Aug. 2023.

MARKING GUIDE (CHEMISTRY P525/1).

1 (a) Colligative property is a property of Solutions that depends on the number of particles of a non-volatile solute but independent of the chemical nature of the solute. ✓ (1)

(b) 5000g of water dissolve 1000g of $C_3H_8O_3$

1000g of water dissolve $\frac{1000}{5000} \times 1000g$ of $C_3H_8O_3$ ✓½

$= 200g$ ✓½

RFM of $C_3H_8O_3 = 36+8+48 = 92$ ✓½

92g of $C_3H_8O_3$ cause ΔT_f of $1.86°C$ ✓½ (3½)

200g of $C_3H_8O_3$ cause ΔT_f of $\frac{1.86}{92} \times 200°C$ ✓½

$= 4.04°C$ ✓½

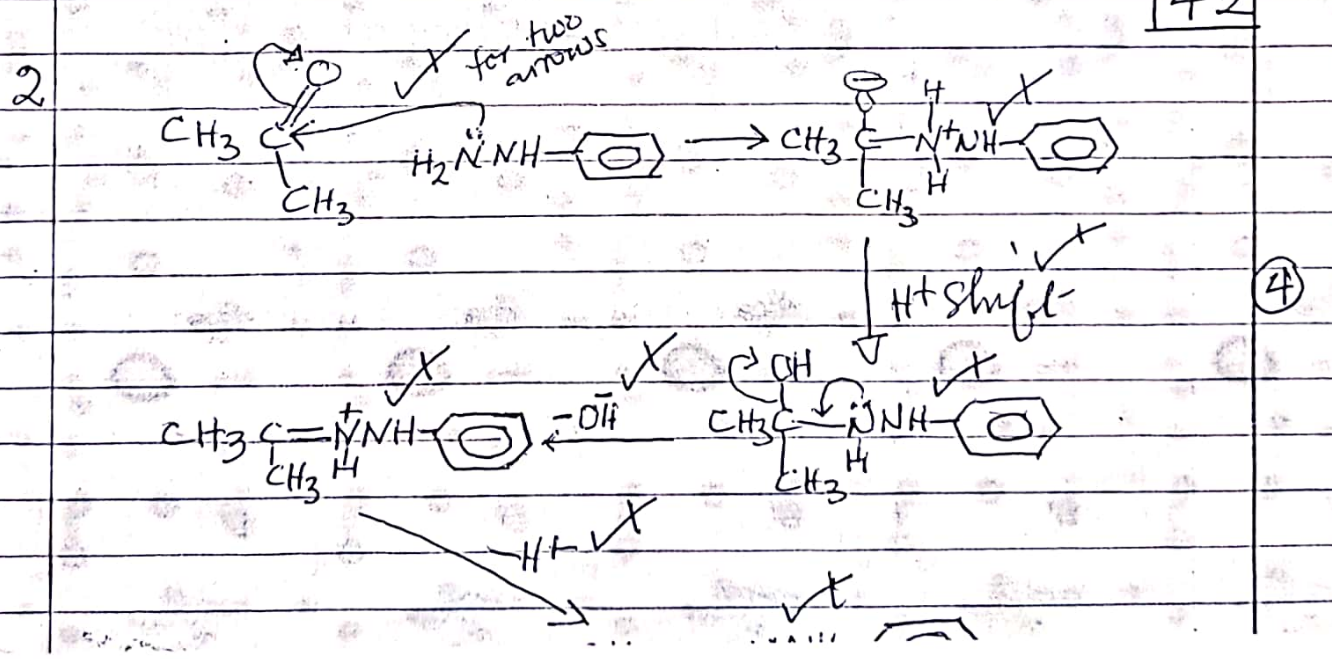
Freezing point of the solution

$= 0 - 4.04$

$= -4.04°C$ ✓½

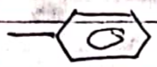
4½

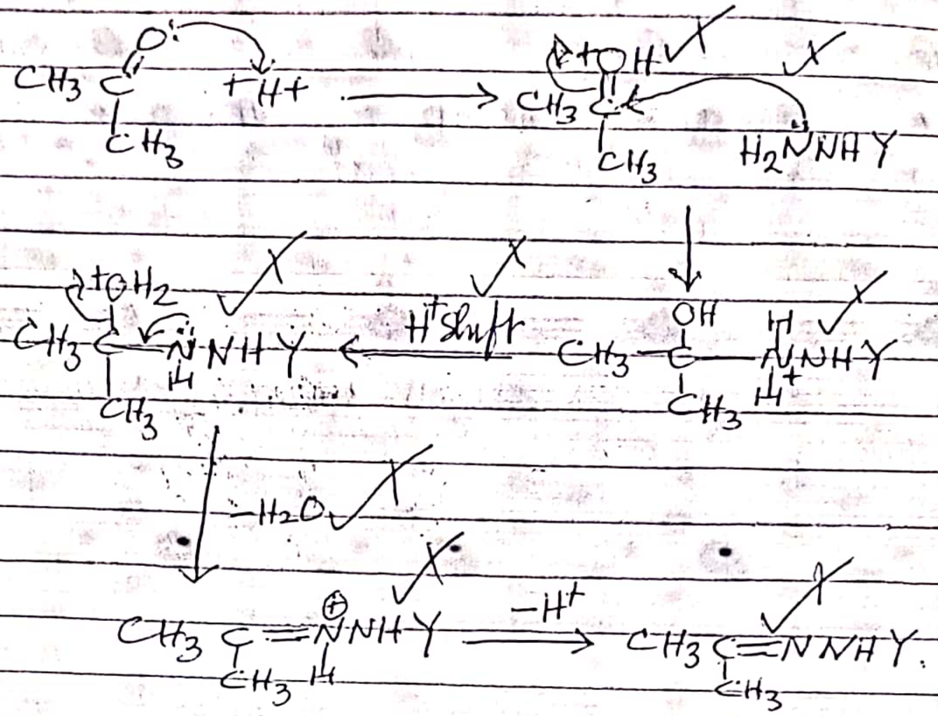
2



(4)

Allow with Protonation

Let Y = 



3 (a) Green precipitate/solid ✓ soluble in excess to give a purple or Violet ✓ Solution (3)

$Cr^{3+}_{(aq)} + 3OH^-_{(aq)} \longrightarrow Cr(OH)_{3\,(s)}$ ✓

$Cr(OH)_{3\,(s)} + 6NH_{3\,(aq)} \longrightarrow Cr(NH_3)^{3+}_{6\,(aq)} + 3\bar{O}H_{(aq)}$ ✓

(b) Green precipitate ✓ and bubbles of a colourless gas ✓ (2½)

$2Cr^{3+}_{(aq)} + 3H_2O_{(l)} + 3CO^{2-}_{3\,(aq)} \longrightarrow 2Cr(OH)_{3\,(s)} + 3CO_{2\,(g)}$ ✓✓

or $2Cr(H_2O)^{3+}_{6\,(aq)} + 3CO^{2-}_{3\,(aq)} \longrightarrow 2Cr(H_2O)_3(OH)_{3\,(s)} + 3CO_{2\,(g)}$

Note: Physical state(s) missing or wrong (−½)
Unbalanced equation(s) (score zero)
Wrong symbol(s) (score zero)

Applies to all inorganic equations

05½

4 a) Nitrous acid.
(i) Amines

(ii) Primary amines ⇒ form a Colourless Solution and bubbles of a colourless gas 2½

Secondary amine – form a yellow oil

Tertiary amines form a colourless solution

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b) Anhydrous Zinc chloride and Concentrated hydrochloric acid

(i) Alcohols

(ii) Primary alcohols ⇒ no observable change at room temperature 2½

Secondary alcohols – form a cloudy solution within 5 to 10 minutes

Tertiary alcohols – form a cloudy solution immediately

10 5.

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5 (a) (i) $S_2O_3^{2-}$

$2x + 3(-2) = -2$

$2x = +4$

$x = +2$ 01

(ii) $S_4O_6^{2-}$

$4x + 6(-2) = -2$ 1

$4x = +10$

$x = +2.5$

(b)(i) $I_{2(aq)} + 2S_2O_{3(aq)}^{2-} \rightarrow S_4O_{6(aq)}^{2-} + 2I^-_{(aq)}$ 3

(ii) $4Cl_{2(g)} + S_2O_{3(aq)}^{2-} + 5H_2O_{(l)} \rightarrow 2SO_{4(aq)}^{2-} + 10H^+_{(aq)} + 8Cl^-_{(aq)}$

6 a(i) $CH_3COO^-(aq) + H_2O(l) \rightleftharpoons CH_3COOH(aq) + \bar{O}H(aq)$

or

$CH_3COONa(aq) + H_2O(l) \rightleftharpoons CH_3COOH(aq) + NaOH(aq)$

Note: If single arrow used $(-\frac{1}{2})$

(ii) $$K_h = \frac{[CH_3COOH][OH^-]}{[CH_3COO^-]}$$ (1/2)

(b) $CH_3COOH(aq) + NaOH(aq) \longrightarrow CH_3COONa(aq) + H_2O(l)$

moles of CH_3COONa formed = moles of ethanoic
$= 0.02 \times 50/1000 = 0.001$

Total Volume of the Solution $= 50 + 50 = 100\ cm^3$

$[CH_3COONa] = \frac{0.01 \times 1000}{100} = 0.01\ M$

Equation of hydrolysis of the Salt is:

$CH_3COONa(aq) + H_2O(l) \rightleftharpoons CH_3COOH(aq) + NaOH(aq)$

or $CH_3CO\bar{O}(aq) + H_2O(l) \rightleftharpoons CH_3COOH(aq) + \bar{O}H(aq)$

$$K_h = \frac{[CH_3COOH][\bar{O}H]}{[CH_3COO^-]} = \frac{[\bar{O}H]^2}{0.01}$$ (5)

$$K_h = K_w/K_a = \frac{1 \times 10^{-14}}{1.8 \times 10^{-5}} = 5.56 \times 10^{-10}$$

$$\frac{[OH^-]^2}{0.1} = 5.56 \times 10^{-10}$$

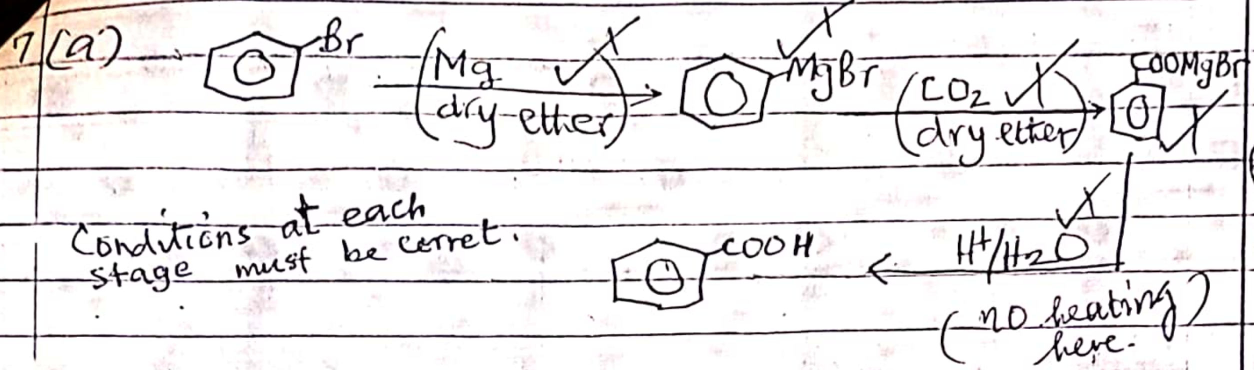
$$[\bar{O}H] = \sqrt{5.56 \times 10^{-10} \times 0.01} = 2.36 \times 10^{-6}\ M$$

$$POH = -\log[\bar{O}H]$$
$$= -\log 2.36 \times 10^{-6} = 5.63$$

$$PH = 14 - POH$$
$$= 14 - 5.63$$
$$= 8.37$$

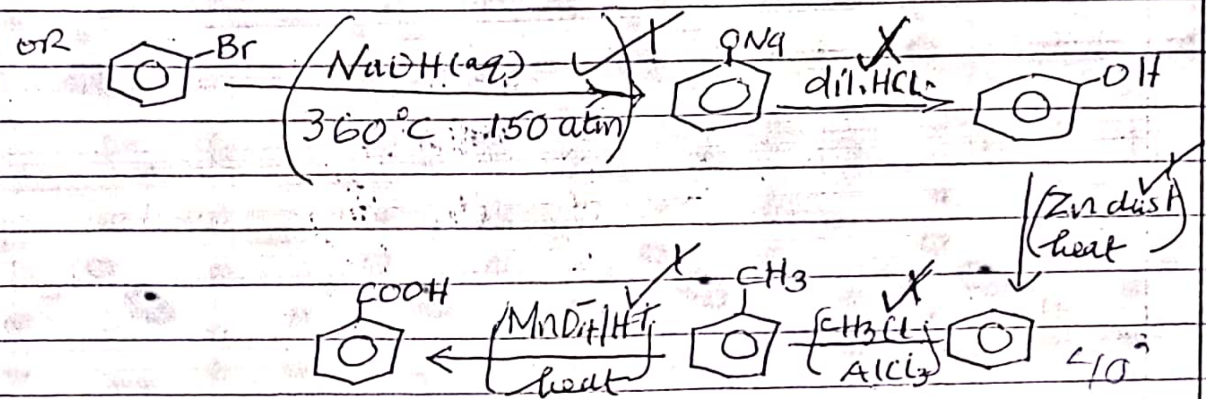
07

7 (a)



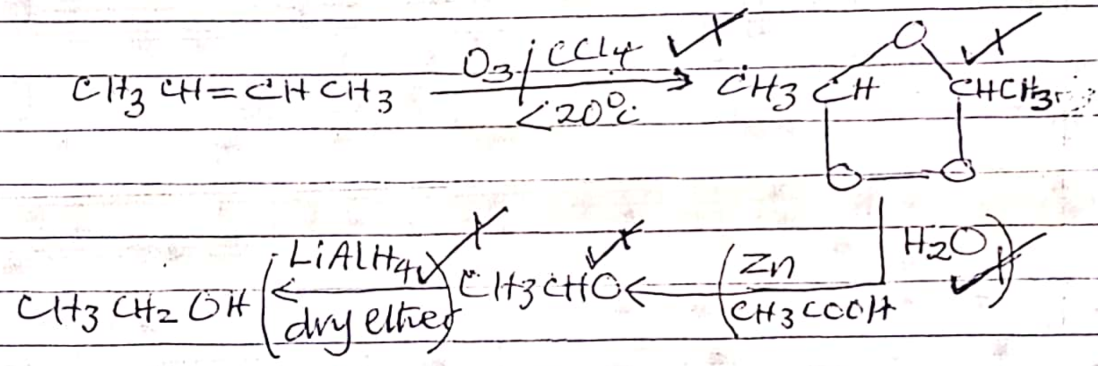
Conditions at each stage must be correct.

or



4/0

(b)



(2½)

(2½)

05

8 In the group;

a) . It has the smallest atomic radius ✓

. It has the highest electronegativity ✓ (1½)

. It has the lowest electronegativity ✓

Only three expected. → Has the lowest negative electrode Potential

→ Forms the smallest cation

→ Its cation has the highest charge density

(Resect has high, small, low ....)

b)

(i) $BeO(s) + 2\bar{O}H(aq) \longrightarrow BeO_2^{2-}(aq) + H_2O(l)$ ✓ (1½)

or $BeO(s) + 2\bar{O}H(aq) + H_2O(l) \longrightarrow Be(OH)_4^{2-}(aq)$

(ii) $Al_2O_3(s) + 2OH^-_{(aq)} \longrightarrow 2AlO_2^-{}_{(aq)} + H_2O(l)$ ✓✓

or $Al_2O_3(s) + 2OH^-_{(aq)} + 3H_2O_{(l)} \rightarrow 2Al(OH)_4^-{}_{(aq)}$

$4\frac{1}{2}$

9(a) (i) one or 1 ✓✓ with respect to A

(ii) Zero or 0 ✓✓ with respect to I_2 (1)

b) By Inspection:

- Tripling the concentration of A while keeping the concentration of Iodine constant, the rate triples ✓ $\Rightarrow$ 1st order w.r.t A

- Doubling the concentration of Iodine while keeping the concentration of A constant, the rate remains constant ✓ $\Rightarrow$ zero order w.r.t I_2. (2)

OR By calculation:

using Rate $= K[A]^x[I_2]^y$

For A

$3\times10^{-4} = K(0.3)^x(0.1)^y$ ---- (i) Expt 3

$1\times10^{-4} = K(0.1)^x(0.1)^y$ ---- (ii) Expt 1

(i) ÷ (ii) $\Rightarrow 3 = 3^x$

$\Rightarrow x = 1$ ✓

For I_2

$1\times10^{-4} = K(0.1)^x(0.2)^y$ ---- (i) Expt 2

$1\times10^{-4} = K(0.1)^x(0.1)^y$ ---- (ii) Expt 4

(i) ÷ ii $\Rightarrow 1 = 2^y$

$\Rightarrow y = 0$ ✓

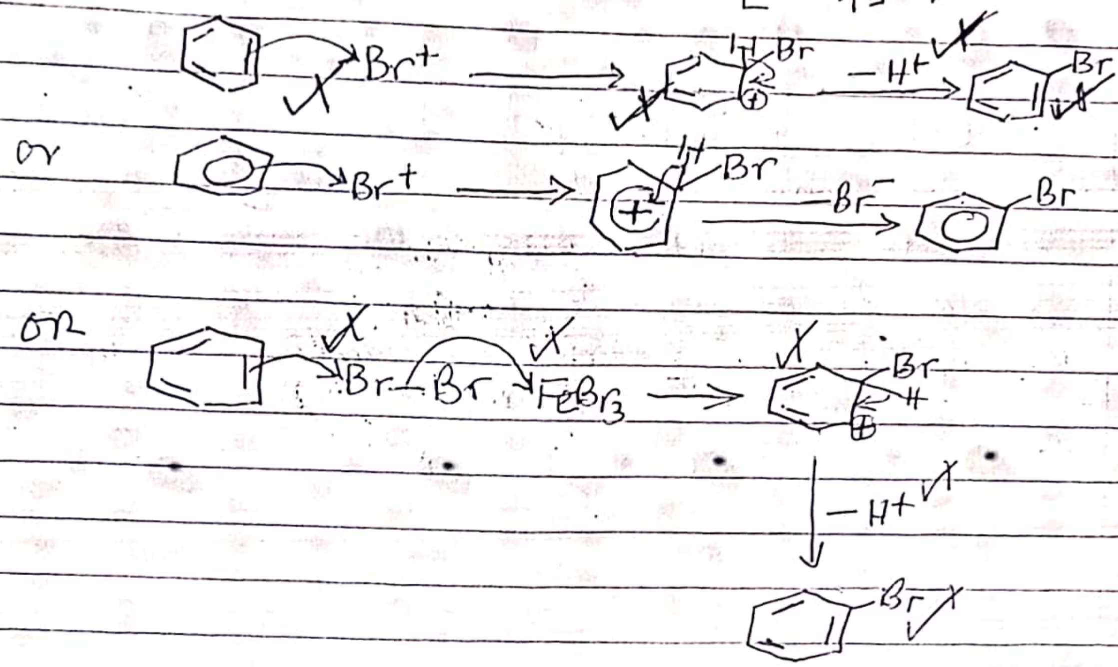
(c) overall order $= 1 + 0 = 1$ ✓✓ ($\frac{1}{2}$)

d) Rate $= K[A][I]^0$ or Rate $= K[A]$ ✓✓ (2)

$k = \frac{1\times10^{-4}}{0.1}$ ✓✓ $= 1\times10^{-3}$ ✓✓ s^{-1} ✓✓

10 (a) $2Fe + 3Br_2 \longrightarrow 2FeBr_3$ ✓

$Br_2 + FeBr_3 \rightleftharpoons Br^+ + [FeBr_4]^-$ ✓



3

b) $H_2SO_4 \rightleftharpoons H^+ + HSO_4^-$

$CH_3CH_2OH + H^+ \longrightarrow CH_3CH_2\overset{+}{O}H_2$ ✓

Allow: $CH_3CH_2\ddot{O}H \quad H-OSO_3H$

$CH_3CH_2\overset{+}{O}H_2 \xrightarrow{-H_2O} CH_3\overset{+}{C}H_2$ ✓

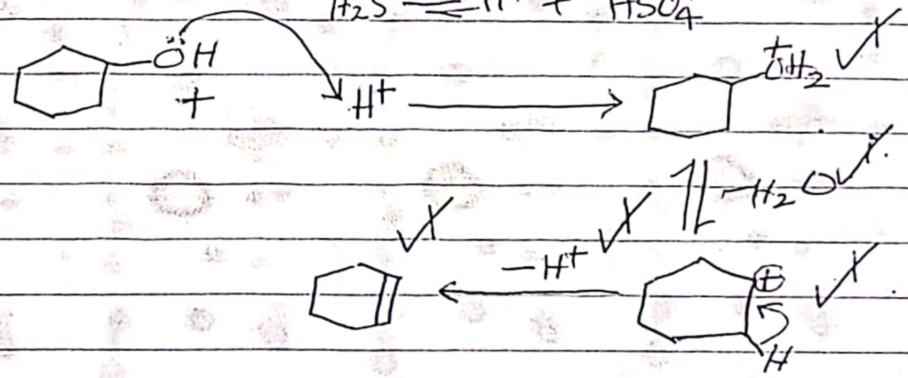
$CH_3\overset{+}{C}H_2 + H-\ddot{O}-CH_2CH_3 \longrightarrow CH_3CH_2\overset{+}{\underset{H}{O}}CH_2CH_3$ ✓

$\xrightarrow{-H^+}$ ✓

$CH_3CH_2OCH_2CH_3$ ✓

$3\frac{1}{2}$

(c) $H_2S \rightleftharpoons H^+ + HSO_4^-$



$2\frac{1}{2}$

(i) First electron affinity is the energy change when an a gaseous atom gains an electron to form a negatively charged gaseous ion ✓

OR

First electron affinity is the energy change when 1 mole of gaseous atoms gains 1mole of electrons to form 1 mole of negatively charged gaseous ions

Reject: If 1mole of gaseous atom, 1mole of electron and 1mole of gaseous ion is used

(ii) · Nuclear charge ✓

· Atomic radius ✓

· Screening effect ✓ (1½)

b) (i) see graph paper Page 15

(shape/scale & plot ✓; axes labelled ✓ Title ✓) (2½)

ii) There is a general increase in electron affinity from sodium to chlorine ✓ due to increase in nuclear charge and decrease in atomic radius resulting into increase in attraction ✓ for the incoming electron by the nucleus. (1)

However the first electron affinity of Magnesium is lower ✓ than that of aluminium because the incoming electron is being added to an energy level which has a completely filled 3s-subenergy level which is full and stable. ✓ Therefore the incoming electron experiences greater repulsion from the existing electrons than nuclear attraction ✓ (1½)

Mg: $1s^2 2s^2 2p^6 3s^2$; Al: $1s^2 2s^2 2p^6 3s^2 3p^1$

In aluminium the 3p-subenergy level has one electron and is unstable therefore the added electron experiences more attraction than repulsion.

Also the first electron affinity of Phosphorus is lower than that of Sulphur because the electron is being added to a half filled 3p-Sub energy level which is stable, therefore the electron experiences more repulsion than nuclear attraction (1½)

P: $1s^2 2s^2 2p^6 3s^2 3p^3$; S: $1s^2 2s^2 2p^6 3s^2 3p^4$

In Sulphur the electron is added to 3p-sub energy level with 4-electrons which is unstable, so the electron experiences more attraction than repulsion.

09

12. a)(i) $Ag_2C_2O_4(s) \rightleftharpoons 2Ag^+(aq) + C_2O_4^{2-}(aq)$

(Deduct ½ mark if single arrow used) (2½)

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

b) RFM of $Ag_2C_2O_4 = (2\times108)+24+64$
$= 304$

Solubility in mol $dm^{-3} = \frac{3.27\times10^{-2}}{304}$
$= 1.076\times10^{-4}$

$Ksp = (2x)^2 \cdot x = 4x^3 = 4(1.076\times10^{-4})^3$ (3)
$= 4.98\times10^{-12}$ $mol^3 dm^{-9}$

(c) $[Ag^+]^2 \times 0.005 = 4.98\times10^{-12}$

$[Ag^+] = \sqrt{\frac{4.98\times10^{-12}}{0.005}} = 3.16\times10^{-5}$ M (1½)

12 d] $[Ag^+] \times 0.005 = 1.96 \times 10^{-10}$ ✓

$[Ag^+] = 3.92 \times 10^{-8}$ M ✓

Silver chloride will be precipitated first ✓ because the concentration of Silver ions required to precipitate 0.005M Chloride ions is less ✓ than the concentration of silver ions required to precipitate 0.005M of oxalate ions. (2)

$\boxed{.09}$

13 a(i) Common oxidation states of group (IV) elements are +2 ✓ and +4 ✓ (1)

(ii) The +2 oxidation state becomes more stable down the group ✓ whereas +4 oxidation state becomes less ✓ stable down the group.

Lead (IV) Chloride decomposes ✓ to Lead (II) chloride and chlorine whereas carbon tetrachloride is very stable ✓ at room temperature. (3)

$PbCl_4(l) \longrightarrow PbCl_2(s) + Cl_2(g)$ ✓

(b) ~~As the atomic radius increases down the group, the two bonding electrons in the s-sub energy level become more penetrating~~

(b) As the atomic radius increases down the group there is increasing tendency for the two bonding electrons in the S-subenergy level to resist taking part in bonding. This because the s-electrons are more penetrating, so they experience a greater nuclear attraction and become relatively more stable than the p-electrons. This makes them less available to be involved in a chemical reaction

$2\frac{1}{2}$

(c)

(i) The dark brown or brown solid dissolves to form a colourless solution and bubbles / effervescence of a greenish-yellow gas is evolved.

1

(ii) $PbO_{2(s)} + 4HCl_{(aq)} \rightarrow PbCl_{2(aq)} + Cl_{2(g)} + 2H_2O_{(l)}$

$1\frac{1}{2}$

09

14 a (i) Zinc is the strongest reducing agent (because it has the largest negative $E^{\ominus}$ value among those given.

1

(ii) Manganate (vi) ion (MnO_4^{2-}) is the strongest oxidising agent (because it has the largest positive $E^{\ominus}$ value among those given)

1

(b) (i) $Zn_{(s)} / Zn^{2+}_{(aq)} // MnO^-_{4(aq)}, H^+_{(aq)}, Mn^{2+}_{(aq)} / Pt_{(s)}$

1

(ii) $5Zn_{(s)} + 2MnO^-_{4(aq)} + 16H^+_{(aq)} \rightarrow 5Zn^{2+}_{(aq)} + 8H_2O_{(l)}$ + $2Mn^{2+}$

1

(iii) $E_{cell} = E_{right} - E_{left}$
$= 1.52 - (-0.76)$ ✓
$= +2.28\,V$ ✓ Deny ½ mark if +ve sign missing

(iv) The reaction is possible ✓ since the Emf of the cell is positive ✓ (1)

(c) (i) Green solution ✗ turned to a purple solution ✗ and a brown precipitate ✓ was also formed (1½)

(ii) $2CO_{2(g)} + 3MnO_{4(aq)}^{2-} \rightarrow 2MnO_{4(aq)}^{-} + MnO_{2(s)} + 2CO_{3(aq)}^{2-}$ ✓✓ (1½)

109

15 (a) % of oxygen = 100 − (80 + 6.7) = 13.3% ✓

	C	H	O
moles of atoms	$\frac{80}{12}$	$\frac{6.7}{1}$	$\frac{13.3}{16}$
	6.7	6.7	0.83 ✓
	$\frac{6.7}{0.83}$	$\frac{6.7}{0.83}$	$\frac{0.83}{0.83}$
	8	8	1 ✓

(2)

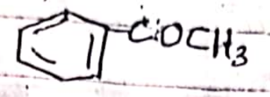
∴ Empirical formula C_8H_8O ✓

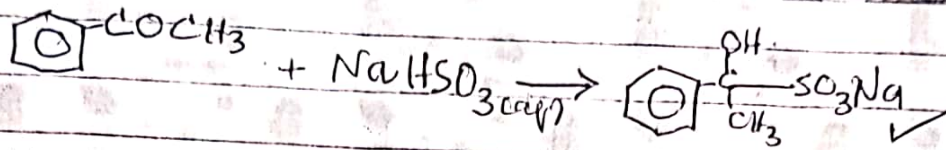
(b) $M_r = \frac{mRT}{PV}$ ✓ $= \frac{0.25 \times 8.31 \times 423}{101325 \times 122.3 \times 10^{-6}}$ ✓

$= 70.91$ ✓

$(C_8H_8O)n = 70.91$ ✓
$96n + 8n + 16n = 70.91$
$120n = 70.91$
$n = 0.59$
$\simeq 1$ ✓ (3)

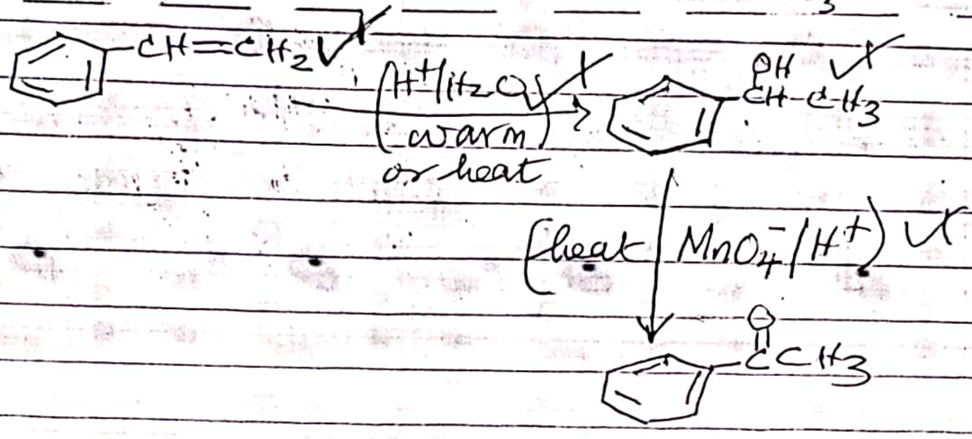
Mol. formula

(c) Q is  or  ✓ 1

(d) 

✓ 1

or $C_6H_5COCH_3 + NaHSO_{3(aq)} \longrightarrow C_6H_5C(OH)(CH_3)SO_3Na.$

(e) 

2

09

16 (a) The orange solution turn green ✓

$Cr_2O_7^{2-}{}_{(aq)} + 2H^+_{(aq)} + 3SO_{2(g)} \longrightarrow 2Cr^{3+}_{(aq)} + H_2O_{(l)} + 3SO_4^{2-}{}_{(aq)}$ ✓ $2\frac{1}{2}$

(b) A yellow solid/precipitate and bubble/effervescence of a colourless gas are formed. ✓

$Na_2S_2O_{3(aq)} + 2HCl_{(aq)} \longrightarrow 2NaCl_{(aq)} + S_{(s)} + SO_{2(g)} + H_2O_{(l)}$

or $S_2O_3^{2-}{}_{(aq)} + 2H^+_{(aq)} \longrightarrow S_{(s)} + SO_{2(g)} + H_2O_{(l)}$ ✓ $2\frac{1}{2}$

(c) Silver mirror ✓

$CH_3CH_2CHO \xrightarrow{Ag(NH_3)_2^+} Ag_{(s)} + CH_3CH_2COONH_{4(aq)}$ or $CH_3CH_2COO^-$

or $CH_3CH_2CHO + 2Ag(NH_3)_2OH \longrightarrow CH_3CH_2COONH_4 + 2Ag + H_2O + 3NH_3$ 2

(Allow both balanced and unbalanced equations)

d) Yellow or Pale yellow ppt ✓

$CH_3CH_2OH \xrightarrow{NaOH_{(aq)}/I_{2(aq)}} CHI_{3(s)} + HCOO^-Na^+$ ✓

Accept balanced and unbalanced equation & Ignore Physical States

09

17 a) Addition Polymerisation is the forming of large molecules from unsaturated molecules (monomers) and there is no loss of small molecules. ✓

Condensation Polymerisation is the joining of bi-functional molecules (monomers) to form a large molecule (Polymer) and there is loss of small molecules ✓

2

b)

Structural formulae	Name of monomer(s)	Type of...
X: $CH_2=C(CH_3)-COOCH_3$ ✓	Methyl-2-methyl propenoate ✓	Addition Polymerisation ✓
Y: $HOOC(CH_2)_4COOH$ ✓ $H_2N(CH_2)_6NH_2$ ✓	Hexane-1,6-dioic acid ✓ Hexane-1,6-diamine ✓	Condensation Polymerisation ✓
Z: $CH_2=C(Cl)-CH=CH_2$ ✓	2-Chlorobuta-1,3-diene ✓	Addition Polymerisation ✓

$5\frac{1}{2}$

(c) uses of:

X: Windscreens of cars, ✓ lenses, corrugated roof lights

Y: Fabrics, ✓ nets, ropes

Z: Conveyor belts, ✓ Erasers, hoses, Electrical insulators tyres, etc.

$1\frac{1}{2}$

Only one expected If more than one, any extra wrong one score zero

09

Turn

UCE

Candidate's Name ....

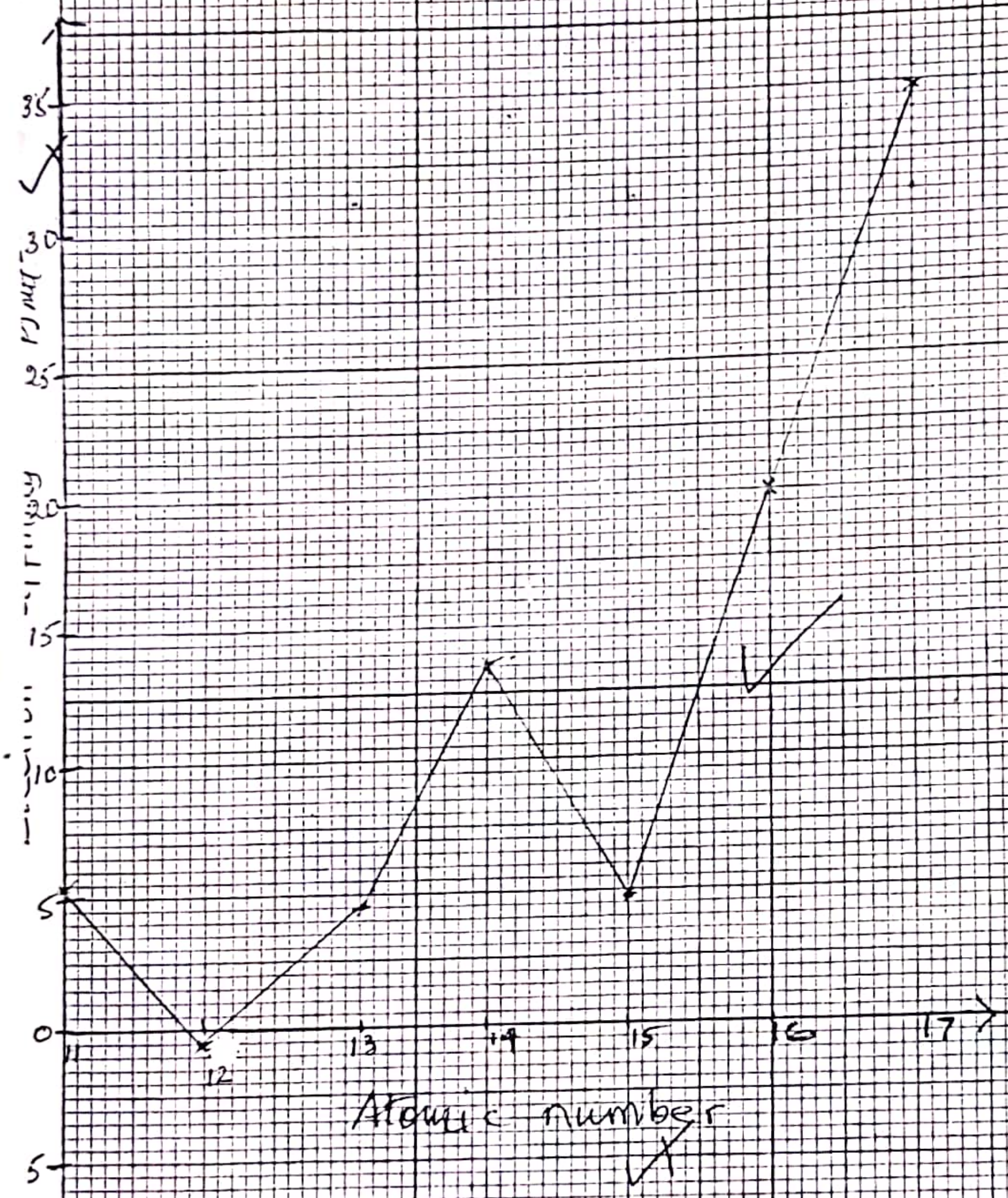
Signature ....

Subject Name ....Page 15...... Paper code ..../........

Random No.	
Personal Number	

Qn 11 b(i)

A graph of first electron affinity versus atomic number



$2\frac{1}{2}$

Axes labelled (1)
Plotting (1)
Title $(\frac{1}{2})$