St Andrew's Junior College

Suggested Answer Scheme Prelim 2013 Paper 2

1 (a) Preparation of saturated solution of lead iodate for titration

- Stir and add solid lead iodate(V) to about **100 cm^3 of distilled water** in a **250 cm^3 beaker** until **no more solid dissolves**.
- **Filter** and **collect the filtrate** which contains saturated $Pb(IO_3)_2$ solution.

Titration

- **Pipette 25.0 / 10.0 cm^3** of this saturated solution into a **250 cm^3 conical flask**
- Add excess solid KI to the flask. Use a **10 cm^3 measuring cylinder** to add about 5 cm^3 of HC*l* (aq) to the flask.
- Titrate the saturated solution with $Na_2S_2O_3$ from the 50 cm^3 **burette** into the flask
- When the **brown colour of the iodine fades to a pale yellow colour, a**dd about **5 drops of starch** solution to the flask.
- Continue adding $Na_2S_2O_3$ until the **blue-black colour just disappears**.
- **Repeat the titrations to obtain at least two consistent results within ± 0.10 cm^3.**
- **Sequence**

[4]

(b) One possible error could be any of the following statements (or more):

- Adding the starch indicator too early in the experiment.
- Temperature is not constant which might affect the solubility.

[1]

(c) Let the average titre of $Na_2S_2O_3$ be *v* cm^3.
Amount of $Na_2S_2O_3$ needed = 2×10^{-5} *v* mol
Amount of iodine liberated = 1×10^{-5} *v* mol
Amount of IO_3^- = 3.33×10^{-6} *v* mol
$[IO_3^-] = 1.33 \times 10^{-4}$ *v* mol dm^{-3}
$[Pb^{2+}] = 6.67 \times 10^{-5}$ *v* mol dm^{-3}
$K_{sp} = [Pb^{2+}][IO_3^-]^2 = (1.33\times10^{-4}\ v)^2\ (\ 6.67 \times 10^{-5}\ v) = 1.179 \times 10^{-12}\ v^3$ mol^3 dm^{-9}

[3]

(d)

Step	**Expected Observations**	**Deduction**
To 1 cm^3 of the mixture in a test tube, add dropwise of $AgNO_3$(aq) until in excess to the solution.	White precipitate and yellow precipitate was formed.	AgC*l*(s) AgI(s)
Add dropwise in excess NH_3(aq).	White precipitate dissolved in excess NH_3(aq); Yellow precipitate remained insoluble.	$[Ag(NH_3)_2]^+C\mathit{l}^-$(aq) AgI(s)
Filter the mixture and wash the residue with distilled water. Dry the residue by pressing between filter papers.	Yellow residue Colourless filtrate obtained.	AgI(s) $C\mathit{l}^-$(aq)

To the filtrate from above, add dropwise of HNO_3(aq) in excess. Filter. Wash the residue with distilled water. Dry the residue by pressing between filter papers	White residue obtained.	AgC*l*(s)

[4]

[Total: 12 marks]

2. (a) (i) The VDW interaction / H - bonding between isopentyl acetate and water is not exothermic enough to overcome the hydrogen bonding between water and the id-id between isopentyl acetate which is predominant due to its large electron cloud size.

[2]

(ii) Isopentyl alcohol is a simple covalent molecule can form hydrogen bonding.
Isopentyl acetate is a simple covalent molecule which can form id-id and pd-pd.
Isopentyl acetate has more electrons which cause the id-id interactions to be more significant than hydrogen bonding in isopentyl alcohol.
Hence more energy is required to overcome the intermolecular forces between isopentyl acetate.

[3]

(iii) H_2O(g) can escape thus shifting the equilibrium to the right to replenish the water vapour lost thus forming more ester as a side product.

[2]

(iv) To react with the excess ethanoic acid.

[1]

(v) To remove the CO_2 so the cap does not pop out from the pressure of the gas.

[1]

[9]

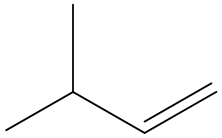
2. (b)

(i)

Step I	**Excess** concentrated H_2SO_4 170^oC
Step II	NaOH (aq) heat
Step III	Ethanolic KCN heat
Step IV	Concentrated H_2SO_4 heat

(ii)

Q



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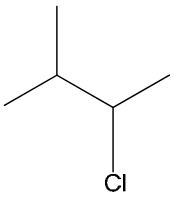

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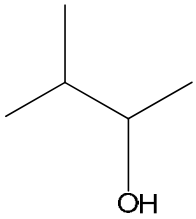

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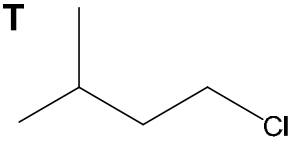

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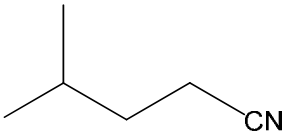

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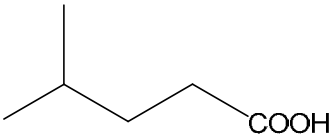

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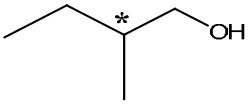
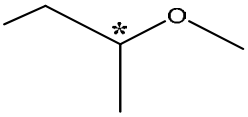


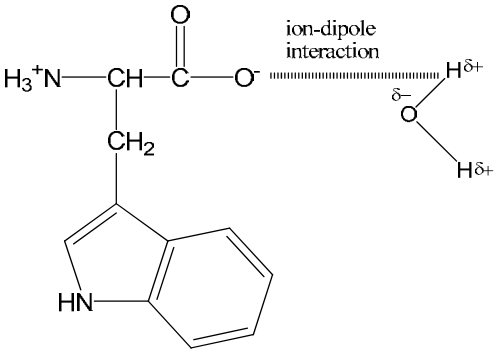


[7]

(c) **(i)** It exist in the <u>giant ionic lattice</u> due to its <u>zwitterion</u> form. Energy is required to break the <u>strong electrostatic forces of attraction</u> between <u>oppositely charged ions</u>.

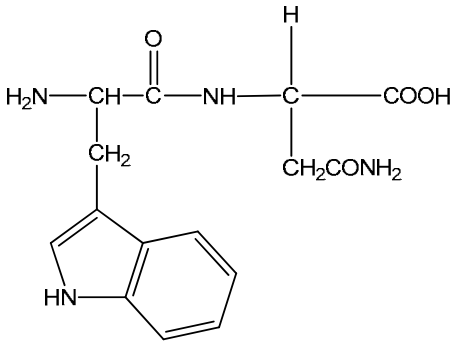
[2]

2 **(c)** **(ii)**



[2]

(iii)



[1]

(iv) **Reagents and conditions:** NaOH(aq), heat, test any gas with moist red litmus paper / with concentrated HCl

Observations: Red litmus turns blue for asparagine / white fumes are formed. Red litmus remains for tryptophan.

OR

Reagents and conditions: Bromine in CCl_4 (in the dark) / Bromine aqueous

Observations: Tryptophan: Reddish brown turn colourless / Orange-red turns colourless. Asparagine: Reddish brown or orange-red remains.

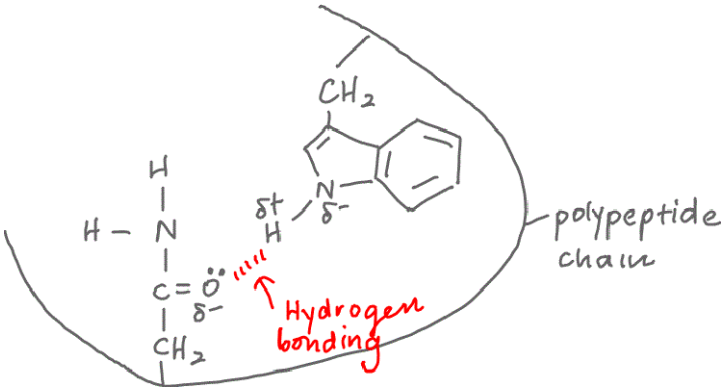
OR

Reagents and conditions: H_2SO_4 (aq), $KMnO_4$, heat

Observations: Purple turns colourless for tryptophan. Purple remains for asparagine.

[2]

(v)



[2]

[9]

Total: 25 marks

3 (a) (i) A <u>saturated solution of $Ca(OH)_2$</u> was to be obtained

[1]

ii) Additional water will dilute the solution formed.

[1]

(b) (i) Phenolphthalein.Pink to colourless
OR any suitable indicator.

[2]

(ii) $K_{sp} = [Ca^{2+}][OH^-]^2$

[1]

(iii) Total $[OH^-] = (10.4 / 1000) \times 0.05 \times 100 = 0.0520$ mol dm^{-3}
$[OH^-]$ from $Ca(OH)_2 = 0.0520 – 0.01 = 0.0420$ mol dm^{-3}
$[Ca^{2+}] = 0.0420/2 = 0.0210$ moldm^{-3}
$K_{sp} = 0.0210 \times 0.0520^2 = 5.68 \times 10^{-5}$ mol^3dm^{-9}

[3]

(iv) Let x be the solubility of $Ca(OH)_2$.
Hence $4x^3 = 5.68 \times 10^{-5}$
$x = 0.024215$ mol dm^{-3}, $2x = [OH^-] = 0.04843$ mol dm^{-3}
Moles of HC*l* in 10 cm^3 = Moles of OH^- in 10 $cm^3 = 4.84 \times 10^{-4}$
Volume of HC*l* $= 4.84 \times 10^{-4}/0.05 = 9.68$ cm^3 **[3]**

[9]

Total: 11 marks

4 (a) (i) $Al_2O_3 + 3/2\ C \rightarrow 2Al + 3/2\ CO_2$

[1]

(ii) Carbon is oxidised to carbon dioxide and is consumed as a result. **[1]**

(iii) $\Delta G = (568) – (1273)(0.158) = +366.9$ $kJmol^{-1}$
Recycling. ΔG required that is **<u>less positive / more negative</u>** is favoured.

[3]

(iv) Copper can <u>delocalise all the **4s and 3d** electrons to form the sea of delocalised electrons</u>. Hence, <u>Cu has stronger electrostatic forces of attraction between the sea of delocalised electrons and positively charged cations</u>. More energy required to break the stronger attraction. **[3]**

[8]

4 (b) (i)

- Blue solution: $[Cr(H_2O)_6]^{2+}$
- Colourless solution: $[Al(H_2O)_6]^{3+}$
- Green solution: $[Cr(H_2O)_6]^{3+}$
- Yellow solution: CrO_4^{2-}
- Orange solution: $Cr_2O_7^{2-}$,
- Colourless solution: $[Al(OH)_4]^-$ or $Na[Al(OH)_4]$
- Reagent: HC*l* (aq) or any acid.
- Grey metal: Cr

[4]

(ii) Transition metal ions contain **partially filled 3d orbitals**. In the complexes, these **<u>3d orbitals split into two groups with a small energy gap between them</u>**. When light shines, **<u>the complex absorbs light energy from the visible</u>**

light spectrum to promote electrons from the lower to the higher energy group. **The light not absorbed will be reflected** and seen as the colour of the complex. **[3]**

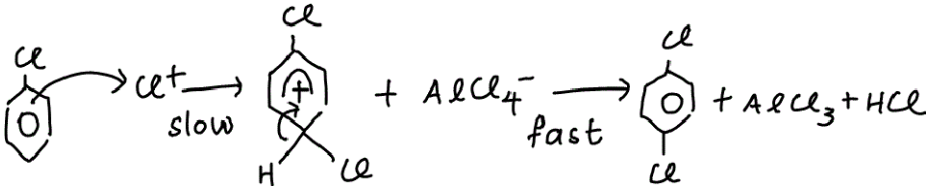
(c) (i) $AlCl_3 + 6H_2O \rightarrow [Al(H_2O)_6]^{3+} + 3Cl^-$ **[1]**

(ii) Entropy increase is due to an increase in the number of ions which is outweighed by the entropy decrease where the water molecules are ordered in the aqua complex / decrease in particle numbers.

[2]

(iii) **Type of reaction:** Electrophilic substitution

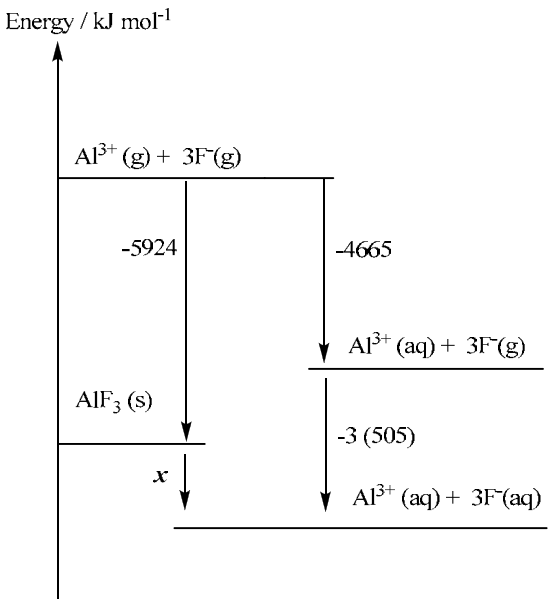
$Cl_2 + AlCl_3 \rightarrow Cl^+ + AlCl_4^-$



- Type of reaction
- Slow
- Intermediate
- Generation of electrophile
- Arrows
- Product (only ortho and para products are accepted)

[3]

(iv)



Enthalpy change of solution, ***x*** = +5924 – 4665 +3(-505) = -256 kJmol^{-1}

[3]

[9]

Total: 25 marks

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