

SAMPLE PAPER (2022-23)

**CHEMISTRY THEORY
(043)**

MARKING SCHEME

SECTION A

Q1 to 18 each correct answer 1 mark

1. b. 1-methylcyclohexene
According to Saytzeff rule i.e highly substituted alkene is major product. Here dehydration reaction takes place, alkene is formed due to the removal of a water molecule.

2. c $\text{C}_6\text{H}_5\text{CH}(\text{C}_6\text{H}_5)\text{Br}$
 $\text{C}_6\text{H}_5\text{CH}(\text{C}_6\text{H}_5)^+$ carbocation formed is more stable

3. b. charge transfer from ligand to metal
The Mn atom in KMnO_4 has +7 oxidation state with electron configuration $[\text{Ar}]3d^04s^0$ Since no unpaired electrons are present, d-d transitions are not possible. The molecule should, therefore, be colourless.
Its intense purple due to L→M (ligand to metal) charge transfer $2p(\text{L})$ of O to $3d(\text{M})$ of Mn.

4. a. ^{15}O
The rate constant for the decay of O-15 is less than that for O-19 . Therefore , the rate of decay of O-15 will be slower and will have a longer half life .

5. b. $115 \text{ Scm}^2/\text{mol}$
 $\Delta^\circ\text{CH}_3\text{COOK} = \Delta^\circ \text{CH}_3\text{COOH} + \Delta^\circ\text{KCl} - \Delta^\circ\text{HCl} = 390 + 150 - 425 = 115 \text{ Scm}^2/\text{mol}$

- 5* (For visually challenged learners)
 - a. $124.66 \times 10^{-4} \text{ Sm}^2\text{mol}^{-1}$
Molar conductance of $\text{NaCl} = \lambda_{\text{Na}^+} + \lambda_{\text{Cl}^-}$
 $= 51.12 \times 10^{-4} + 73.54 \times 10^{-4}$
 $= 124.66 \times 10^{-4} \text{ Sm}^2\text{mol}^{-1}$

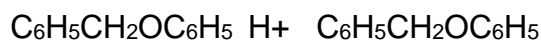
6. a. increases 4 times
Rate = $[\text{A}]^2$
If $[\text{A}]$ is doubled then Rate' = $[2\text{A}]^2 = 4 [\text{A}]^2 = 4 \text{ Rate}$

7. d. $\text{B} < \text{C} < \text{A}$
In primary amine intermolecular association due to H-bonding is maximum while in tertiary it is minimum.

8. b. 8000 cm^{-1}

$$\Delta t = (4/9) \times 18000 \text{ cm}^{-1} = 8000 \text{ cm}^{-1}$$

9. d. A = C₆H₅CH₂Br, B = C₆H₅OH,



10. c. CH₃NH₂ on reaction with nitrous acid releases NO₂ gas
Wrong statement. The evolution of nitrogen gas takes place.

11. c. 2,4 DNP test

Fehling's, Tollen's and Cannizzao reaction is shown by alcohols only.

12. c. (i) ln A (ii) - E_a/R

12* (For visually challenged learners)

d. mol⁻² L² s⁻¹ since the order of reaction is 3.

13. c. 5

1Fe²⁺, 2SO₄²⁻ and 2NH₄⁺ ions

14. A Etard reaction

15. b Both A and R are true but R is not the correct explanation of A.

A and R are two different statements about ethers

The correct reason is that hydrogen bonding does not exist amongst ether molecules.

16. b Both A and R are true but R is not the correct explanation of A.

17. b Both A and R are true but R is not the correct explanation of A.

The magnetic moment is less as the 5f electrons of actinides are less effectively shielded which results in quenching of orbital contributions, they are strongly paramagnetic due to presence of unpaired electrons

18. a Both A and R are true and R is the correct explanation of A.

SECTION B

19. Half life t_{1/2} = 0.693 / k

$$k = 0.693/69.3 = 1/100 = 0.01 \text{ min}^{-1}$$

(1/2)

For first order reaction

$$k = \frac{2.303}{t} \log \frac{[R_0]}{[R]}$$

(1)

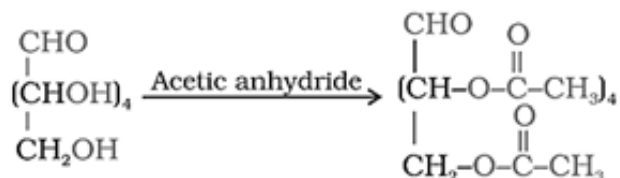
$$t = \frac{2.303}{0.01} \log \frac{100}{20}$$

$$t = 230.3 \log 5 \quad (\log 5 = 0.6990)$$

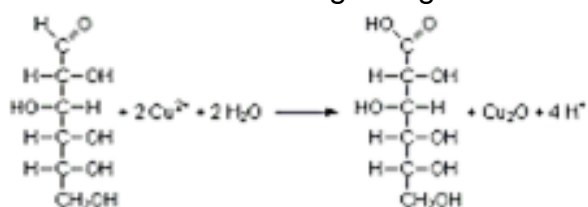
$$t = 160.9 \text{ min}$$

(1/2)

20. a. Acetylation of glucose with acetic anhydride gives glucose pentaacetate which confirms the presence of five -OH groups. Since it exists as a stable compound, five -OH groups should be attached to different carbon atoms (1)



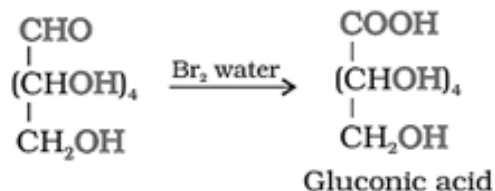
b. Glucose reduces Fehlings reagent



(1)

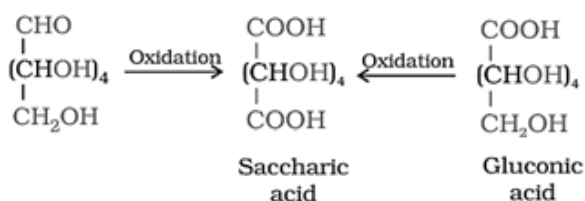
OR

a.



(1)

b.



(1)

21.

a. At the ortho position, higher steric hindrance is there, hence para isomer is usually predominate and is obtained in the major amount. (1)

b. During the $\text{S}_{\text{N}}1$ mechanism, intermediate carbocation formed is sp^2 hybridized and planar in nature. This allows the attack of nucleophile from either side of the plane resulting in a racemic mixture. (1)

OR

a. Tert butyl alcohol or 2-methyl propan-2-ol using Lucas reagent, mixture of concHCl and ZnCl₂ the reaction will follow the S_N¹ pathway. (1)

b. Chloromethane is having higher dipole moment. Due to smaller size of fluorine the dipole moment of fluoromethane is comparatively lesser. (1)

22. [Co(NH₃)₅CO₃]Cl and [Co(NH₃)₅Cl]CO₃ (1/2+1/2)

Pentaaminecarbonatocobalt(III)chloride (1/2)

Pentaaminechloridocobalt(III)carbonate (1/2)

23. Anode: Zn (s) → Zn²⁺ (aq) + 2 e⁻ (1/2)

Cathode: O₂(g) + 2H₂O(l) + 4e⁻ → 4OH⁻ (aq). (1/2)

Overall: 2 Zn (s) + O₂(g) + 2H₂O(l) → 2 Zn²⁺ (aq) + 4OH⁻ (aq)

2 Zn (s) + O₂(g) + 2H₂O(l) → 2 Zn(OH)₂ (ppt) (1)

24. The rate of reaction will increase. The catalyst decreases the activation energy of the reaction therefore the reaction becomes faster. (1/2+1/2)

b. The rate of reaction will decrease. At lower temperatures the kinetic energy of molecules decreases thereby the collisions decrease resulting in a lowering of rate of reaction. (1/2+1/2)

25. (CH₃)₂CHCHO + C₂H₅MgBr $\xrightarrow{\text{dry ether}}$ (CH₃)₂CHCH(C₂H₅)(OMgBr)
 (CH₃)₂CHCH(C₂H₅)(OMgBr) $\xrightarrow{\text{H}^+/\text{H}_2\text{O}}$ (CH₃)₂CHCH(C₂H₅)(OH) (1)

2-Methylpentan-3-ol (1)

SECTION C

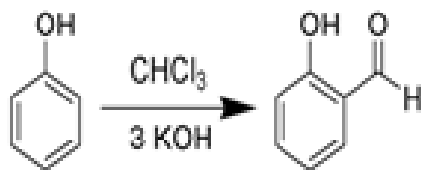
26. (i) Aspirin is formed



(1)

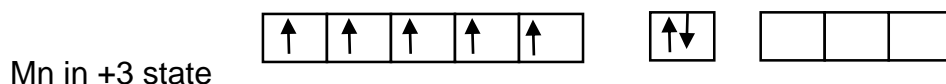
(ii) (CH₃)₃CCl $\xrightarrow{\text{sodium ethoxide}}$ (CH₃)₂C=CH₂
 2methylpropene (1)

(iii) o-hydroxybenzaldehyde will be formed



(1)

27. $[\text{Mn}(\text{CN})_6]^{3-}$
 $\text{Mn} = [\text{Ar}] 3d^5 4s^2$
 $\text{Mn}^{3+} = [\text{Ar}] 3d^4$
 Mn (ground state)



Mn in $[\text{Mn}(\text{CN})_6]^{3-}$



d^2sp^3 hybridisation

xx are electrons donated by ligand CN^-

Type of hybridization – d^2sp^3 (1)

Magnetic moment value – $\sqrt{n(n+2)} = \sqrt{2(2+2)} = 2.87 \text{ BM}$
 (n= no. of unpaired electrons) (1)

Type of complex – inner orbital (1)

28. a. Henry's law: the partial pressure of the gas in vapour phase (p) is proportional to the mole fraction of the gas (x) in the solution. (1)

The pressure underwater is high, so the solubility of gases in blood increases. When the diver comes to surface the pressure decreases so does the solubility causing bubbles of nitrogen in blood, to avoid this situation and maintain the same partial pressure of nitrogen underwater too, the dilution is done. (1)

b. $p = K_H x$

mole fraction of argon in water $x = p/k = 6/ 40 \times 10^3 = 1.5 \times 10^{-4}$ (1)

29. (any 3)

a. Aniline is acetylated, before nitration reaction in order to avoid formation of tarry oxidation products and protecting the amino group, so that p -nitro derivative can be obtained as major product. (1)

b. pK_b of aniline is lower than the m-nitro aniline. The basic strength of aniline is more than m-nitroaniline. pK_b value is inversely proportional to basic strength. Presence of Electron withdrawing group decrease basic strength. (1)

c. Due to the presence of acidic hydrogen in the N-alkylbenzenesulphonamide formed by the treatment of primary amines. (1)

d. Aniline does not react with methylchloride in the presence of AlCl_3 catalyst, because aniline is a base and AlCl_3 is Lewis acid which lead to formation of salt. (1)

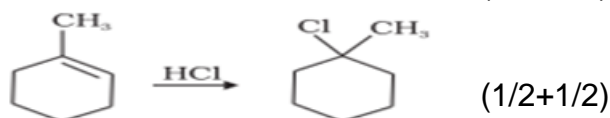
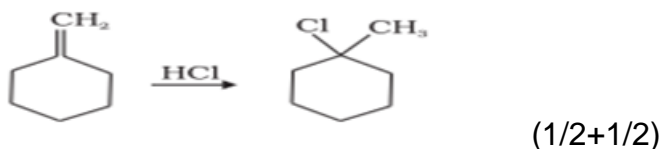
30.

a. The major product formed when 2-cyclohexylchloroethane undergoes dehydrohalogenation reaction is 1-cyclohexylethene. The reagent which is used to carry out the reaction is ethanolic KOH. (1+1)

b. Haloalkanes are more reactive than haloarenes and vinylic halides because of the presence of partial double bond character C-X bond in haloarenes and vinylic halides. Hence they do not undergo nucleophilic reactions easily. (1)

OR

a. Methylencyclohexane



b. Allyl chloride shows high reactivity as the carbocation formed in the first step is stabilised by resonance while no such stabilisation of carbocation exists in the case of n-propyl chloride. (1)

SECTION D

31. a. $A = 100$ so $T = 100$

$C = 150$ so $G = 150$

Total nucleotides = $100 + 100 + 150 + 150 = 500$ (1)

b. They studied the nucleotide composition of DNA. It was the same so they concluded that the samples belong to same species. (1)

c. $A = T = 20\%$

But G is not equal to C so double helix is ruled out. (1/2)

The bases pairs are ATGC and not AUGC so it is not RNA (1/2)

The virus is a single helix DNA virus (1)

OR

According to Chargaff rule, all double helix DNA will have the same amount of A and T as well as C will be same amount as G . If this is not the case then the helix is single stranded. (2)

32. The melting point of ice is the freezing point of water. We can use the depression in freezing point property in this case.

a. 3rd reading for 0.5 g there has to be an increase in depression of freezing point and therefore decrease in freezing point so also decrease in melting point when amount of salt is increased but the trend is not followed on this case. (1)

b. two sets of reading help to avoid error in data collection and give more objective data. (1)

$$c. \Delta T_f (\text{glucose}) = 1 \times K_f \times \frac{0.6 \times 1000}{180 \times 10} \quad (1/2)$$

$$\Delta T_f (\text{NaCl}) = 2 \times K_f \times \frac{0.6 \times 1000}{58.5 \times 10} \quad (1/2)$$

$$3.8 = 2 \times K_f \times \frac{0.6 \times 1000}{58.5 \times 10}$$

Divide equation 1 by 2

$$\frac{\Delta T_f (\text{glucose})}{3.8} = \frac{58.5}{2 \times 180} \quad (1/2)$$

$$\Delta T_f (\text{glucose}) = 0.62 \quad \text{Freezing point or Melting point} = -0.62 \text{ }^\circ\text{C} \quad (1/2)$$

OR

depression in freezing point is directly proportional to molality (mass of solute when the amount of solvent remains same) (1)

0.3 g depression is 1.9 $^\circ\text{C}$

0.6 g depression is 3.8 $^\circ\text{C}$

1.2 g depression will be $3.8 \times 2 = 7.6 \text{ }^\circ\text{C}$ (1)

SECTION E

33. The cell potential remains constant during its life as the overall reaction does not involve any ion in solution whose concentration can change during its life time. (1)

b. $\text{KCl (aq)} \rightarrow \text{K}^+ (\text{aq}) + \text{Cl}^- (\text{aq})$

cathode: $\text{H}_2\text{O (l)} + \text{e}^- \rightarrow \frac{1}{2} \text{H}_2 (\text{g}) + \text{OH}^- (\text{aq})$ (1/2)

anode: $\text{Cl}^- (\text{aq}) \rightarrow \frac{1}{2} \text{Cl}_2 (\text{aq}) + \text{e}^-$ (1/2)

net reaction:

$\text{KCl (aq)} + \text{H}_2\text{O (l)} \rightarrow \text{K}^+ (\text{aq}) + \text{OH}^- (\text{aq}) + \frac{1}{2} \text{H}_2 (\text{g}) + \frac{1}{2} \text{Cl}_2 (\text{g})$ (1)

c. Given, potential of hydrogen gas electrode = -0.59 V

Electrode reaction: $\text{H}^+ + \text{e}^- \rightarrow \frac{1}{2} \text{H}_2$

Applying Nernst equation,

$$E (\text{H}^+/\text{H}_2) = E^\circ (\text{H}^+/\text{H}_2) - \frac{0.059}{n} \log \frac{[\text{H}_2]^{1/2}}{[\text{H}^+]} \quad (1)$$

$$E^\circ (\text{H}^+/\text{H}_2) = 0 \text{ V}$$

$$E (\text{H}^+/\text{H}_2) = -0.59 \text{ V}$$

$$n = 1$$

$$[\text{H}_2] = 1 \text{ bar}$$

$$-0.59 = 0 - 0.059 (-\log [\text{H}^+]) \quad (1/2)$$

$$-0.59 = -0.059 \text{pH}$$

$$\therefore \text{pH} = 10 \quad (1/2)$$

OR

a. "A" is copper, metals are conductors thus have high value of conductivity. (1)

b. $\text{Mg}^{2+} + 2\text{e}^- \rightarrow \text{Mg}$

1 mole of magnesium ions gains two moles of electrons or 2F to form 1 mole of Mg

24 g Mg requires 2 F electricity

4.8 g Mg requires $2 \times 4.8/24 = 0.4 \text{ F} = 0.4 \times 96500 = 38600\text{C}$ (1)

$\text{Ca}^{2+} + 2\text{e}^- \rightarrow \text{Ca}$

2 F electricity is required to produce 1 mole = 40 g Ca

0.4 F electricity will produce 8 g Ca (1)

c. $F = 96500\text{C}$, $n=2$,

$\text{Sn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Sn}(\text{s}) -0.14\text{V}$

$\text{Cu}^{2+}(\text{aq}) + \text{e}^- \rightarrow \text{Cu}^+(\text{aq}) \quad 0.15 \text{ V}$

$E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}}$

$= 0.15 - (-0.14) = 0.29\text{V}$ (1)

$\Delta G^\circ = -nFE^\circ_{\text{cell}}$

$= -2 \times 96500 \times 0.29 = 55970 \text{ J/mol}$ (1)

34. A is an alkene

B is an aldehyde with $-\text{CH}_3$ group

C is a methyl ketone

$\text{CH}_3\text{CHO} + [\text{Ag}(\text{NH}_3)_2]^+ + \text{OH}^- \xrightarrow{\hspace{2cm}} \text{CH}_3\text{COO}^- + \text{Ag} + \text{NH}_3 + \text{H}_2\text{O}$ (1/2)

$\text{CH}_3\text{COCH}_3 + \text{NaOH} + \text{I}_2 \xrightarrow{\hspace{2cm}} \text{CHI}_3 + \text{CH}_3\text{COONa}$ (1/2)

A : $\text{CH}(\text{CH}_3)=\text{C}(\text{CH}_3)_2$ B: CH_3CHO C: $\text{O}=\text{C}(\text{CH}_3)_2$ (1.5 = 1/2 each)

$\text{CH}_3\text{COCH}_3 + \text{CH}_3\text{CHO}$

$\downarrow \text{Ba}(\text{OH})_2$
 $(\text{CH}_3)_2\text{C}(\text{OH})\text{CH}_2\text{COCH}_3 + \text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{CHO} + (\text{CH}_3)_2\text{C}(\text{OH})\text{CH}_2\text{CHO}$
 $+ \text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{COCH}_3$

$\downarrow \text{heat}$
 $(\text{CH}_3)_2\text{C}=\text{CHCOCH}_3 + \text{CH}_3\text{CH}=\text{CHCHO} + (\text{CH}_3)_2\text{C}=\text{CHCHO}$
 $+ \text{CH}_3\text{CH}=\text{CHCOCH}_3$ (2.5 = 1/2 mark for each product, 1/2 for the reaction)

OR

a. (A): CCl_3COOH (B): CH_3COOH (1)

b. $\text{CH}_3\text{COOH} \xrightarrow[\text{(ii)H}_2\text{O}]{\text{(i)Red P / Cl}_2} \text{CCl}_3\text{COOH}$, Hell Volhard Zelinsky reaction (1/2 +1/2)

c. $\text{CH}_3\text{COCl} \xrightarrow{\text{H}_2\text{O}} \text{CH}_3\text{COOH}$ (1)

d. A will be more acidic due to presence of 3 Cl groups (electron withdrawing groups) which increase acidity of carboxylic acid. (1)

e. $\text{CH}_3\text{COOH} \xrightarrow{\text{(i)NaOH, CaO (ii) heat}} \text{CH}_4 + \text{Na}_2\text{CO}_3$ (1)

35. a. Cu^{2+} oxidizes iodide ion to iodine. (1)

b. The low value for V is related to the stability of V^{2+} (half-filled t_{2g} level) (1)

c. Permanganate titrations in presence of hydrochloric acid are unsatisfactory since hydrochloric acid is oxidised to chlorine.

d. The d orbital is full with ten electrons and shield the electrons present in the higher s-orbital to a greater extent resulting in increase in size.

e. The chromates and dichromates are interconvertible in aqueous solution depending upon pH of the solution. Increasing the pH (in basic solution) of dichromate ions a colour change from orange to yellow is observed as dichromate ions change to chromate ions.