

Additional Practice Question Paper

(2023 -24)

CHEMISTRY THEORY (043)

MARKING SCHEME

SECTION-A

(Q1 to 16, 1 mark allotted for the correct option)

- (c) $(\text{CH}_3)_2\text{CH} = \text{CH}_2$, Tertiary alcohol undergoes intramolecular dehydration reaction in the presence of H_3PO_4
- (c) Linkage isomerism, NO_2^- is an ambidentate ligand .
- (d)
- (c) Cathodic protection
Iron pipes are connected to more reactive metal like Magnesium, zinc so that an electrochemical cell is set up between the two. Iron behaves like cathode and doesn't corrode.
- (d) $\text{C}_6\text{H}_5-\text{I}$, ether having an aryl part will lead to the formation of phenol rather than iodobenzene. Formation of phenyl cation will not be favoured , partial double bond character of $\text{C}-\text{O}$ will make it less stable.
- (d) Order is one, molecularity is two
- (c) $e_g^4 t_{2g}^6$
- (c) Hinsberg reagent helps in identifying primary, secondary and tertiary amines and Lucas reagent helps in identification of primary, secondary and tertiary alcohols.
- (a) Enzymes are majorly globular proteins. So this statement mentioning enzymes as fibrous protein is false. Rest all are true statements.
- (c) Both CN^- and $\bar{\text{O}}\text{NO}$ are ambident nucleophiles and KCN and KNO_2 are ionic in nature
- (c) Chromium is having higher melting point than Vanadium and Manganese .This statement shows that melting point is higher because of involvement of $(n-1)d$ electrons in addition to the s electrons in the interatomic metallic bonding.
- (d) Gattermann-Koch reaction involves the conversion of benzene to benzaldehyde on reaction with CO and HCl . Rest of the named reactions involve preparation of benzaldehyde from the different starting material.
- (a) Both A and R are true and R is the correct explanation of A
- (d) A is false but R is true. Decomposition of ammonia follows zero order kinetics.
- (c) A is true but R is false. Reason is false, as there is no loss of exchange energy in d^6 configuration.
- (b) Halogens withdraw electrons through an inductive effect (-I) and release electrons through resonance (+R). Through inductive effect, halogens destabilize the intermediate carbocation formed during the electrophilic substitution. Through resonance, halogen tends to stabilize the carbocation and the effect is more pronounced at ortho- and para- positions. Reactivity is thus controlled by the stronger inductive effect and orientation is controlled by resonance effect.

SECTION-B

- (a) E_0 values $\text{Cr}^{3+}/\text{Cr}^{2+}$ is negative shows that Cr^{2+} whereas positive value of $E^\circ\text{Co}^{3+}/\text{Co}^{2+}$, shows Co^{3+} it will not displace hydrogen from dilute acid.
(b) The ability of transition metals to adopt multiple oxidation states and to form complexes using empty atomic orbitals make them suitable to act as catalyst. Finely divided iron is used in Haber's Process. Catalytic property can be attributed to their large surface area. (1)
- The metal-carbon bond in metal carbonyls possess both σ and π character. The $\text{M}-\text{C}$ σ bond is formed by the donation of lone pair of electrons from $\sigma 2p_z$ on the carbonyl carbon into a d_z^2 vacant

orbital of the metal. The M-C π bond is formed by the donation of a pair of electrons from a filled d orbital d_{xy} of metal into the vacant antibonding $\pi^* 2p_x$ orbital of carbon monoxide. (1+1)

19. (a) An amine with basic strength greater is N, N-Dimethylethanamine and less is methanamine (or any other correct option) (1/2+1/2)
- (b) An isomeric amine with boiling point less than the N-Ethyl ethanamine is N,N-Dimethylethanamine and more is Butanamine (1/2+1/2)
- 20 (a) Since the formation of intermediate is slow, the first step is the slowest step. Hence the rate will depend on the first step.
- Therefore,
- $$\text{Rate} = k[\text{H}_2\text{O}_2][\text{I}^-] \quad (1/2+1/2)$$
- (b) If the concentration of peroxide is doubled, the rate of the reaction also doubles. (1)

OR

20. Since $t_{1/2}$ for sample A did not change with change in concentration, it follows first order kinetics. Therefore, the rate constant is
- $$t_{1/2} = 0.693/k \quad (1/2)$$
- $$k = 0.693/100 = 0.00693/\text{day} \quad (1/2)$$
- Since $t_{1/2}$ for sample B decreases with decrease in concentration, it follows zero order kinetics.
- $$t_{1/2} = [A_0]/2k \quad (1/2)$$
- $$k = 1/2 \times 120$$
- $$k = 1/240 = 0.0041 \text{ M/day} \quad (1/2)$$
21. (a) n-Butane < Methoxymethane < Propanal < Acetone < Propan-1-ol
- The boiling points of aldehydes, ketone, ethers are lower than those of alcohols of similar molecular masses due to absence of intermolecular hydrogen bonding. (1)
- (b) Acetophenone < Acetone < Acetaldehyde
- Aldehydes are generally more reactive than ketones in nucleophilic addition reactions due to steric and electronic reasons. Among the ketones, in acetophenone the positive charge over carbonyl carbon is delocalized, involved in resonance, so its reactivity decreases in comparison to aliphatic ketones. (1)

SECTION-C

- 22 (a) There is a difference in activation energy because the process with E_{a1} is a catalysed reaction which lowers the threshold energy for the formation of intermediate activated complex while. (1)
- E_{a2} path is uncatalyzed and has higher threshold energy. (1/2)
- (b) In a reversible catalysed reaction, the rate of both forward and backward reactions are faster than an uncatalyzed reaction. (1/2)
- (c) ΔG value is independent of the path taken as Gibbs free energy is a state function and not a path function. (1)

(for visually challenged learners)

- (a) The value of E_a will be lower as the threshold energy for the formation of intermediate activated complex is less. (1/2+1/2)
- A catalyst does not alter Gibbs energy, ΔG of a reaction. ΔG value is independent of the path taken as Gibbs free energy is a state function and not a path function. (1/2+1/2)
- (b) Activation energy and proper orientation of the molecules (1/2+ 1/2)

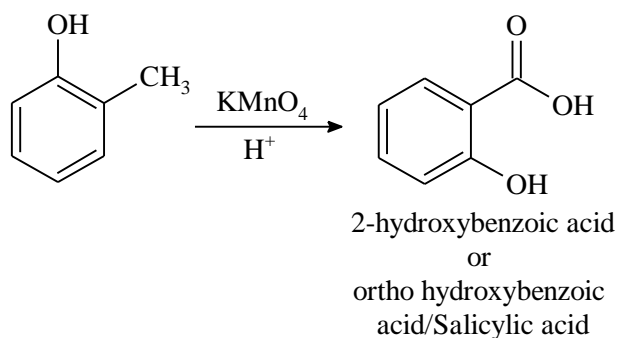
- 23 (a) Ethanol and acetone, or any other example, the volume will increase (The liquids show positive deviation from Raoult's law) (1/2+1/2)
- (b) $\pi_1/\pi_2 = 4$ (1)
- (c) 2 molal glucose because it will have lower depression in freezing point, higher melting point. (1)
- 24 (a) EDTA is a hexadentate ligand while ethylene diamine is bidentate, the chelating effect of EDTA is more therefore EDTA-Ca²⁺ complex is more stable. (1)
- (b) If $\Delta_o < P$, the fourth electron enters one of the e_g orbitals giving the configuration $t_{2g}^3 e_g^1$ (1)
- (c) On heating water molecule which is acting as ligand is lost. In the absence of ligand, crystal field splitting does not occur so there is no d-d transition and hence the substance is colourless (1)

OR

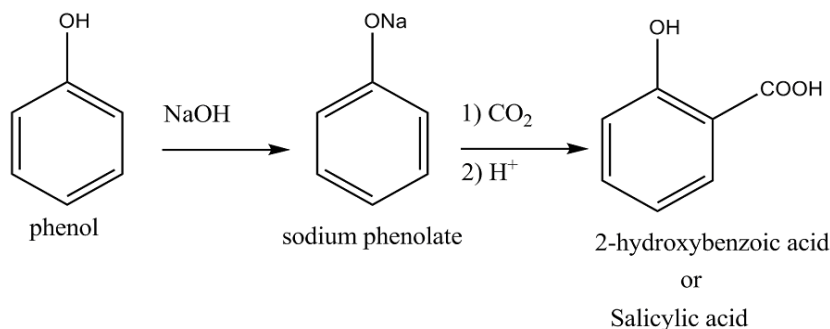
24. (a) The colour of precipitate obtained when ionization isomer of compound $[\text{Co}(\text{NH}_3)_5\text{Br}]\text{SO}_4$, i.e. $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Br}$ reacts with AgNO_3 will be pale yellow. The pale yellow precipitate of AgBr will be obtained. (1)
- (b) (i) The complex A with ligand ethane-1,2-diamine will be more stable as it is didentate ligand leading to the formation of chelate and hence increasing the stability. (1)
- (ii) The higher magnetic moment will be in the case of Complex B, with ligand chlorido as no pairing up of electrons will take place. (1)
25. Compound - A is ortho methylphenol, (1/2)
 Compound- B is ortho hydroxybenzoic acid. (1/2)
 Compound - C is Phenol. (1/2)

The chemical reaction involved are :

- (a) Formation of B from compound A using KMnO_4

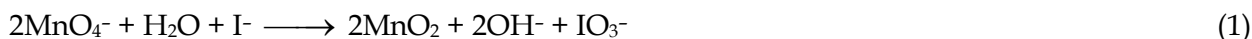


- (b) Formation of B from C i.e Phenol

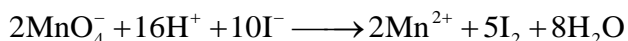


- (c) $\text{C}_6\text{H}_5\text{OCH}_2\text{CH}_2\text{CH}_2\text{CH}_3 \xrightarrow{\text{HI}} \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{I} + \text{C}_6\text{H}_5\text{OH}$ (1/2)

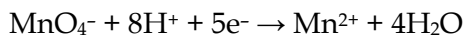
- 26 (i) A notable reaction is the oxidation of iodide to iodate, when no acid present



When the acid was present



- (ii) In case of oxidising action of KMnO_4 , the hydrogen ion concentration plays an important part in influencing the reaction. In the presence of acid medium, oxidation number of Mn changes from +7 to +2 and in basic medium from +7 to +4 (1)



(iii)



27.(a) Since electrolysis (decomposition) happens with current type 'X', it is a DC (Direct current).

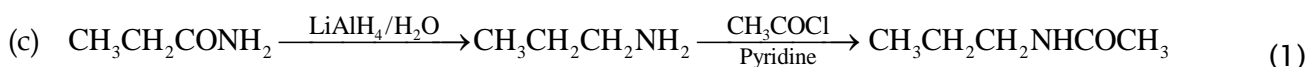
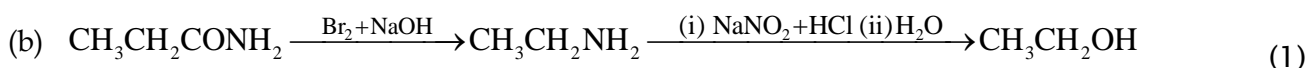
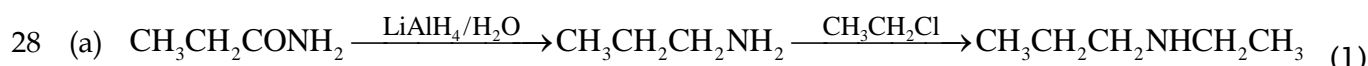
Current type 'Y' is AC (Alternating current) and is used to measure conductivity of solutions. (1+1)

(b) When CuSO_4 is electrolysed, copper gets deposited at cathode and oxygen gas is released at anode.

At cathode reduction of Cu^{2+} occurs (as it requires lesser electrode potential than H^+)



At anode oxidation of water occurs (as it requires lesser electrode potential to get oxidized than SO_4^{2-})



SECTION D

29 (a) (iii) Rate constant (k), it changes with temperature (1)

(b) The solubility will decrease with temperature at low temperatures, reach a minimum value and then increase at higher temperatures because the Henry's constant typically increases with temperature at low temperatures, reaches a maximum, the temperature at which maxima occurs for n-octane-water pair is nearly 90°C and then decreases at higher temperatures. (1)

OR

It is not a good proposal.

K_{H} for CO_2 is higher at 40°C ,

so the solubility of CO_2 will be lower, thus fizz be less.

(c) Ratio of solubility will be greater than 1 because

$$p = K_{\text{H}} X$$

At 20°C $K_{\text{H}} = 50\text{MPa}$, and at 60°C $K_{\text{H}} = 100\text{MPa}$

$$K_{\text{H}}(60) / K_{\text{H}}(20) = X(20) / X(60)$$

$$100/50 = 2 = X(20) / X(60) \quad (2)$$

For Visually impaired

(a) (iii) Rate constant (k), it changes with temperature. (1)

(b) The solubility will decrease with temperature at low temperatures, reach a minimum value and

then increase at higher temperatures because the Henry's constant typically increases with temperature at low temperatures, reaches a maximum, and then decreases at higher temperatures. (1)

OR

It is not a good proposal.

K_H for CO_2 will be higher at $40^\circ C$, because maxima is obtained above $80^\circ C$

So, the solubility of CO_2 will be lower, thus fizz be less.

(c) Ratio of solubility greater than 1 because

$$p = K_H X$$

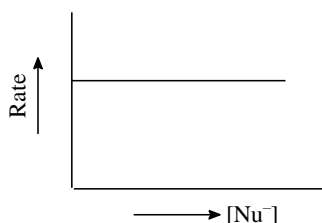
At $20^\circ C$ K_H will be less than K_H at $60^\circ C$

So solubility at $20^\circ C$ will be more than at $60^\circ C$ (2)

30 (a) The activation energy for step 1 is larger than step 2, so step 1 is the slowest step and the rate determining step. (1)

(b) (i) E_a for step 2 will be more than shown in figure 1, because Br^- is a better-leaving group than Cl^- . (1)

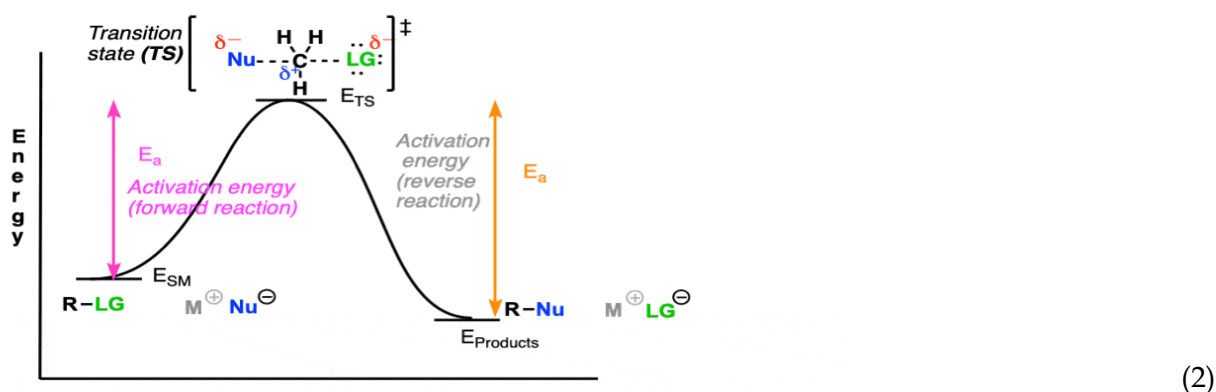
OR



(c)

Reaction Energy Diagram for the S_N2 Reaction

The reaction coordinate for a typical S_N2 reaction shows a single transition state and no intermediates.



(For visually impaired)

(a) Activation energy (1)

(b) step 1 The rate-determining step of a reaction is the step requiring the highest activation energy. (1)

OR

slowest step is the rate determining step so it requires highest activation energy The rate-determining step of a reaction is the step requiring the highest activation energy.

(c) (i) leaving group is Cl^- and nucleophile is OH^- (1)

(ii) leaving group Br^- and nucleophile is F^- (1)

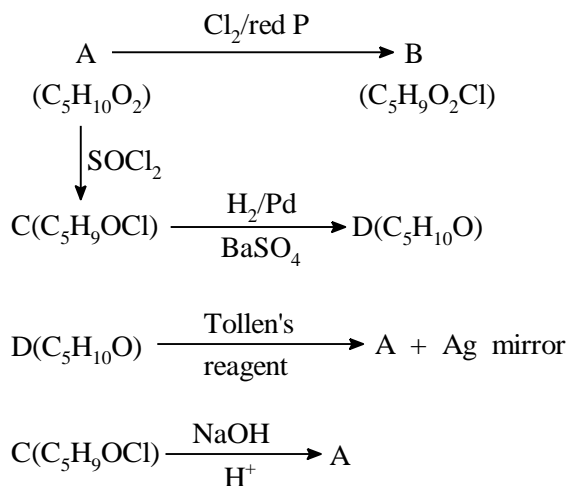
SECTION E

31. (a)



(b) Benzoic acid is more acidic. This is because of greater electronegativity of sp^2 hybridized carbon to which carboxyl carbon is attached, whereby phenyl group acts as an electron withdrawing group and stabilizes the intermediate carboxylate ion. (1)

(c)

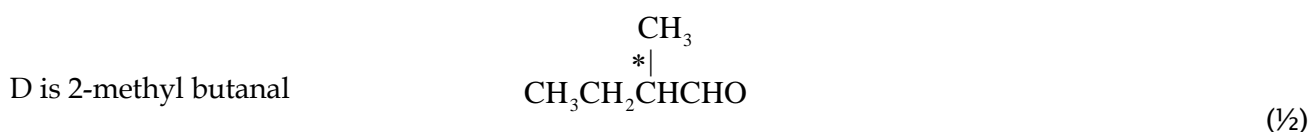
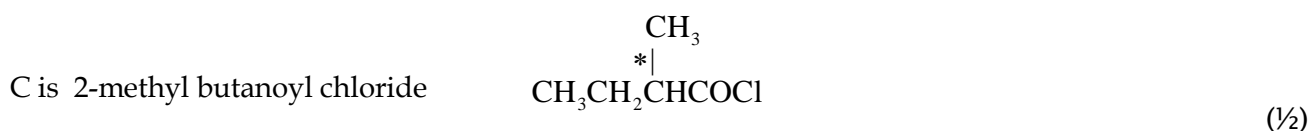
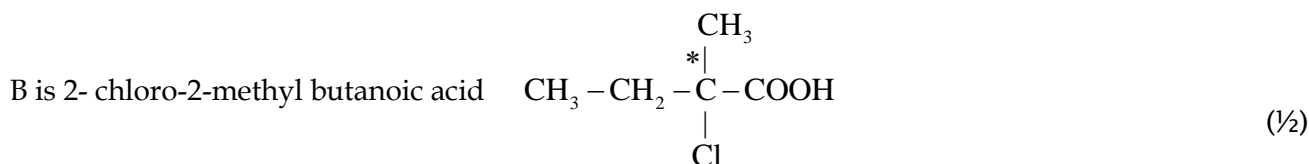
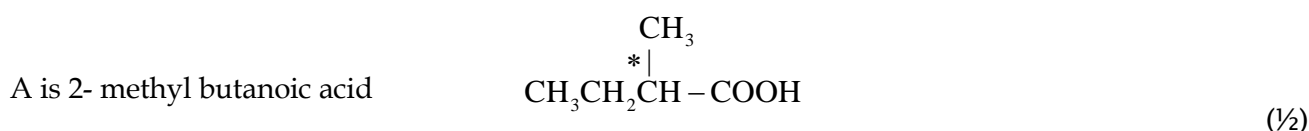


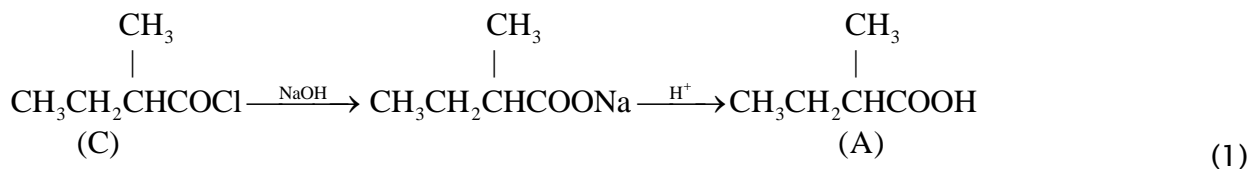
Since D, $\text{C}_5\text{H}_{10}\text{O}$ gives a positive Tollen's test, it is an aldehyde. D is also obtained from C by controlled catalytic hydrogenation, so C is an acid halide.

C is obtained by treatment of thionyl chloride on A, so A is an acid.

A when reacted with halogen in Red phosphorus produces B, So B is α -halocarboxylic acid and A is an acid with α -hydrogen.

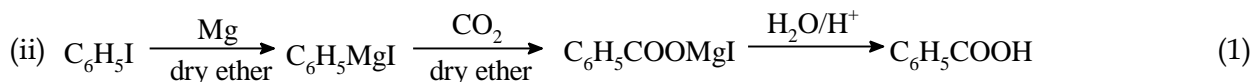
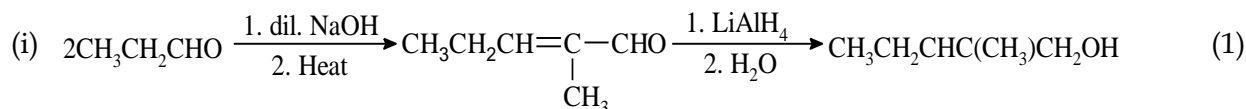
Since A is an optically active compound with 5 carbons, therefore



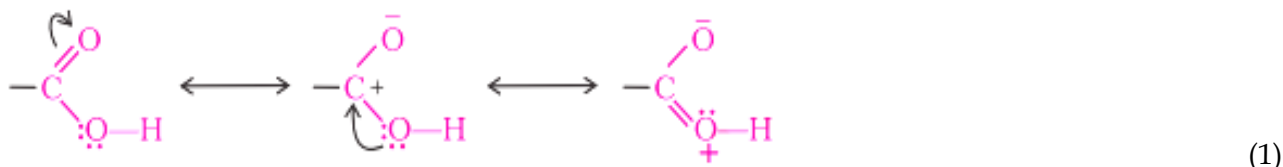


OR

31. (a)

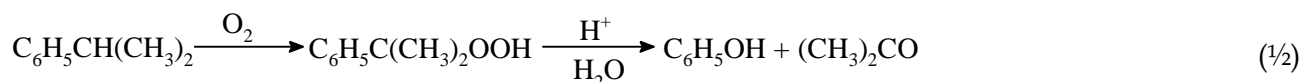
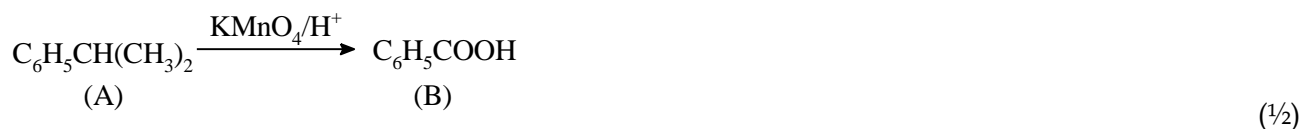


(b) This is so because the Carbon in $>\text{C}=\text{O}$ group in carboxylic group is less electrophilic due to the possible resonance as shown:



(c) A is oxidized to monocarboxylic acid, B indicates that the ring structure has only one side chain. Also, Phenol is formed when oxidized in the presence of air and further treatment with dil acid so A must be Cumene. (1/2)

Sodium salt of B is food preservative and esters of it is used in perfumery, confirms B to be benzoic acid. (1/2)

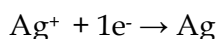


32. (a) Mass of Ag deposited = 2g

$$\text{Volume} = \frac{\text{mass}}{\text{density}} = \frac{2 \text{ g}}{10.5 \text{ gcm}^3} = 0.190 \text{ cm}^3 \quad (1/2)$$

$$\text{Thickness} = \frac{0.190 \text{ cm}^3}{1 \text{ cm}^2} = 0.190 \text{ cm} \quad (1/2)$$

For current



108 g of Ag is deposited by 1F of charge

$$\begin{aligned}
 2 \text{ g of Ag will be deposited by } & \frac{1 \times 2}{108} \text{ charge} \\
 & = 0.0185 \text{ F} = 0.0185 \times 96500 \text{ C} \quad (1)
 \end{aligned}$$

$$t = 1 \text{ hr}$$

$$Q = Ixt$$

$$0.0185 \times 96500 = I \times 60 \times 60$$

$$I = \frac{0.0185 \times 96500}{3600} = 0.495 \text{ A} \quad (1)$$

$$(b) E_{\text{Cr}^{3+}/\text{Cr}} = E_{\text{Cr}^{3+}/\text{Cr}}^{\circ} - \frac{0.059}{3} \log \frac{1}{[\text{Cr}^{3+}]} \quad (1/2)$$

$$E_{\text{Cr}^{3+}/\text{Cr}} = -0.74 - \frac{0.059}{3} \log 10^3 \quad (1/2)$$

$$E_{\text{Cr}^{3+}/\text{Cr}} = -0.74 - 0.059 \quad (1/2)$$

$$E_{\text{Cr}^{3+}/\text{Cr}} = -0.799 \text{ V} \quad (1/2)$$

OR

$$32. (a) (i) \text{Ag}_{(s)} | \text{Ag}^+ (0.001\text{M}) || \text{Mn}^{3+} (0.1\text{M}) | \text{Mn}^{2+} (0.01\text{M}) | \text{Pt} \quad (1)$$

$$(ii) E_{\text{cell}}^{\circ} = +1.50 - 0.80 = +0.70 \text{ V} \quad (1/2)$$

$$Q = \frac{[\text{Ag}^+][\text{Mn}^{2+}]}{[\text{Mn}^{3+}]} \quad (1/2)$$

$$Q = \frac{10^{-3} \times 10^{-2}}{10^{-1}} = 10^{-4}$$

$$\log Q = -4$$

$$E = E^{\circ} - \frac{0.059}{n} \log Q \quad (1/2)$$

$$E = +0.70 - \frac{0.059}{1} \times (-4)$$

$$= +0.70 + 0.236 \quad (1/2)$$

$$E = +0.936 \text{ V}$$

(b) Strong Electrolyte

$$\Lambda = \Lambda^{\circ} - A\sqrt{C} \quad (1/2)$$

For a straight line equation,

$$y = c + mx$$

$$\text{Slope} = m = -A$$

Slope is also given by $\tan\theta$.

Slope = Perpendicular/base

$$= \frac{150}{0.034} \quad (1/2)$$

$$\text{Slope} = -A = -4411.76 \quad A = 4411.76 \quad (1)$$

(for visually challenged learners)

32. (a) and (b) Same as above

OR

(a) Same as above

(b) (i) Strong electrolyte

$$\Lambda = \Lambda^\circ - A\sqrt{C} \quad (1/2)$$

Slope = Perpendicular/base

$$= \frac{150}{0.034} \quad (1/2)$$

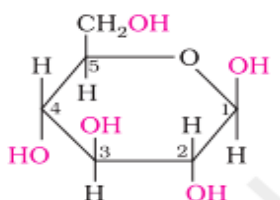
$$\text{Slope} = -A = -4411.76 \quad A = 4411.76 \quad (1)$$

33. (a) (i) Cellulose (1/2)

β -D(+) Glucose (1/2)

(ii) C-1 of one unit of glucose is linked to C-4 of another unit of glucose. These units are linked to each other by **glycosidic linkages**. (1)

iii) Haworth structure of β -D(+)-Glucose:



(1)

(b) Maltose (1/2)

Silver mirror will be observed as Tollen's reagent is reduced by maltose due to the presence of free aldehyde group. (1/2)

(c) Sucrose is dextrorotatory, but on hydrolysis it produces a mixture of α -D-(+) Glucose and β -D-(-) Fructose. Since the laevorotation of fructose is more than the dextrorotation of α -glucose, so overall mixture becomes laevorotatory, hence inversion is observed. (1)

OR

33. (a) (i) DNA (1/2)

Specific base pair sequence 1) Adenine with Thymine by two H- bonds and 2) Guanine with Cytosine by three H- bonds (1/2)

ii) Phosphodiester linkages. (1)

iii) Function: DNA is a reserve of genetic information and is responsible for identity of different species (1/2)

Application: DNA fingerprinting is used in forensic labs for identification of Criminals (1/2)

(b) Fibrous protein (1/2)

In the fibrous protein the polypeptide chains run parallel and are held together by hydrogen and disulphide bonds, resulting in a fibre-like structure. (1)

Fibrous proteins are insoluble in water (1/2)