$$

$$E_2 = E^\circ - \frac{0.059}{2} \log \frac{1.0}{0.01} = E^\circ - 0.059 \therefore E_1 > E_2.$$

8. The magnetic moment of a transition metal ion has been found to be 3.87 B.M. It is probably

- (a)  $\text{Fe}^{2+}$                                   (b)  $\text{Ti}^{2+}$   
(c)  $\text{Cr}^{3+}$                                   (d)  $\text{Ni}^{2+}$

Ans. (c)  $\text{Cr}^{3+}$

Hint : The number of unpaired electrons 'n' is related to magnetic moment as

$$\mu = \sqrt{n(n+2)} \text{ B.M.}$$

$$\sqrt{n(n+2)} = 3.87$$

$$n(n+2) = 14.98 \text{ or } n = 3$$

No. of unpaired electrons in different ions

$$\text{Fe}^{2+} : 3d^6 = 4, \quad \text{Ti}^{3+} : 3d^1 = 1 \quad \text{Cr}^{3+} : 3d^3 = 3,$$

$$\text{Ni}^{2+} : 3d^8 = 2$$

It corresponds to  $\text{Cr}^{3+}$ .

9. Match the reaction with the main product.

Reaction	Main product
(i) $\text{C}_6\text{H}_5\text{N}_2^+\text{Cl}^- \xrightarrow{\text{H}_3\text{PO}_3, \text{H}_2\text{O}}$	(A) $\text{C}_6\text{H}_5\text{NO}_2$
(ii) $\text{C}_6\text{H}_5\text{N}_2^+\text{Cl}^- \xrightarrow[\text{Boil}]{\text{H}_2\text{O}}$	(B) $\text{C}_6\text{H}_6$
(iii) $\text{C}_6\text{H}_5\text{N}_2^+\text{Cl}^- \xrightarrow[\text{H}_3\text{O}^+]{\text{CuCN}}$	(C) $\text{C}_6\text{H}_5\text{OH}$
(iv) $\text{C}_6\text{H}_5\text{N}_2^+\text{Cl}^- \xrightarrow[\text{(ii) NaNO}_2, \text{Cu}]{\text{(i) HBF}_4}$	(D) $\text{C}_6\text{H}_5\text{COOH}$

(a) (i) (A), (ii) (D), (iii) (B), (iv) (C)

(b) (i) (C), (ii) (D), (iii) (A), (iv) (B)

(c) (i) (B), (ii) (A), (iii) (C), (iv) (D)

(d) (i) (B), (ii) (D), (iii) (C), (iv) (A)

Ans. (d) (i) (B), (ii) (D), (iii) (C), (iv) (A).

10. Match the following :

List I	List II
A Van't Hoff factor, i	I. Cryoscopic constant
B $K_f$	II. Isotonic solution
C Solution with same osmotic pressure	III. Normal molar mass Abnormal molar mass
D Azeotropes	IV. Solution with same composition of vapour above it.

Choose the correct answer from the options given below:

- (a) A-III, B-I, C-II, D-IV  
(b) A-III, B-II, C-I, D-IV  
(c) A-III, B-I, C-IV, D-II  
(d) A-I, B-III, C-II, D-IV

Ans. (a) A-III, B-I, C-II, D-IV.

11. Which of the following elements have half-filled f-orbitals in their ground state?

(Given: atomic number Sm = 72; Eu = 63; Tb = 65; Gd = 64; Pm = 61)

- A. Sm                                  B. Eu                                  C. Tb  
D. Gd                                  E. Pm

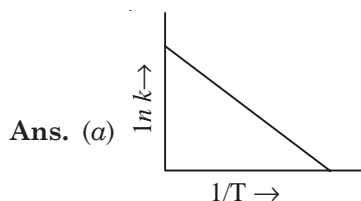
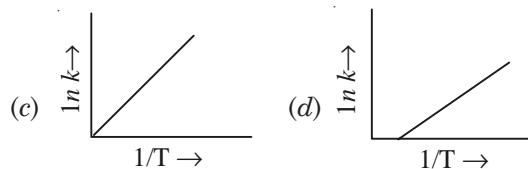
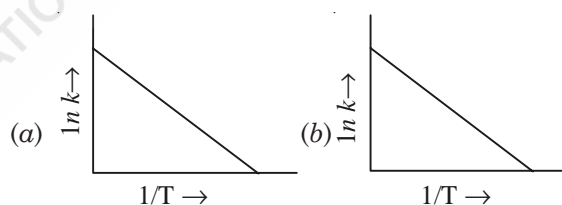
Choose the correct answer from the options given below :

- (a) B and D only                      (b) A and E only  
(c) A and B only                      (d) C and D only

Ans. (a) B and D only.

12. According to Arrhenius equation rate constant  $l$  is equal to  $A e^{-E_a/RT}$ . Which of the following options represents the graph in

$k$  vs  $\frac{1}{T}$ ?



In the following questions, a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices:

- (a) Assertion and reason both are correct statements and reason is correct explanation for assertion.  
(b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.  
(c) Assertion is correct statement but reason is wrong statement.  
(d) Assertion is wrong statement but reason is correct statement.



13. **Assertion (A)** : Phenol undergoes Kolbe's reaction but ethanol does not.

**Reason (R)** : Phenol is more acidic than ethanol.

**Ans.** (b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

14. **Assertion (A)** : The  $\alpha$ -hydrogen atom in carbonyl compounds is less acidic.

**Reason (R)** : The anion formed after the loss of  $\alpha$ -hydrogen atom is resonance stabilised.

**Ans.** (d) Assertion is wrong statement but reason is correct statement.

**Correct assertion** : The  $\alpha$ -hydrogen atom in carbonyl compounds is acidic.

15. **Assertion (A)** : Magnetic moment values of actinides are lesser than the theoretically predicted values.

**Reason (R)** : Actinide elements are strongly paramagnetic.

**Ans.** (b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

16. **Assertion (A)** : The secondary structure of a protein gives the shape or conformation of the protein molecule.

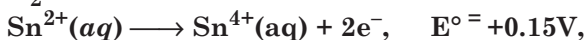
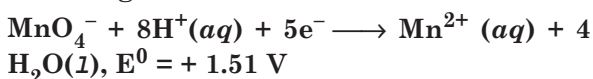
**Reason (R)** : The secondary structure gives the manner in which the polypeptide chains are folded or arranged.

**Ans.** (a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

### SECTION-B

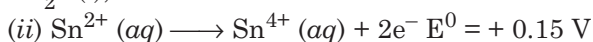
This section contains 5 questions with internal choice in one question. The following questions are very short answer type and carry 2 marks each.

17. Two half reactions of an electrochemical cell are given below :

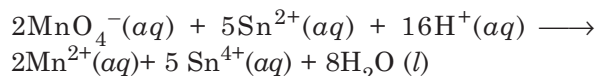


Construct the redox reaction equation from the two half reactions and calculate the cell potential from the standard potential and predict if the reaction is reactant or product favoured ?

**Ans.** (i)  $\text{MnO}_4^- (\text{aq}) + 8\text{H}^+ (\text{aq}) + 5\text{e}^- \longrightarrow \text{Mn}^{2+} (\text{aq}) + 4\text{H}_2\text{O}(\text{l}), E^0 = +1.51 \text{ V}$



Redox reaction can be obtained by multiplying eq. (i) by 2 and eq. (ii) by 5 and then adding :

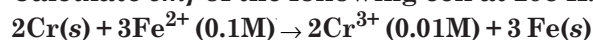


$$E^0 = E_{\text{cathode}}^0 - E_{\text{anode}}^0 = +1.51 - 0.15 = +1.36 \text{ V}$$

Since  $E^0$  cell is +ve, the reaction is product favoured.

Or

Calculate *emf* of the following cell at 298 K:



Given :  $E^0 (\text{Cr}^{3+} | \text{Cr}) = -0.74 \text{ V}$ ,

$E^0 (\text{Fe}^{2+} | \text{Fe}) = -0.44 \text{ V}$

**Ans.**  $2\text{Cr}(\text{s}) + 3\text{Fe}^{2+} (0.1\text{M}) \rightarrow 2\text{Cr}^{3+} (0.01\text{M}) + 3\text{Fe}(\text{s})$

$$E = E^0 - \frac{0.059}{6} \log \frac{[\text{Cr}^{3+}]^2}{[\text{Fe}^{2+}]^3}$$

$$E^0 = -0.44 - (-0.74) = 0.30$$

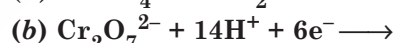
$$E = 0.30 - \frac{0.059}{6} \log \frac{(0.01)^2}{(0.1)^3}$$

$$E = 0.30 - \frac{0.059}{6} \log 0.1$$

$$E = 0.30 - \frac{0.059}{6} \times (-1)$$

$$E = 0.30 - 0.01(-1) = 0.31 \text{ V}$$

18. Complete the following equations :

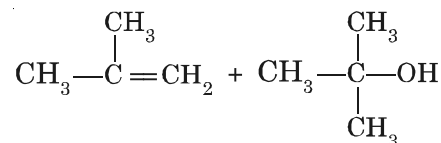
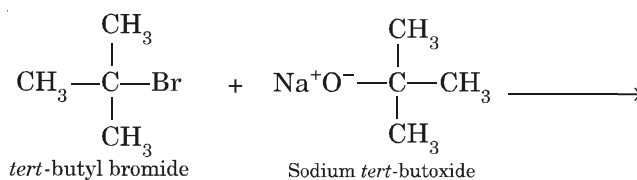


**Ans.** (a)  $2\text{MnO}_4^- + 5\text{NO}_2^- + 6\text{H}^+ \longrightarrow 2\text{Mn}^{2+} + 5\text{NO}_3^- + 3\text{H}_2\text{O}$



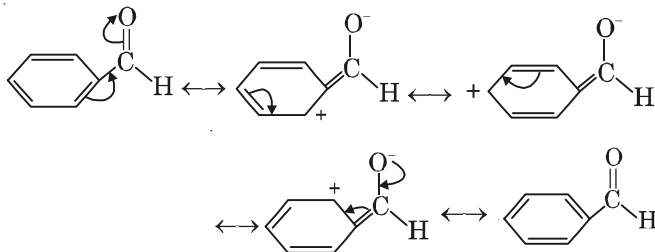
19. Why di-*tert*-butyl ether cannot be prepared by Williamson synthesis ?

**Ans.** To prepare di-*tert*-butyl ether by Williamson's synthesis, we require *tert*-butyl bromide and sodium *tert*-butoxide. Since *tert*-butyl bromide is a 3° alkyl halide, it prefers to undergo elimination rather than substitution. Therefore, isobutylene is obtained as the product rather than di-*tert* butyl ether.



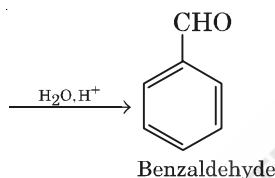
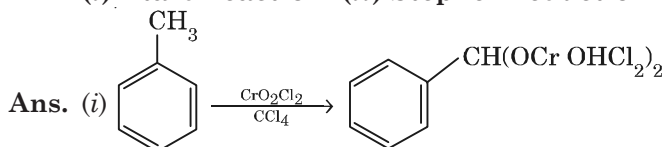
20. Would you expect benzaldehyde to be less or more reactive in nucleophilic addition reactions than propanal ? Explain.

**Ans.** The carbon atom of the carbonyl group of benzaldehyde is less electrophilic than carbon atom of the carbonyl group in propanal. This is because the polarity of the carbonyl group is decreased in benzaldehyde due to resonance. Therefore, benzaldehyde is less reactive than propanal.

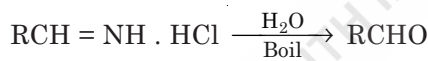


21. Write the reactions involved in the following :

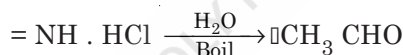
(i) Etard reaction (ii) Stephen reduction



(ii)  $\text{RCN} + \text{SnCl}_2 + 2\text{HCl} \longrightarrow$



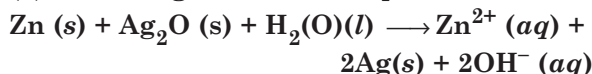
e.g.,  $\text{CH}_3\text{CN} + \text{SnCl}_2 + 2\text{HCl} \longrightarrow \text{CH}_3\text{CH} = \text{NH} \cdot \text{HCl}$



### SECTION-C

This section contains 7 questions with internal choice in one question. The following questions are short answer type and carry 3 marks each.

22. (a) Following reaction takes place in the cell :



Calculate  $\Delta_r G^\circ$  of the reaction.

[Given:  $E^\circ_{(\text{Zn}^{2+}/\text{Zn})} = -0.76\text{V}$ ,  $E^\circ_{(\text{Ag}^+/\text{Ag})} = 0.80\text{V}$ ,  $1\text{F} = 96,500\text{C mol}^{-1}$ ]

$$= 0.80\text{V}, 1\text{F} = 96,500\text{C mol}^{-1}]$$

(b) How can you determine limiting molar conductivity ( $\Lambda_m^\circ$ ) for strong electrolyte and weak electrolyte ?

**Ans.**  $E^\circ_{\text{cell}} = E^\circ_{\text{Ag}^+/\text{Ag}} - E^\circ_{\text{Zn}^{2+}/\text{Zn}} = 0.80 - (-0.76) = 1.56\text{V}$   
 $\Delta G^\circ = -nFE^\circ_{\text{cell}}$  (Here  $n = 2$ )

$$= -2 \times 96500 \times 1.56$$

$$= -301080\text{J mol}^{-1}$$

$$\text{or } = -301.080\text{kJ mol}^{-1}$$

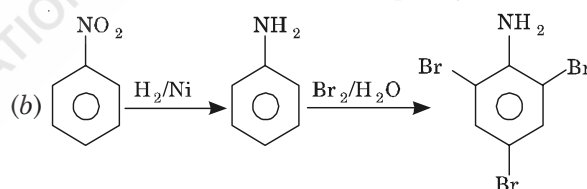
(b) For strong electrolytes  $\Lambda_m^\circ$  can be obtained as intercept from the plot of  $\Lambda_m^\circ$  vs  $c$ . graph. For weak electrolytes  $\Lambda_m^\circ$  can be obtained from Kohlrausch law.

23. (a) Give a chemical test to distinguish between N-methylethanamine and N,N-dimethyl ethanamine.

(b) Write the reaction for catalytic reduction of nitrobenzene followed by reaction of product so formed with bromine water.

(c) Out of butan-1-ol and butan-1 amine, which will be more soluble in water and why ?

**Ans.** (a) N-methylethanamine is a secondary amine. When it reacts with benzenesulphonyl chloride, it forms N-ethyl-N methylsulphonamide while N,N-dimethylethanamine is a tertiary amine it does not react with benzenesulphonyl chloride.



(c) Butan-1-ol is more stable in water because alcohol forms stronger hydrogen bonds with water than formed by amine due to higher electronegativity of O in alcohol than N in amine.

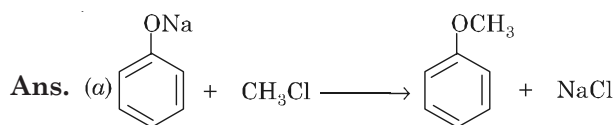
24. What happens when

(a) Sodium phenoxide is treated with  $\text{CH}_3\text{Cl}$  ?

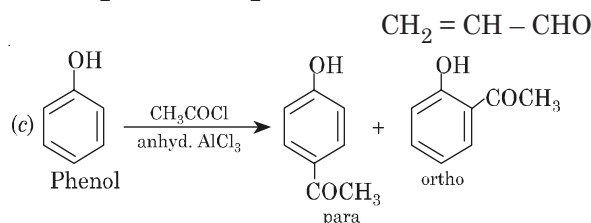
(b)  $\text{CH}_2 = \text{CH} - \text{CH}_2 - \text{OH}$  is oxidised by PCC ?

(c) Phenol is treated with  $\text{CH}_3\text{COCl}$ /anhydrous  $\text{AlCl}_3$  ?

Write chemical equations in support of your answer.



(b)  $\text{CH}_2 = \text{CH} - \text{CH}_2 - \text{OH} \xrightarrow{\text{PCC}} \text{CH}_2 = \text{CH} - \text{CHO}$



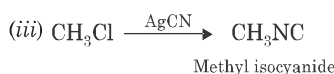
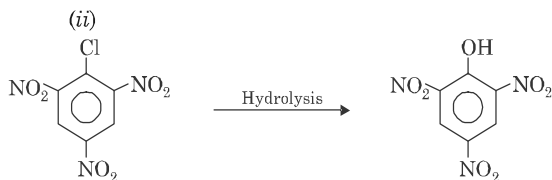
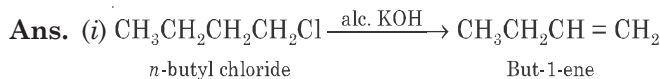
Or

Write the main products when

(i) n-butyl chloride is treated with alcoholic KOH.

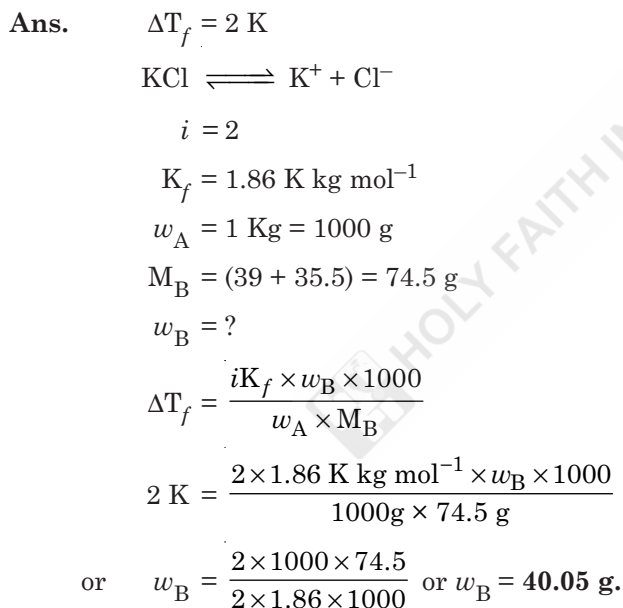
(ii) 2, 4, 6-trinitrochlorobenzene is subjected to hydrolysis.

(iii) methyl chloride is treated with AgCN.



25. Calculate the amount of KCl which must be added to 1 kg of water so that the freezing point is depressed by 2K.

( $K_f$  for water = 1.86 K kg mol<sup>-1</sup>)



26. (a) Complete the following table :

Complex	Electronic configuration (according to CFT)	No. of unpaired electrons
(a) $[\text{Fe}(\text{CN})_6]^{4-}$	.....	.....
(b) $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$	.....	.....
(c) $[\text{FeF}_6]^{3-}$	.....	.....

Ans.

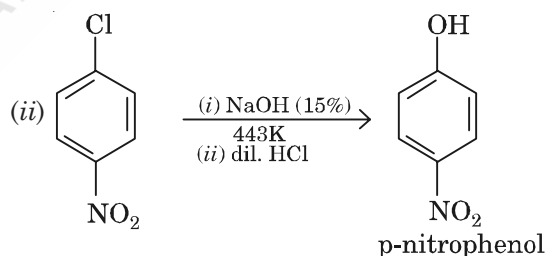
Complex	Electronic configuration (according to CFT)	No. of unpaired electrons
(a) $[\text{Fe}(\text{CN})_6]^{4-}$	$t_2g^6$	0
(b) $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$	$t_2g^4 eg^2$	4
(c) $[\text{FeF}_6]^{3-}$	$t_2g^5$	5

27. (i) Out of  $(\text{CH}_3)_3\text{C-Br}$  and  $(\text{CH}_3)_3\text{C-I}$ , which one is more reactive towards  $\text{S}_{\text{N}}1$  and why?

(ii) Write the product formed when p-nitrochlorobenzene is heated with aqueous NaOH at 443 K followed by acidification.

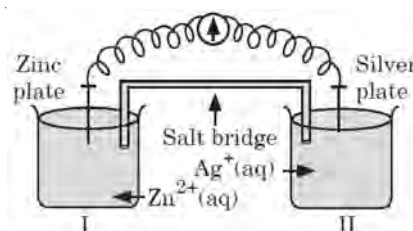
(iii) Why are dextro- and laevo-rotatory isomers of Butan-2-ol difficult to separate by fractional distillation?

Ans. (i)  $(\text{CH}_3)_3\text{C-I}$ , because it can readily form stable carbocation because C-I bond is weaker than C-Br bond.



(iii) Dextro- and laevo-rotatory isomers of butan-2-ol are enantiomers of each other and both have same boiling point. Hence, these cannot be separated by fractional distillation.

28. Observe the following cell and answer the questions that follow :



- (a) Is silver plate the anode or cathode?  
 (b) When does electrochemical cell behave like an electrolytic cell?  
 (c) What will happen to the concentration of  $\text{Zn}^{2+}$  and  $\text{Ag}^+$  when  $E_{\text{cell}} = 0$ ?

- Ans. (a) Cathode.  
 (b) When  $E_{\text{ext}}$  becomes greater than  $E_{\text{cell}}$ .  
 (c) Concentration of  $\text{Zn}^{2+}$  and  $\text{Ag}^+$  become constant (equilibrium concentrations) because the reaction will be at equilibrium.

### SECTION-D

The following questions are case-based questions. Each question has an internal choice and carries 4 (1+1+2) marks each.

Read the passage carefully and answer the questions that follow :

29. The *d*-block elements are the elements which have one or two electrons in the outermost *s*-subshell (*ns*) but the last electron enters the *d*-subshell i.e., (*n*−1) *d*. These consist of 40 elements contained in four rows of ten elements each in 3–12 groups. This set of *d*-block elements are often called transition elements. But sometimes the group 12 elements; zinc, cadmium and mercury are excluded from the transition elements. The physical properties of the transition elements vary greatly. As we move across a period from scandium to copper in first transition series, the nuclear charge, of course increases but the electrons are being added to the inner *3d*-subshell. These inner *3d*-electrons shield the outer *4s*-electrons from the increasing nuclear charge more effectively than the outer shell electrons which shield one another and therefore, atomic radii decrease less rapidly unlike *p*-block elements. These also influence the other physical properties such as ionisation enthalpies, metallic character, oxidation states, oxidation potential, magnetic character, etc. The transition elements also show good tendency to form complexes, form coloured ions and act as catalysts.

(i) In the first transition series, name the element which shows highest oxidation state ?

(ii) How many unpaired electrons are present in  $\text{Fe}^{2+}$  and  $\text{Fe}^{3+}$  ions ?

(iii) (a) Why is third ionisation enthalpy of manganese exceptionally high ?

(b) Which metal in the first transition series exhibits +1 oxidation state most frequently and why ?

Or

Scandium ( $Z = 21$ ) is a transition element but zinc ( $Z = 30$ ) is not. Explain.

- Ans. (i) Manganese  
 (ii)  $\text{Fe}^{2+} : 3d^6$  ; 4 unpaired electrons  
 $\text{Fe}^{3+} : 3d^5$ ; 5 unpaired electrons  
 (iii) (a)  $\text{Mn}^{2+}$  has the electronic configuration:  $[\text{Ar}]3d^5$ . This configuration is symmetrical and

half filled and, therefore, is stable. As a result, high energy is required to remove the third electron and therefore, third ionisation enthalpy is exceptionally high.

(b) Copper has electronic configuration  $3d^{10}4s^1$ . It can easily lose one ( $4s^1$ ) electron to give stable  $3d^{10}$  configuration. Therefore, it exhibits + 1 oxidation state.

Or

According to definition, transition elements are those which have partially filled *d*-subshells in their elementary state or in their commonly occurring oxidation states.

Scandium ( $Z = 21$ ) has partially filled *d*-subshell ( $3d^1$ ) and is therefore, a transition element. On the other hand, zinc ( $Z = 30$ ) has the configuration  $3d^{10}4s^2$ . It does not have partially filled *d*-subshell in its elementary form or in commonly occurring oxidation state ( $\text{Zn}^{2+} : 3d^{10}$ ). Therefore, it is not regarded as transition element.

30. Read the passage carefully and answer the questions that follow :

There are many properties of the dilute solutions which depend upon the number of particles of the solute present in the solution. These are called colligative properties. The addition of non-volatile substances to a solvent decreases the vapour pressure, increases the boiling point and depresses the freezing point. The relative lowering in vapour pressure, elevation in boiling point, depression in freezing point and osmotic pressure are colligative properties. These properties have many practical applications. For example, depression in freezing point helps to make antifreeze solutions or clearing the snow on the roads in cold countries where it snows heavily. The osmosis plays a very significant role in biological processes and reverse osmosis process is used in desalination of sea water.

(a) Name the substance commonly used in car radiators to make antifreeze solutions.

(b) Molal elevation constant for benzene is  $2.58 \text{ K m}^{-1}$ . A solution of a non-volatile substance Z in benzene boils at  $0.129^\circ\text{C}$  higher than benzene. What is the concentration of the solution.

(c) A solution of a non-volatile solute 'X' freezes at  $272.07 \text{ K}$ , while pure water freezes at  $273 \text{ K}$ . What will be boiling point of this solution? ( $K_f = 1.86 \text{ K m}^{-1}$ ,  $K_b = 0.512 \text{ K m}^{-1}$ .)

Or

How does sprinkling of salt help in clearing the snow covered roads in hilly areas ? Explain the phenomenon involved in the process.

Ans. (a) Ethylene glycol.

$$(b) \Delta T_b = K_b \times m$$

$$\text{or } m = \frac{\Delta T_b}{K_b} = \frac{0.129}{2.58} = 0.05 \text{ m}$$

$$(c) \Delta T_f = 273 - 272.07 = 0.93^\circ \text{ or } m = \frac{\Delta T_f}{K_f} = \frac{0.93}{1.86} = 0.5 \text{ m}$$

$$\therefore \Delta T_b = K_b \times m = 0.512 \times 0.5 = 0.256^\circ$$

$$\therefore \text{Boiling point of solution} = 373 + 0.256 = 373.256 \text{ K}$$

Or

When salt is spread over snow covered roads, it lowers the freezing point of water to such an extent that water does not freeze to form ice. As a result, the snow starts melting from the surface and therefore, it helps in clearing the roads. Hence, common salt acts as de-icing agent.

### SECTION-E

The following questions are long answer type and carry 5 marks each. Two questions have an internal choice.

31. (a) An organic compound (A) having molecular formula  $C_4H_8O$  gives orange red precipitate with 2, 4-DNP reagent. It does not reduce Tollens' reagent but gives yellow precipitate of iodoform on heating with  $NaOH$  and  $I_2$ . Compound (A) on reduction with  $NaBH_4$  gives compound (B) which undergoes dehydration reaction on heating with conc.  $H_2SO_4$  to form compound (C). Compound (C) on ozonolysis gives two molecules of ethanal.

Identify (A), (B) and (C) and write their structures. Write the reactions of compound (A) with (i)  $NaOH/I_2$ , and (ii)  $NaBH_4$ .

(b) Give reasons:

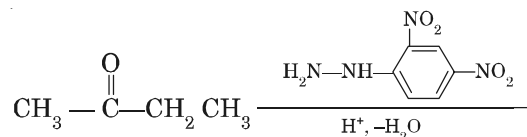
(i) Oxidation of propanal is easier than propanone.

(ii)  $\alpha$ -hydrogen of aldehydes and ketones is acidic in nature.

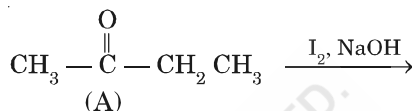
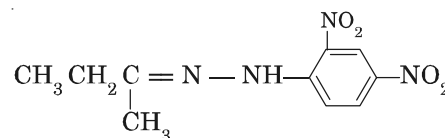
- Ans. (a) Since the compound (A) gives orange red precipitate with 2, 4-DNP reagent, it may be aldehyde or ketone. The compound (A) does not reduce Tollen's reagent but gives positive iodoform test, it suggests the presence of methyl ketone ( $-\overset{\text{O}}{\parallel}{C}-CH_3$ ).

Molecular formula suggests it to be an aliphatic compound.

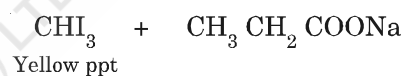
Therefore, its structural formula is  $CH_3\overset{\text{O}}{\parallel}CCH_2CH_3$



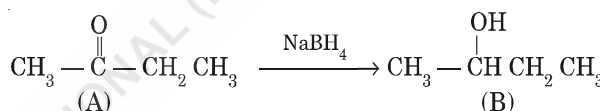
(A)



(A)

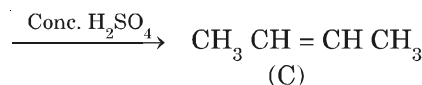


Yellow ppt

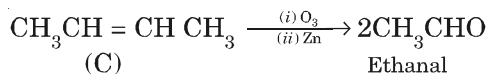


(A)

(B)



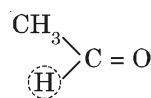
(C)



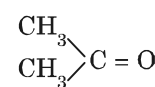
(C)

Ethanal

- (b) (i) Oxidation of propanal is easier than propanone because of the presence of hydrogen atom bonded to carbonyl carbon in propanal. This can be easily converted to  $-OH$  group without undergoing the cleavage of any other bond.

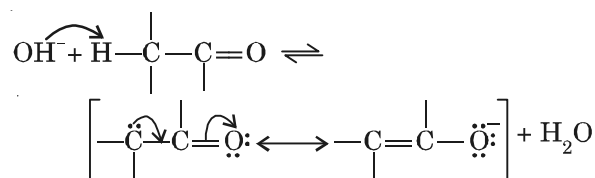


Propanal



Propanone

- (ii) The  $\alpha$ -hydrogen atoms of aldehydes and ketones are slightly acidic in nature due to strong electron withdrawing inductive ( $-I$ ) effect of carbonyl group. The acidity is because of resonance stabilization of the conjugate base formed.



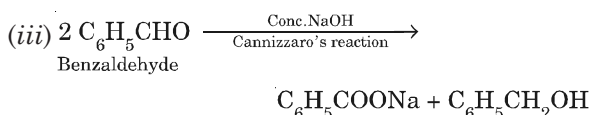
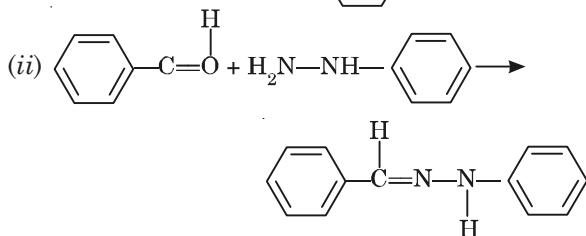
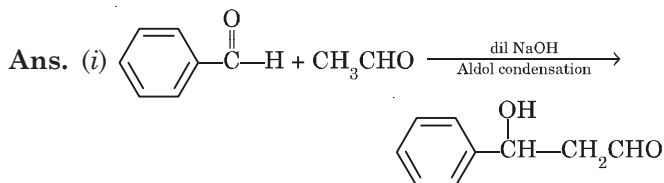
Resonance stabilized enolate anion

Or

(a) Write the product formed when benzaldehyde reacts with the following reagents :

(i)  $\text{CH}_3\text{CHO}$  in presence of dilute NaOH

(ii)  $\text{H}_2\text{N}-\text{NH}-\text{C}_6\text{H}_5$  (iii) Conc. NaOH



32. (a) A first order reaction is 25% complete in 40 minutes. Calculate the value of rate constant. In what time will the reaction be 80% completed ?

(b) Define order of reaction. Write the condition under which a bimolecular reaction follows first order kinetics.

Ans. (a) For the first order reaction,

$$k = \frac{2.303}{t} \log \frac{a}{a-x} \quad \dots(1)$$

Given, 25% of the reaction completes. So

$$x = \frac{25}{100}a = 0.25 \times a, \text{ and } t = 40 \text{ minutes}$$

$$\therefore k = \frac{2.303}{40} \log \left( \frac{a}{a-0.25a} \right) \Rightarrow k = \frac{2.303}{40} \log \left( \frac{1}{0.75} \right)$$

$$\Rightarrow k = \frac{2.303}{40} \log \left( \frac{4}{3} \right)$$

$$\Rightarrow k = \frac{2.303}{40} (\log 4 - \log 3)$$

$$\Rightarrow k = \frac{2.303}{40} (0.6021 - 0.4771)$$

$$\Rightarrow k = \frac{2.303}{40} (0.125) \therefore k = 7.197 \times 10^{-3} \text{ min}^{-1}$$

Now, for 80% reaction completion,

Using equation (1), we have

$$t = \frac{2.303}{7.197 \times 10^{-3}} \log \frac{a}{a-x} = \frac{2.303}{7.197 \times 10^{-3}} \log \frac{a}{a-0.8a} \\ = \frac{2.303}{7.197 \times 10^{-3}} \log 5$$

$$\text{or } t = \frac{2.303}{7.197 \times 10^{-3}} \times 0.6991 \therefore t = 223.71 \text{ min}$$

(b) The sum of the powers of the concentration of reactants in the rate law expression is called the order of the reaction.

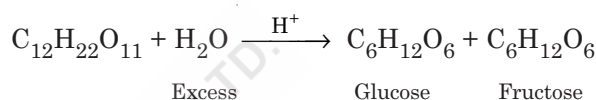
For example, if rate law expression for a reaction is

$$\text{Rate} = k[\text{A}]^a[\text{B}]^b[\text{C}]^c$$

then order of reaction is

$$\text{order} = a + b + c$$

When a bimolecular reaction follows first-order kinetics, it is known as pseudo first-order reaction. This happens when one of the reacting species is present in excess. For example, inversion of cane sugar.



Or

(a) A first order reaction is 50% complete in 30 minutes at 300 K and in 10 minutes at 320 K. Calculate activation energy ( $E_a$ ) for the reaction.

(R = 8.314 J K<sup>-1</sup> mol<sup>-1</sup>)

(b) Write the two conditions for collisions to be effective collisions.

(c) How order of reaction and molecularity differ towards a complex reaction ?

[Given: log 2 = 0.3010, log 3 = 0.4771, log 4 = 0.6021, log 5 = 0.6991]

Ans. (a) The rate equation for a first order is given as follows :

$$2.303 \log \frac{a}{a-x} = kt$$

Given, at 300 K, 50% of the reaction completes,

$$\text{so } x = \frac{50}{100} = 0.5 \times a, \text{ at } t = 30 \text{ minutes}$$

$$\frac{2.303}{30} \log \frac{a}{a-0.5a} = k_1$$

and at 320 K, 50% of the reaction completes so,

$$x = \frac{50}{100} = 0.5 \times a, \text{ and } t = 10 \text{ minutes}$$

$$\frac{2.303}{10} \log \frac{a}{a-0.5a} = k_2$$

$$\frac{k_2}{k_1} = \frac{2.303}{10} \log \frac{a}{a-0.5a} \div \frac{2.303}{30} \log \frac{a}{a-0.5a} = \frac{30}{10}$$

Therefore,

Arrhenius equation is given as follows :

