Model Question Paper

Time allowed : 3 hours **Maximum marks : 70**

General Instructions:

(i) All questions are compulsory.

(ii) Question numbers 1 to 5 are very short answer questions and carry 1 mark each.

(iii) Question numbers 6 to 10 are short answer questions and carry 2 marks each.

(iv) Question numbers 11 to 22 are also short answer questions and carry 3 marks each.

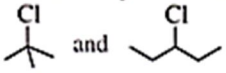
(v) Question number 23 is value based question and carries 4 marks.

(vi) Question numbers 24 to 26 are long answer questions and carry 5 marks each.

(vii) There is no overall choice. However, an internal choice has been provided in one question of 2 marks, one question of 3 marks and three questions of 5 marks weightage. A student has to attempt only one of the alternatives in such questions.

(viii) Use log tables, if necessary. Use of calculators is not allowed.

1. What is Frenkel defect?
2. Which compound in the following pair undergoes faster S_N1 reaction and why?



3. Give the IUPAC name of the following compound:

$$(CH_3)_3—C—\underset{\underset{O}{\|}}{C}—COOH$$

4. Explain why $MeNH_2$ is stronger base than MeOH.
5. Write the reaction when glucose is heated with excess of HI.
6. (*a*) State the law which helps to determine the limiting molar conductivity of weak electrolyte.
   (*b*) Calculate limiting molar conductivity of $CaSO_4$ (limiting molar conductivity of calcium and sulphate ions are 119.0 and 160.0 S cm^2 mol^{-1} respectively).
7. Rate constant *k* for first order reaction has been found to be 2.54×10^{-3} s^{-1}. Calculate its three-fourth life.

OR

A first order gas reaction $A_2B_2(g) \longrightarrow 2A(g) + 2B(g)$ at the temperature 400°C has the rate constant $k = 2.0 \times 10^{-4}$ s^{-1}. What percentage of A_2B_2 is decomposed on heating for 900 seconds?

8. Draw the molecular structures of the following species:
   (*i*) $H_2S_2O_8$ (*ii*) XeF_2

9. Write the mechanism for preparation of ethanol from ethene.

10. How may the following conversions be carried out:

    (*i*) Propene to propan-2-ol

    (*ii*) Anisole to phenol (Write the reaction only)

11. An element X with an atomic mass of 60 g/mol has density of 6.23 g cm^{-3}. If the edge length of its cubic unit cell is 400 pm, identify the type of cubic unit cell. Calculate the radius of an atom of this element.

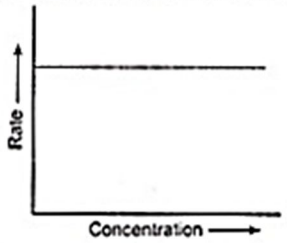
12. A voltaic cell is set up at 25°C with the following half cells:

    $Al|Al^{3+}$ (0.001 M) and $Ni|Ni^{2+}$ (0.50 M)

    Write an equation for the reaction that occurs when the cell generates an electric current and determine the cell potential.

    $E^{\circ}_{Ni^{2+}/Ni} = -0.25$ V; $E^{\circ}_{Al^{3+}/Al} = -1.66$ V ($\log S \times 10^{-6} = -0.54$)

13. For a chemical reaction variation in rate with concentration is shown below:



    (*i*) What is the order of the reaction?

    (*ii*) What are the units of rate constant *k* for the reaction?

    (*iii*) Derive an expression to calculate the time required for completion of the zero order reaction.

14. (*a*) Give one example of each of the following:

    (*i*) Acidic flux (*ii*) Basic flux

    (*b*) What happens when:

    (*i*) Cu_2O undergoes self reduction in a silica line converter.

    (*ii*) Haematite oxidises carbon to carbon monoxide.

    OR

    (*a*) What role does cryolite play in Hall Heroult process?

    (*b*) How can alumina be separated from silica in a bauxite ore associated with silica? Give equations also.

15. Write balanced chemical equations for the following reactions.

    (*i*) Hypophosphorous acid is added to $AgNO_3$ solution.

    (*ii*) Chlorine gas is passed through hot and concentrated solution of sodium hydroxide.

    (*iii*) XeF_2 undergoes hydrolysis.

16. How would you account for the following:

    (*i*) Bond dissociation enthalpy of flourine is less than that of chlorine.

    (*ii*) H_2S acts only as a reducing agent but SO_2 acts both as a reducing agent as well as an oxidising agent.

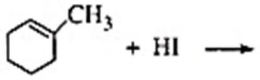
    (*iii*) A sparkless current is passed through oxygen to prepare ozone.

17. (*a*) Give IUPAC name of linkage isomer of $[Co(NH_3)_5(NO_2)]^{+}$.

(*b*) Give the electronic configuration of *d*-orbitals of $K_3[Fe(CN_6)]$ and $K_3[FeF_6]$ and explain why these complexes give different colour with same solution.

(At. No. of Fe = 26u)

18. (*a*) Complete the following reaction equation:



(*b*) How will you distinguish between the following pairs of compounds:

(*i*) Chloroform and carbon tetrachloride.

(*ii*) Benzyl chloride and chlorobenzene.

19. (*a*) Write the following name reactions:

(*i*) Gabriel phthalimide reaction

(*ii*) Hoffman bromamide reaction

(*b*) How would you convert aniline to 1,3,5-tribromobenzene.

20. (*a*) Give one structural difference between amylose and amylopectin.

(*b*) Name the protein and its shape present in oxygen carrier in human body.

(*c*) Name two fat storing tissues in human body.

21. Define the following by giving one example of each:

(*i*) Antiseptics (*ii*) Antioxidants

(*iii*) Narcotic analgesics

22. (*a*) Write the names of the monomers of polymer used for making unbreakable crockery.

(*b*) Write the reaction of preparation of neoprene.

(*c*) Arrange the following polymers in decreasing order of intermolecular forces.

PVC; Nylon-6, 6; Natural rubber

23. ***In thermal power stations, coal is burnt to produce steam for generation of electricity. The smoke produced is passed through electrostatic precipitators.***

Answer the following questions based on the above information:

(*i*) ***Why is the smoke passed through electrostatic precipitators in thermal power stations? Which property of colloidal solution is used in an electrostatic precipitator?***

(*ii*) ***How does coal ash affect environment? Suggest a method to use coal ash.***

(*iii*) ***Which value is promoted through the use of electrostatic precipitator?***

(*iv*) ***Suggest one activity to inculcate this value in students.***

24. (*a*) Give names of the reagents to bring about the following transformations:

(*i*) Ethanoic acid to ethanol

(*ii*) Propane-1-ol to propanal

(*iii*) Pent-3-en-2-ol to pent-3-en-2-one

(*iv*) Sodium benzoate to benzene

(*b*) Arrange the following in the increasing order of:

(*i*) Methanal, Propanal, Butanone, Ethanal, Propanone (nucleophilic addition reaction)

(*ii*) Formaldehyde, Acetone, Acetaldehyde (reactivity towards HCN)

(*iii*) Acetophenone, *p*-Tolualdehyde, *p*-Nitrobenzaldehyde, Benzaldehyde (nucleophilic addition reaction)

OR

(*a*) Bring out the following conversions:

(*i*) 4-Nitrotoluene to 2-bromobenzoic acid

(*ii*) Ethylcyanide to 1-phenyl propanone

(*b*) Give a reason for the following:

(*i*) Chloroacetic acid is more acidic than acetic acid.

(*ii*) Carboxylic acids have higher boiling point than alcohols.

(*iii*) 4-Nitrobenzoic acid is more acidic than 4-methoxy benzoic acid.

25. Account for the following :

(*i*) Transition elements show highest oxidation state in their oxides than fluorides.

(*ii*) Cu has positive electrode potential in the first transition series.

(*iii*) Ionisation enthalpy of lanthanides is higher than actinides.

(*iv*) Potassium dichromate is a good oxidising agent in acidic medium.

(*v*) Actinides show more number of oxidation states than lanthanides.

OR

(*a*) Compare non-transition and transition elements on the basis of their

(*i*) variability of oxidation states.

(*ii*) stability of oxidation states.

(*b*) Give chemical reactions for the following observations:

(*i*) Potassium permanganate is a good oxidising agent in basic medium.

(*ii*) Interconvertibility of chromate ion and dichromate ion in aqueous solution depends upon pH of the solution.

(*iii*) Potassium permanganate is thermally unstable at 513 K.

26. (*a*) What is the freezing point of 0.4 molal solution of acetic acid in benzene in which it dimerises to the extent of 85%? Freezing point of benzene is 278.4 K and its molar heat of fusion is 10.042 kJ mol^{-1}.

(*b*) Explain the following:

(*i*) Solution of chloroform and acetone is an example of maximum boiling azeotrope.

(*ii*) A doctor advised a person suffering from high blood pressure to take less quantity of common salt.

OR

(*a*) Calculate the boiling point of a solution containing 0.61 g of benzoic acid in 5 g of CS_2. Assuming 84% dimerisation of acid, the boiling point and K_b of CS_2 are 46.2°C and 2.3 K kg mol^{-1} respectively.

(*b*) State Raoult's law for the solution containing non-volatile solute. Give its mathematical expression also.

Solutions

1. When some ions (usually cations) are missing from the lattice sites and they occupy the interstitial sites so that electrical neutrality as well as stoichiometry is maintained, it is called Frenkel defect.

2. 

   2-Chloro-2-methylpropane as the tertiary carbocation is more stable than secondary carbocation.

3. 3,3-Dimethyl-2-oxobutanoic acid

4. Nitrogen is less electronegative than oxygen therefore lone pair of electrons on nitrogen is readily available for donation. Hence, $MeNH_2$ is more basic than MeOH.

5. $CHO—(CHOH)_4CH_2OH + HI \text{ (excess)} \xrightarrow{\Delta} \underset{n\text{-Hexane}}{CH_3CH_2CH_2CH_2CH_2CH_3}$

6. (*a*) **Kohlrausch law of independent migration of ions:** The limiting molar conductivity of an electrolyte can be represented as the sum of the individual contribution of the anions and cations of the electrolyte.

   (*b*) $\Lambda_m^o(CaSO_4) = \lambda^0_{Ca^{2+}} + \lambda^0_{SO_4^{2-}}$

   $= 119.0 \text{ S cm}^2 \text{ mol}^{-1} + 160.0 \text{ S cm}^2 \text{ mol}^{-1}$

   $= 279.0 \text{ S cm}^2 \text{ mol}^{-1}$

7. $$t = \frac{2303}{k} \log \frac{[R]_0}{[R]} \qquad ...(i)$$

   $$k = 2.54 \times 10^{-3} \text{ s}^{-1}; [R] = \frac{[R]_0}{4}$$

   Substituting these values in equation (*i*), we get

   $$t_{3/4} = \frac{2.303}{2.54 \times 10^{-3}} \log \frac{[R]_0}{\frac{[R]_0}{4}} = 0.9066 \times 10^3 \log 4$$

   $$t_{3/4} = 0.9066 \times 10^3 \times 0.6021 \text{ s} = 5.46 \times 10^2 \text{ s}$$

   OR

   $$k = \frac{2.303}{t} \log \frac{[R]_0}{[R]}$$

   $$2.0 \times 10^{-4} \text{ s}^{-1} = \frac{2303}{900} \log \frac{[R]_0}{[R]}$$

   $$\log \frac{[R]_0}{[R]} = \frac{2.0 \times 10^{-4} \times 900}{2.303} = 0.0781$$

   $$\log \frac{[R]}{[R]_0} = -0.0781$$

$$\frac{[R]}{[R]_0} = \text{Antilog } \bar{1}.9219$$

$$\frac{[R]}{[R]_0} = 0.835$$

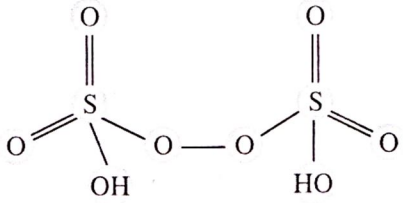
$$[R] = 0.835\,[R]_0$$

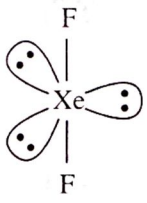
If $[R]_0 = 100$, then

$[R] = 83.5$

$[R]_0 - [R] = 100 - 83.5 = 16.5$, *i.e.*, 16.5% of initial concentration has changed into produc

8. (*i*) $H_2S_2O_8$ (Peroxodisulphuric acid) (*ii*) XeF_2

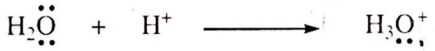


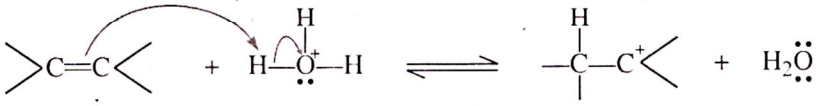


9. Mechanism:

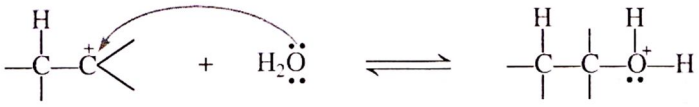
The mechanism of the reaction involves the following three steps:

Step I: Protonation of alkene to form carbocation by electrophilic attack of H_3O^+.

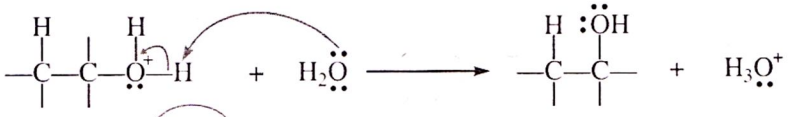




Step II: Nucleophilic attack of water on carbocation.



Step III: Deprotonation to form an alcohol.



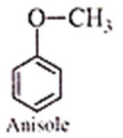
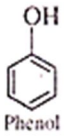
10. (*i*) $CH_3 - CH = CH_2 + H - OSO_3H$ (conc.) $\longrightarrow CH_3 - \underset{\displaystyle OSO_3H}{\underset{|}{CH}} - CH_3$

Propene — Sulphuric acid — Isopropyl hydrogen sulphate

$H_2O,\ \Delta \downarrow - H_2SO_4$

$CH_3 - \underset{\displaystyle OH}{\underset{|}{CH}} - CH_3$

Propan - 2 - ol

(*ii*)  + HI $\xrightarrow{373\ K}$  + CH_3-I

Anisole — Phenol

11. Density $(d) = \dfrac{z \times M}{a^3 \times N_A}$

$d = 6.23\ g/cm^3$ $z = ?$ $M = 60\ g/mol$ $N_A = 6.022 \times 10^{23}$

$a = 400\ pm = 400 \times 10^{-10}\ cm = 4 \times 10^{-8}\ cm$

$$6.23 = \frac{z \times 60}{(4 \times 10^{-8})^3 \times 6.022 \times 10^{23}}$$

$$z = \frac{6.23 \times 64 \times 10^{-24} \times 6.022 \times 10^{23}}{60}$$

$z = 4$

The unit cell is face-centred cubic.

For *fcc*, $r = \dfrac{a}{2\sqrt{2}} = \dfrac{400}{2\sqrt{2}} = \dfrac{400}{2\sqrt{2}} \times \dfrac{\sqrt{2}}{\sqrt{2}}$

$r = 100\sqrt{2} = 100 \times 1.414$

$r = 141.4\ pm$

12. **At anode:** $[Al \longrightarrow Al^{3+} + 3e^-] \times 2$

At cathode: $[Ni^{2+} + 2e^- \longrightarrow Ni] \times 3$

Cell reaction: $2Al + 3Ni^{2+} \longrightarrow 2Al^{3+} + 3Ni$

$$E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode} = E^\circ_{Ni^{2+}/Ni} - E^\circ_{Al^{3+}/Al}$$

$= -0.25V - (-1.66\ V) = 1.41\ V$

$[Al^{3+}] = 1 \times 10^{-3}M$; $[Ni^{2+}] = 0.5\ M$; $n = 6$

Substituting the values in the Nernst equation.

$$E_{cell} = E^\circ_{cell} - \frac{0.059}{n} \log \frac{[Al^{3+}]^2}{[Ni^{2+}]^3}$$

$$E_{cell} = 1.41\ V - \frac{0.059}{6} \log \frac{(10^{-3})^2}{(0.5)^3}$$

$$= 1.41\ V - \frac{0.059}{6} \log 8 \times 10^{-6} = 1.41\ V - \frac{0.059}{6}(-0.54)$$

$E_{cell} = 1.41\ V + 0.0053\ V = 1.4153\ V$

13. (*i*) Order of reaction is zero.

(*ii*) Units of rate constant is mol L^{-1} s^{-1}.

(*iii*) For zero order reaction $t = \dfrac{[R]_0 - [R]}{k}$

For completion, $[R] = 0$

$\therefore \quad t = \dfrac{[R]_0}{k}$

14. (*a*) (*i*) Acidic flux: SiO_2

(*ii*) Basic flux: CaO

(*b*) (*i*) Cu_2O undergoes self reduction to form blister copper as

$$2Cu_2O + Cu_2S \longrightarrow 6Cu + SO_2$$

(*ii*) $Fe_2O_3 + 3C \longrightarrow 3CO + 2Fe$

OR

(*a*) Cryolite reduces melting point of alumina.

(*b*) Concentration of ore is carried out by digesting the powdered ore with a concentrated solution of NaOH at 473-523 K and 35-36 bar pressure. Al_2O_3 is leached out as sodium meta aluminate and SiO_2 as sodium silicate leaving behind impurities.

$$Al_2O_3(s) + 2NaOH(aq) + 3H_2O \longrightarrow 2Na[Al(OH)_4](aq)$$

The resulting solution is filtered, cooled and neutralised by passing CO_2 gas through it. Then hydrated Al_2O_3 gets precipitated leaving sodium silicate in the solution.

$$2Na[Al(OH)_4]\ (aq) + CO_2(g) \longrightarrow Al_2O_3.xH_2O(s) + 2NaHCO_3(aq)$$

Sodium silicates remain in the solution and hydrated alumina is filtered, washed, dried and heated to get pure alumina (Al_2O_3).

$$Al_2O_3.x\ H_2O(s) \xrightarrow{1470\ K} Al_2O_3(s) + xH_2O(g)$$

15. (*i*) $H_3PO_2 + 4AgNO_3 + 2H_2O \longrightarrow 4Ag + 4HNO_3 + H_3PO_4$

(*ii*) $3Cl_2 + 6NaOH\ (conc.) \longrightarrow 5NaCl + NaClO_3 + 3H_2O$

(*iii*) $2XeF_2 + 2H_2O \longrightarrow 2Xe + O_2 + 4HF$

16. (*i*) Relatively large electron-electron repulsion among the lone pairs of F_2 molecule as they are much closer to each other than in Cl_2 molecule.

(*ii*) The minimum oxidation number (O.N) of S is –2 while its maximum O.N is +6. In SO_2, the O.N of sulphur is +4, hence, it can not only increase its O.N by losing electrons but also reduce its O.N by gaining electrons. Thus, it acts both as a reducing agent as well as an oxidising agent.

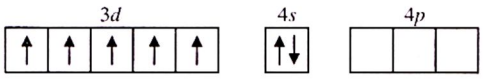
In contrast, in H_2S, S has an O.N of –2. Thus, it can only increase its O.N by losing electrons and hence acts only as a reducing agent.

(*iii*) Since the formation of ozone from oxygen is endothermic reaction, silent electric discharge prevents its decomposition.

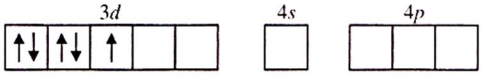
17. (*a*) The linkage isomer is $[Co(NH_3)_5(NO_2)]^{2+}$. Its IUPAC name is Pentaaminenitrito-O-cobalt(III).

(*b*) Oxidation state of Fe in $K_3[Fe(CN)_6]$ is +3

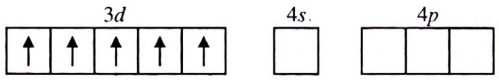
Configuration of Fe^{3+} is [Ar] $3d^5$



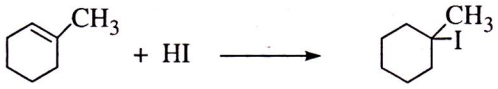
It has 5 unpaired electrons in 3*d* orbital which get paired leaving behind one unpaired electron only.



In $K_3[FeF_6]$ oxidation state of Fe is +3 and 5 unpaired electrons are there in 3*d* orbitals.



Because of the presence of different number of unpaired electrons these impart different colour to the same solution.

18. (*a*) 

1-Iodo-1-methyl cyclohexane

(*b*) (*i*) On heating chloroform and carbon tetrachloride with aniline and ethanolic potassium hydroxide separately chloroform forms pungent smelling isocyanide but carbon tetrachloride does not form this compound.

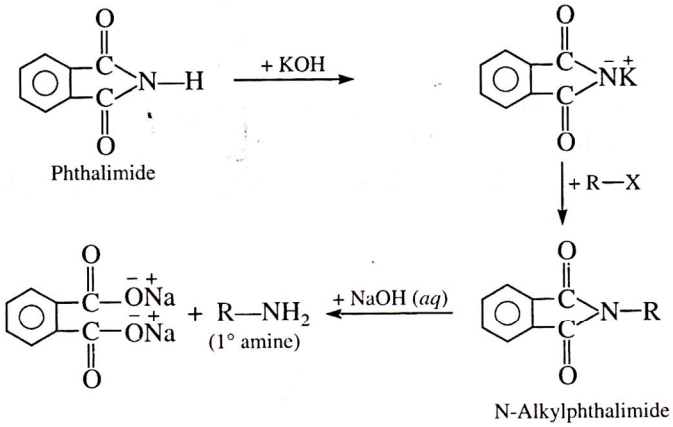
$$C_6H_5NH_2 + CHCl_3 + 3KOH \text{ (ethanolic)} \xrightarrow{\Delta} \underset{\text{Phenyl isocyanide}}{C_6H_5NC} + 3KCl + 3H_2O$$

(*ii*) On adding sodium hydroxide and silver nitrate to both the compounds benzyl chloride forms white precipitate but chlorobenzene does not form white precipitate.

$$C_6H_5CH_2Cl + NaOH \longrightarrow C_6H_5CH_2OH + NaCl$$

$$NaCl + AgNO_3 \longrightarrow \underset{\text{White ppt.}}{AgCl(s)} + NaNO_3$$

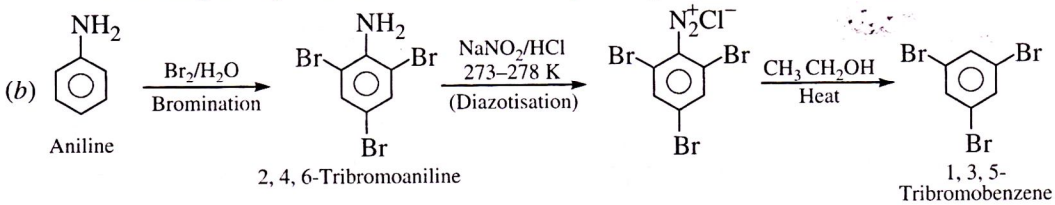
19. (*a*) (*i*) Gabriel phthalimide reaction:



N-Alkylphthalimide

(*ii*) Hoffmann bromamide degradation reaction:

$$RCONH_2 + Br_2 + 4NaOH \longrightarrow RNH_2 + Na_2CO_3 + 2NaBr + 2H_2O$$

(*b*) 

20. (*a*) Amylose is a long unbranched chain polymer of α-D(+) glucose.
Amylopectin is a branched chain polymer of α-D glucose.

(*b*) Globular protein and its shape is spherical.

(*c*) Liver and adipose tissue.

21. (*i*) Antiseptics are the chemicals applied to the living tissues either to kill or prevent the growth of microorganisms, *e.g.*, dettol.

(*ii*) Antioxidants are the compounds which retard the action of oxygen on food and reduces its rate of decomposition by oxidation,.*e.g.*, BHA.

(*iii*) Narcotic analgesics are the drugs used for the relief of post operative pain, *e.g.*, morphine.

22. (*a*) Monomers of the polymer are melamine and formaldehyde.

(*b*) $n\ CH_2{=}\underset{\underset{Cl}{|}}{C}{-}CH{=}CH_2 \xrightarrow[O_2 \text{ or peroxide}]{\text{Polymerisation}} \left[CH_2{-}\underset{\underset{Cl}{|}}{C}{=}CH{-}CH_2\right]_n$

Chloroprene — Neoprene

(*c*) Nylon-6, 6 > Natural rubber > PVC

23. (*i*) To prevent the passage of particulates in atmosphere.
Electrophoresis.

(*ii*) Coal contains sulphur, arsenic, lead. Thus, coal ash contaminates air and water.
Coal ash can be used to form bricks for the construction of buildings.

(*iii*) **Value:** Reducing air and water pollution/Environmental concern.

(*iv*) Organising debate on related topics/Assigning projects.

24. (*a*) (*i*) $LiAlH_4/H_3O^+$

(*ii*) PCC

(*iii*) PCC

(*iv*) Sodalime (CaO/NaOH)

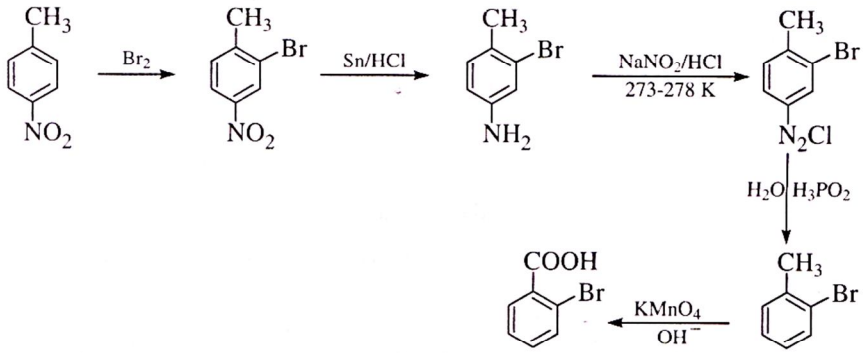
(*b*) (*i*) Butanone < Propanone < Propanal < Ethanal < Methanal.

(*ii*) Acetone < Acetaldehyde < Formaldehyde.

(*iii*) Acetophenone < *p*-Tolualdehyde < Benzaldehyde < *p*-Nitrobenzaldehyde.

OR

(*a*) (*i*)



(*ii*) $CH_3{-}CH_2{-}CN \xrightarrow[\text{Ether}]{+\,C_6H_5MgBr} CH_3CH_2{-}\underset{\underset{NMgBr}{\|}}{C}{-}C_6H_5 \xrightarrow{H_3O^+} CH_3{-}CH_2{-}\underset{\underset{O}{\|}}{C}{-}C_6H_5$

(*b*) (*i*) Because chloroacetate ion is more resonance stabilised than acetate ion due to the presence of electron withdrawing chlorine atom (+I effect).

(*ii*) Due to extensive intermolecular hydrogen bonding in carboxylic acids than in alcohols.

(*iii*) Because of –I effect of nitro group stability of benzoate ion increases in 4-nitro benzoic acid. But methoxy (+I effect) group decreases the stability of benzoate ion.

25. (*i*) Because oxygen forms multiple bonds with transition metals but fluorine does not form multiple bonds.

(*ii*) Cu has lower hydration enthalpy which is unable to compensate sum of first and second ionisation enthalpy.

(*iii*) 4*f* electrons of lanthanides is less effectively shielded from nuclear charge than 5*f* electrons of actinides.

(*iv*) Because dichromate ions get reduced to chromium ions in acidic medium.

(*v*) The actinides show more number of oxidation states than lanthanides because in actinides 5*f*, 6*d* and 7*s* levels have much comparable energies.

OR

(*a*) (*i*) Oxidation states of transition elements differ from each other by unity. In non-transition elements oxidation states normally differ by a unit of two.

(*ii*) In transition elements higher oxidation states are favoured by heavier elements whereas in non-transition elements lower oxidation state is favoured by heavier elements.

(*b*) (*i*) $MnO_4^- + 2H_2O + 3e^- \longrightarrow MnO_2 + 4OH^-] \times 2$

$$I^- + 6OH^- \longrightarrow IO_3^- + 3H_2O + 6e^-$$

$$2MnO_4^- + I^- + H_2O \longrightarrow IO_3^- + 2MnO_2 + 2OH^-$$

(*ii*) $2CrO_4^{2-} + 2H^+ \underset{\text{Alkali (pH more than 7)}}{\overset{\text{Acid (pH less than 7)}}{\rightleftharpoons}} Cr_2O_7^{2-} + H_2O$

(*iii*) $2KMnO_4 \xrightarrow{513\ K} K_2MnO_4 + MnO_2 + O_2$

26. (*a*) Given, M = 78 g mol^{-1}, T_f^0 = 278.4 K, ΔH_{fus} = 10.042 kJ mol^{-1}

$$K_f = \frac{RT_f^2 M}{1000 \times \Delta H_{fus}}$$

$$K_f = \frac{8.314 \times 10^{-3} \times (278.4)^2 \times 78}{1000 \times 10.042} = 5.0 \text{ K kg mol}^{-1}$$

$$2CH_3COOH \longrightarrow \underset{\text{Dimer}}{(CH_3COOH)_2}$$

$$\alpha = \frac{i-1}{\frac{1}{n}-1} = \frac{i-1}{n-1}$$

$$0.85 = \frac{i-1}{\frac{1}{2}-1}$$

or $i = 1 - 0.425 = 0.575$

$$\Delta T_f = iK_f m$$

$$= 0.575 \times 5 \times 0.4 = 1.15 \text{ K}$$

$$T_f = T_f^0 - \Delta T_f$$

$$= 278.4\ K - 1.15\ K = 277.25\ K$$

(*b*) (*i*) This solution has lesser vapour pressure due to stronger interactions (hydrogen bonds) between chloroform and acetone molecules.

(*ii*) Because higher quantity of NaCl will increase number of sodium and chloride ions in the body fluid which can increase the osmotic pressure of body fluid, *i.e.*, blood pressure of a person.

OR

(*a*) $2C_6H_5COOH \longrightarrow \underset{\text{Dimer}}{(C_6H_5COOH)_2}$

$$\alpha = \frac{i-1}{\frac{1}{n}-1}$$

$$0.84 = \frac{i-1}{\frac{1}{2}-1}$$

or $i = 1 - 0.42 = 0.58$

Normal molar mass of benzoic acid = $122\ g\ mol^{-1}$

$$\Delta T_b = i \,.\, K_b \,.\, m$$

$$= 0.58 \times 2.3 \times 1 = 1.334\ K \text{ or } 1.334\ °C$$

$$T_b = T_b^0 + \Delta T_b$$

$$= 46.2°C + 1.334°C = 47.534°C$$

(*b*) **Raoult's law:** The relative lowering of vapour pressure of the solvent over a solution is equal to the mole fraction of non-volatile solute present in the solution.

Mathematical expression, $x_B = \frac{p_A^o - p}{p_A^o}$