1. a) From graph Axes = 01 @ ½ with units if any
Shape = 01
Plot = 02
04

(ii) The melting point generally decrease from sodium chloride to disulphur dichloride

sodium chloride and Magnesium chloride have giant ionic structure in which the ions of opposite charge are held by strong ionic bonds; as ionic charge increases from sodium ion to magnesium ion, charge density increases in that order and so does the polarizing power; ionic character of the chlorides decreases sodium chloride and Magnesium chloride. 05

Al_2Cl_6, $SiCl_4$, PCl_3 amd S_2Cl_2 have simple molecular structure with weak Van der Waal. Forces of attraction; as molecular mass increases, the Van der Wall's forces become stronger.

The melting point of disulphur dichloride is higher than that of phosphorous trichloride because it has a high molecular mass therefore forms stronger van-der-Waals forces of attraction

b) (i) Aluminum oxide is added to dilute hydrochloric acid as the mixture is being stirred to obtain a saturated solution; the solution is filtered and the filtrate is evaporated up to crystallization point. The solution is cooled, the crystals are washed and dried. 03

(ii) Misty fumes and white solid. rej white fumes 2½

$2AlCl_3 . 6H_2O_{(s)} \longrightarrow 6HCl_{(g)} + 9H_2O_{(g)} + Al_2O_{3\,(s)}$ - deny ½ for wrong or missing state symbol
- rej unbalanced equation.

(iii) Misty fumes.

Aluminum ion has high charge density undergoes hydrolysis to form aluminum hydroxide and hydrogen ions.

$$Al^{3+}{}_{(aq)} + 3H_2O_{(l)} \longrightarrow Al(OH)_{3\,(s)} + 3H^+{}_{(g)}.$$ 2½

Accept:

$$AlCl_{3\,(s)} + 3H_2O_{(l)} \longrightarrow Al(OH)_{3\,(s)} + 3HCl_{(g)}$$

c) Alkanoate ion from soap under goes hydrolysis to form a carboxylic acid and hydroxide ions.

$$RCOO^-{}_{(q)} + H_2O_{(l)} \rightleftharpoons RCOOH_{(q)} + \bar{O}H_{(q)}.$$ ignore states

3

Aluminum being amphoteric reacts with hydroxide ions to from aluminate ions.

$$2Al_{(s)} + 2\bar{O}H_{(q)} + 6H_2O_{(l)} \longrightarrow 2Al(OH)_4^-{}_{(q)} + 3H_{2\,(q)}$$ ignore states

20

No2

(a)The ore is crushed and mixed with a frothing agent, air at high pressure passed through the mixture to agitate the mixture and the ore particles and the frothing agent rise and float while the impurities are wet by water and sink to the bottom. The ore in the froth is skimmed off and dilute nitric acid added, to break it down, it is filtered and dried.

The purified ore is is roasted in air to form zinc oxide and sulphur dioxide

$ZnS_{(s)} + \frac{3}{2}O_{2(g)} \longrightarrow ZnO_{(s)} + SO_{2(g)}$

The mixture of zinc oxide, lime stone and coke are put in the blast furnace and hot air blown into the furnace

Zinc oxide is reduced to zinc by carbon or carbon monoxide 7½

$ZnO_{(s)} + C_{(s)} \longrightarrow Zn_{(g)} + CO_{(g)}$.

Or

$ZnO_{(s)} + -CO_{(g)} \longrightarrow Zn_{(g)} + CO_{2(g)}$

Zinc vapour distills off from the furnace, its cooled by spray of molten lead. It is the purified by redistillation

b(i) zinc is a d-block element because its outer most electrons are filled in the d-sub energy level. Zinc is not a transition element because both the tom and the zinc ion have completely filled 3d sub energy level.

(ii) zinc chloride undergoes hydrolysis to form zinc oxide and hydrogen chloride gas that dissolves in the solution and make it acidic 3

$$ZnCl_{2(s)} + H_2O_{(s)} \rightleftharpoons ZnO_{(s)} + 2HCl_{(aq)}$$

c (i) Potassium manganate(VI) 01

$2MnO_{2(s)} + 4KOH_{(aq)} + O_{2(g)} \rightarrow 2K_2MnO_{4(s)} + 2H_2O_{(l)}$ 1½

(ii) $3MnO_4^{2-}(aq) + 4H^+(aq) \rightarrow 2MnO_4^-(aq) + MnO_{2(s)} + 2H_2O_{(l)}$

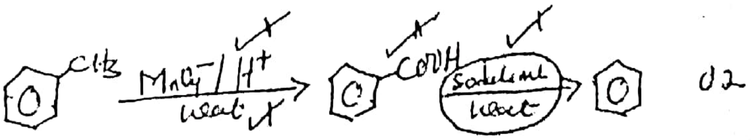
(iii) Sulphur dioxide is a reducing agent, It reduces manganate(VII) ions to manganese(II) ions and itself ~~reduced~~ oxidised to a sulphate 3½

$2MnO_4^-(aq) + 5SO_{2(g)} + 2H_2O_{(l)} \rightarrow 2Mn^{2+}(aq) + 5SO_4^{2-}(aq) + 4H^+(aq)$

3. a) (i) Reaction of benzene with an electrophile in which the electrophile replaces one of the hydrogen atoms of benzene.

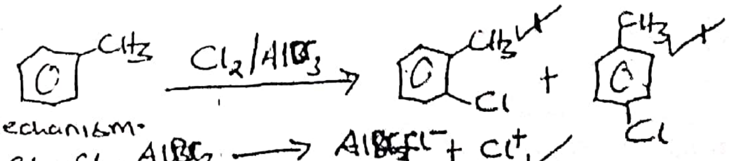
(ii) Benzene has delocalized pie electron which mark it stable.

b) (i)



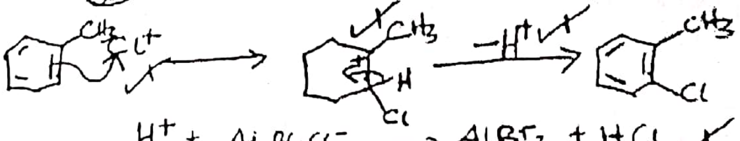
02

(ii)



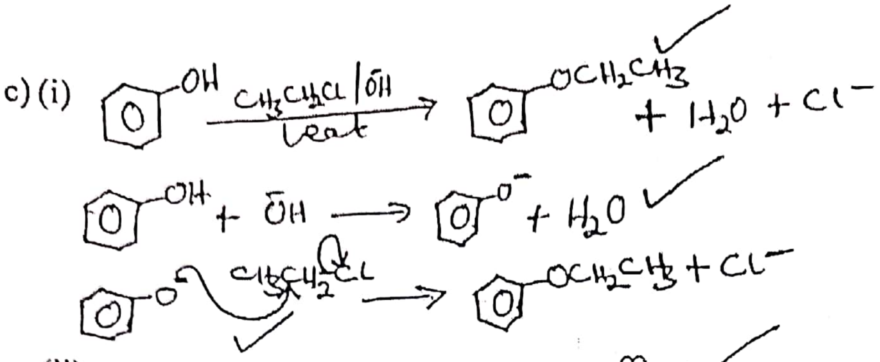
Mechanism.

$Cl-Cl + AlBr_3 \longrightarrow AlBr_3Cl^- + Cl^+$ 04



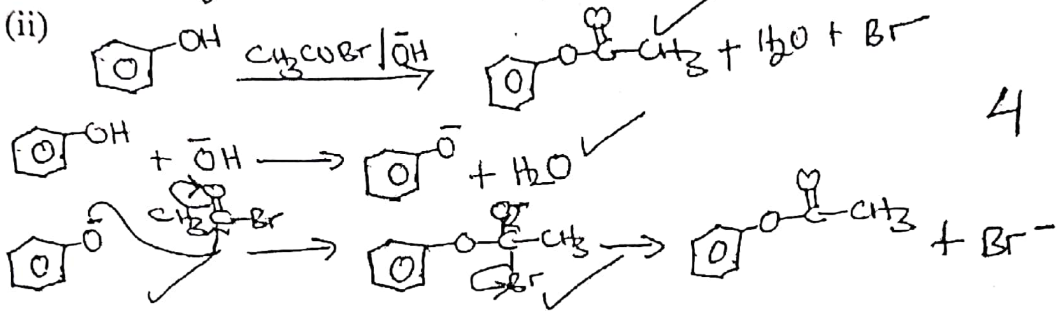
$H^+ + AlBr_3Cl^- \longrightarrow AlBr_3 + HCl$

c) (i)



3

(ii)



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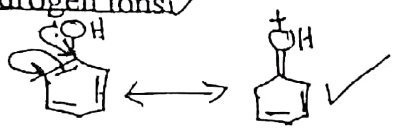
d) The lone pair of electron on the oxygen atom interacts with the declocalised pie electrons of benzene ring, the oxygen to hydrogen bond weakens and break to release hydrogen ions.



4

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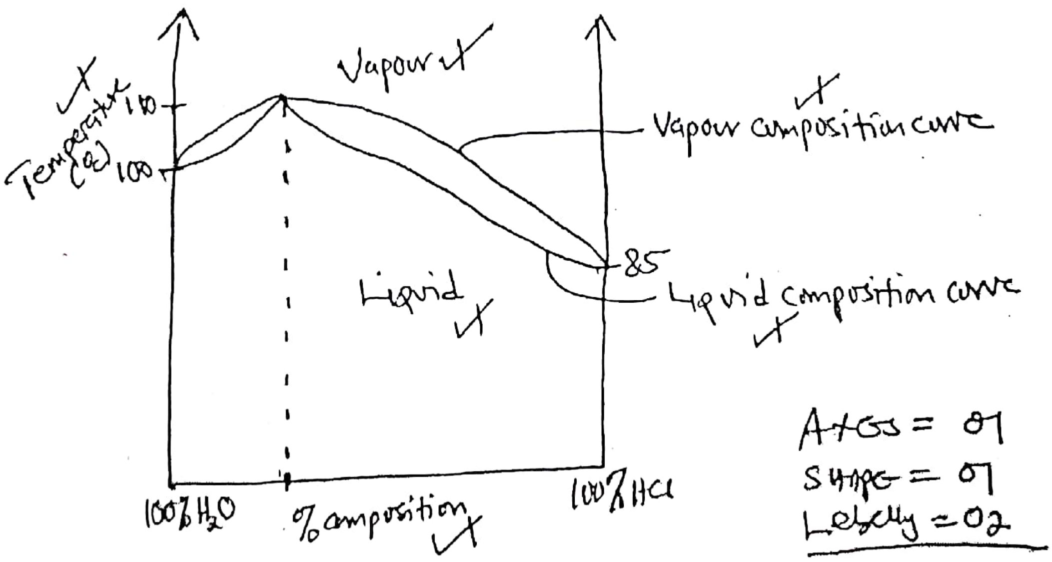
4. a) A solution that obeys Raoult's law formed with no change in total volume expected, no heat change occurs and adhesive forces are equal in magnitude to cohesive forces. 3

b) (i) A liquid mixture of fixed boiling point and composition that boils at constant temperature at given pressure to form vapour of the same composition of the liquid. 02

(ii)



Axes = 01
Shape = 01
Labelling = 02
04

(iii) The mixture boils at a given temperature to form vapour which is richer in water ✓ than the origin liquid mixture, the vapour condenses forming a liquid of the same ✓ composition as the vapour.
Repeated heating and cooling of subsequent liquid mixtures produces pure water ✓ as the distillate and azeotropic mixture as the residue. ✓ 3

c) $1 cm^3$ of mixture contains 1.18g

$1000 cm^3$ of mixture contains $\frac{1.18 \times 1000}{1} = 1180 g/l$ ✓

Mass of pure HCl $= \frac{20.5}{100} \times 1180$

$= 241.9 g/l$ ✓ 2

RFm of HCl $= 1 + 35.5 = 36.5$

36.5g of HCl contain 1 mole

241.9g of HCl contain $= \frac{1}{36.5} \times 241.9 = 6.62M$ ✓ ✓

d) (i) Partial pressure ~~of x~~ = mole fraction x vapoour ✓

$(P_Z) = \frac{1}{5} \times 0.674 = 0.1348$ atm ✓ ✓

$P_y = \frac{4}{5} \times 0.453 = 1.348$ atm ✓ 4

$P_{total} = P_x + P_Z$
$= 0.1348 + 0.3624 = 0.4972$ atm ✓ ✓

20

(ii) Solution deviates ~~negative negatively~~ positively ✓. This is because the vapour pressure of solution is ~~less~~ greater than that expected if the solution was ideal. ✓ 02

5. a) (i) Reagent : Brady's reagent ✓ | 2,4-dinitrophenyl hydrazine solution
Observation : Yellow/orange precipitate ✓
Accept : Ammoniacal silver intrate solution and heat
Observation : Silver mirror.

(ii) Reagent : Acidified potassium manganite (VII) solution ✓
Observation : Puple solution turns colourless. ✓ 2
Accept : Bromine water.
Observation : reddish brown solution turns colourless.

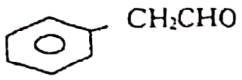
(iii) Reagent : ~~Podium clarbonate solution~~ Potassium / sodium carbonate solution ✓
Observation : bubbles of a coulourless gass. ✓

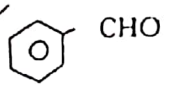
(iv) Reagent : Phosphorus pentachloride ✓

Observation : misty fumes. ✓

Accept Sodium metal → Bubbles of a colourless gas

b) (i) Reagent : Fehling's solution and heat ✓

observation : reddish brown precipitate with ✓ 

: no observable change with ✓  3

(ii) Reagent : Ammionaical silver nitrate solution ✓

observation :

$CH_3C{\equiv}CCH_3$ no observable change ✓ 3

$CH_3C{\equiv}CH$ white precipitate. ✓

Accept : Ammioniacal copper(I) chloride solution

observation :

$CH_3C{\equiv}CCH_3$ no observable change

$CH_3C{\equiv}CH$ red precipitate.

(iii) Reagent : Concentrated sulphuric acid and heat ✓

observation : 3

CH_3COOH No observable change ✓

$H_2C_2O_4$ Bubbles of a colourless gas. ✓

Accept : Acidified potassium manganate (VII) solution and heat.

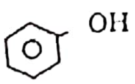
observation :

CH_3COOH no observable change

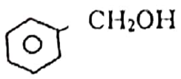
$H_2C_2O_4$: Purple solution turns colourless with bubbles of a colourless gas.

(iv) Reagent : Neutral iron (III) chloride solution ✓

observation :



Purple colouration ✓ 3



no observable change ✓

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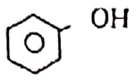
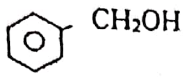
Accept: Ethanioc acid, concentrated pulphuric acid and heat.

Observation

	Purple colouration
	Sweat fruity smell.

6. a) A saturated solution of the salt ✓ is prepared by adding excess of the salt ✓ to water in a bottle, the bottle is stopped, shaken and allowed to stand for some time at constant temperature. The conductivity of the saturated solution is measured using conductivity meter. The molar conductivity of the salt at infinite dilution is determined by getting the sum of the molar conductivities of the component ions at infinite dilution.is determined by getting the sum of the molar conductivities of the component ions at infinite dilution. The solubility of the salt is determined from the expression ✓ 6½

$\Lambda_0 = \frac{K_{salt}}{C}$ ✓ But $K_{salt} = K_{solution} - K_{water}$ ✓

C is the Solubility of the salt, Assumption: Molar conductivity of solution is equal to molar conductivity at infinite dilution for sparingly soluble salts ✓

Equation.

$Ag_2C_2O_4(s) \rightleftharpoons Ag^+{}_{(aq)} + C_2O_4^{2-}{}_{(aq)}$ ✓

$[Ag^+] = 2S$ ✓ $[C_2O_4^{2-}] = S$ ✓

$Ksp = [Ag^+]^2[C_2O_4^{2-}]$ ✓

$= (2S)^2(S)$

$= 4S^3 mol^3dm^{-9}$ ✓

Alternative:

A saturated solution of the salt is prepared by adding excess of the salt to water in a bottle to stand for some time at constant temperature. ✓ A known volume of the saturated solution is pipette, a small amount of dilute sulphuric acid is added and the mixture is warmed. ✓ The mixture is titrated with a standard solution of potassium manganate (VII) solution. ✓

Manganate (VII) ions react with oxalate ions according to the equation.

$2MnO_4^-{}_{(aq)} + SC_2O_4^-{}_{(aq)} + 16H^+{}_{(aq)} \longrightarrow 2Mn^{2+}_{(aq)} + 10CO_{2(g)} + 8H_2O_{(l)}$. ✓

The results of the titration are used to calculate the concentration of oxalate ions

if $[C_2O_4^{2-}] = x$ ✓ $[Ag^+] = 2x$ ✓ Eqn: $Ag_2C_2O_4(s) \rightleftharpoons Ag^+{}_{(aq)} + C_2O_4^{2-}{}_{(aq)}$ ✓

$Ksp = [Ag^+]^2 \cdot [C_2O_4^{2-}]$ ✓

$= (2x)^2 \times x$ ✓

$= 4x^3 mol^3 dm^{-9}$

(ii) Ksp = $[Ag^+]^2\ [C_2O_4^{2-}]$

$[Ag^+]$ = 1.1 x 10^{-4} x 2

$[C_2O_4^{2-}]$ = 1.1 x 10^{-4}

Ksp = $(2 \times 1.0 \times 10^{-4})^2 \times 1.1 \times 10^{-4}$

= 5.324 x 10^{-12} mol^3 dm^{-9} (7½)

Let S be solubility of $Ag_2C_2O_4$ in 0.01M $AgNO_3$

$[Ag^+]$ = 2S + 0.01, $[C_2O_4^{2-}]$ = S

5.324 x 10^{-12} = $(S + 0.01)^2 \times S$

Assumption 2S + 0.01 $\simeq$ 0.01

5.324 x 10^{-12} = $(0.01)^2 \times S$

S = 5.324 x 10^{-8} moldm^{-3}

b) (i) Silver ions in the saturated solution react with aqueous ammonia to form a soluble complex ion, equilibrium concentration of silver ions decreases, more silver chloride dissolves to replace the complexed silver ions. $Ag^+_{(aq)} + 2NH_{3(aq)} \rightarrow Ag(NH_3)_2^+{}_{(aq)}$

3

(ii) Barium ions in the saturated solution react with nitrate ions to form barium nitrate, the equilibrium concentration of barium ions decreases, more barium sulphate dissolves to replace the reacted barium ions

$Ba^{2+}_{(aq)} + 2NO_3^-{}_{(aq)} \rightarrow Ba(NO_3)_{2(aq)}$

3

20

7a

(i) Reduction potential of a half cell measured relative to the standard hydrogen electrode at 298k (25^{0}c) and 1atom. 2

ii) **Atomization energy**. The lower the ionization energy, the higher the standard electrode potential because gaseous atoms and easily formed.

04

Ionization energy. The lower the ionization energy, the higher the standard electrode potential because gaseous ions are easily formed.

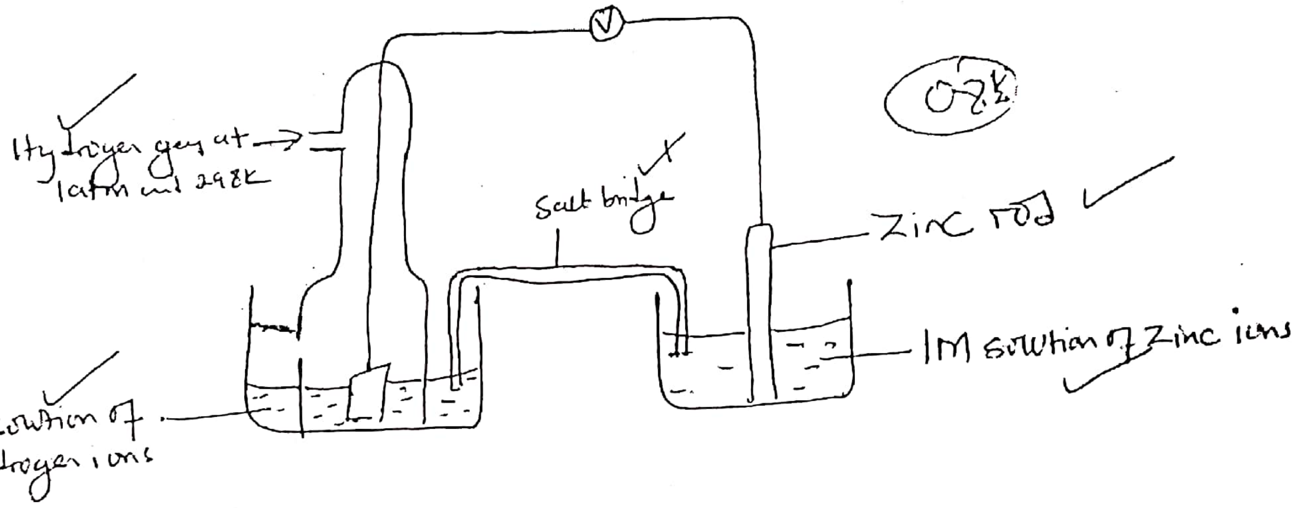
Accept any two

Hydration energy, the higher the hydration energy the higher the standard electrode potential because gaseous ions attract more water molecules

b) The zinc rod is dipped in a one molar solution of its ions to make a zinc half-cell. The zinc half-cell on the right is connected to the standard hydrogen electrode on the left using a salt bridge to complete the internal circuit and connecting wire through a high resistance voltmeter to complete the external circuit

The standard hydrogen electrode consists of Hydrogen gas bubbled at 25°C over platinized platinum dipped in a one molar solution of hydrogen ions at 298k

The e.m.f of the zinc half-cell is measured using the voltmeter since the electrode potential of the standard hydrogen electrode is taken as 0.00v, the reading of the voltmeter is the reduction potential of the zinc half-cell.



07½

c)(i)

Anode: $Fe^{2t}_{(aq)} \longrightarrow Fe^{3t}_{(aq)} + e$

$Zn_{(s)} + 4OH^-_{(aq)} \longrightarrow Zn(OH)^{2-}_{4(aq)} + 2e$ 2

Cathode : $2H^+_{(aq)} + 2e \longrightarrow H_{2(g)}$

$BrO^-_{3(aq)} + 3H_2O_{(l)} + 6e \longrightarrow Br^-_{(aq)} + 6OH^-_{(aq)}$

(ii) $Pt_{(s)}/Fe^{2+}_{(aq)}, Fe^{3+}_{(aq)}// H^+_{(aq)}/H_{2(g)}/Pt_{(s)}$ 2

$Zn_{(s)}/OH^-_{(aq)}, Zn(OH)^{2-}_{4(aq)}//BrO^-_{3(aq)}, Br^-_{(aq)}, OH^-_{(aq)}/Pt_{(s)}$

(iii) // salt bridge

/ Separation of species at the same electrode in different physical state 1½

, separation of species at the same electrode in different physical states

20

No 8

(a) Cations of group (II) elements have higher ionic charge (+2) and smaller ionic radius than the corresponding cations of group (I) elements. The charge density of cations of group (II) elements therefore higher than that of group(I) cations 3

(b) Zinc chloride undergoes hydrolysis in water to form zinc oxide and hydrogen chloride

$$ZnCl_{2(s)} + H_2O_{(s)} \rightleftharpoons ZnO_{(s)} + 2HCl_{(aq)}$$ 3

(c) Alkenes have a carbon to carbon double bond which is electron rich and donates electrons to the electrophiles while the carbonyl group is polar because oxygen is more electronegative than carbon, oxygen attracts the bonding electrons to attain a partial negative charge and carbon attains a partial positive charge. The carbon atom is center for nucleophilic attack

(d) Methanoic acid has a hydrogen atom attached to the carboxyl group, the hydrogen atom has no inductive effect, the oxygen–hydrogen bond is weakest 06
Ethanoic acid has methyl group attached to the carboxyl carbon, it exerts a positive inductive effect making the oxygen-hydrogen bond stronger. The oxygen-hydrogen bond in methanoic acid breaks easily to release hydrogen ions in solution than oxygen-hydrogen in Ethanoic acid.

(e) Bromide ions is stronger reducing agent than the chloride ion because the ionic radius of bromide ions is bigger than that of chloride ion. The bromide ion reduces the lead(IV) ion to lead(II) ions

$$Pb^{4+}_{(aq)} + 2Br^{-}_{(aq)} \longrightarrow Pb^{4+}_{(aq)} + Br_{2(aq)}$$ 3½

20

END