Mark Scheme - 3.7 Entropy and Feasibility of Reactions

1 *(a)* (i) atomisation of magnesium / vaporisation of magnesium **[1]**

(ii) increased ratio positive charge on nucleus: number of electrons **[1]**

(iii) is positive because the (negative) electron is repelled by negative species **[1]**

(iv) lattice enthalpy is –3835(kJ mol^{-1}) numerical value (1) negative sign (1) **[2]**

(b) (i) gases are more random/ have more disorder / move more freely and therefore have a higher entropy **[1]**

(ii) $\Delta S = 21.8$ ($JK^{-1}mol^{-1}$) **[1]**

(iii) $\Delta G = \Delta H - T\Delta S$ (1) ft from (ii)

ΔG must be –ve if reaction to be spontaneous/ to calculate T make $\Delta G = 0$ (1)

0 = 318000 – T 21.8 T = 14587/14600 (K) (1) **[3]**

(c) use of aqueous sodium hydroxide (1)

white precipitate for all possible ions (1)

excess aqueous sodium hydroxide – precipitate dissolves for Pb^{2+} and Al^{3+} (1)

use of aqueous (potassium) iodide/ hydrochloric acid/ sulfuric acid / soluble

chloride/ soluble sulfate (1)

result – yellow ppt for Pb^{2+} + I^- and no ppt for Al^{3+} / white ppt for Pb^{2+} + Cl^- or SO_4^{2-}

and no ppt for Al^{3+} [result for both needed] (1) **[5]**

QWC Organisation of information clear and coherent (1)

Use of specialist vocabulary (1) *QWC* **[2]**

(d) (i) diagram to show central Al, 4 Cl^- and 4 shared pairs of electrons, all Cl outer electrons, dative pair identifiable **[1]**

(ii) chlorination of benzene (1) produces Cl^+ as electrophile (1)

OR gives ionic liquids (1) with low vapour pressure/ non-volatile/ do not evaporate

in use (1)

OR catalyst (1) in polymerisation of alkenes (1) **[2]**

Total [20]

2.

(a) $2 \times (0) + 3 \times (-394) - (-826) - 3 \times \Delta H^{\ominus}_f(CO) = -23$ (1)

$2 \times (\Delta H^{\ominus}_f(Fe)) + 3 \times (\Delta H^{\ominus}_f(CO_2)) - (\Delta H^{\ominus}_f(Fe_2O_3)) - 3 \times \Delta H^{\ominus}_f(CO) = -23$ (1)

$-1182 + 826 + 23 = 3 \times \Delta H^{\ominus}_f(CO)$

$-333 = 3 \times \Delta H^{\ominus}_f(CO)$

-111 kJ mol^{-1} = $\Delta H^{\ominus}_f(CO)$ (1) [3]

(b) Gases have higher entropies than solids as the molecules have a greater degree of freedom / disorder [1]

(c) (i) $\Delta G = \Delta H - T\,\Delta S = -23 - (298 \times 9/1000)$ (1)

$= -25.7$ kJ mol^{-1} (1) [2]

(ii) A reaction is feasible when ΔG is negative (1)

No temperature exists where ΔG is positive / ΔG is negative at all temperatures (1) [2]

(iii) Higher temperature used to increase rate of reaction [1]

Total [9]

3.

(a) $CO \rightarrow$ C +2 $CO_2 \rightarrow$ +4 (1)

Increase of (positive) oxidation number = oxidation / reducing agents themselves are always oxidised are always oxidised (1)

OR

$I_2O_5 \rightarrow$ I +5 $I_2 \rightarrow I_2$ 0 (1)

Oxidation number of iodine reduced, reduction occurring, CO reducing agent (1) [2]

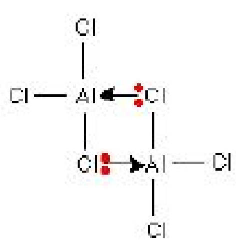
(b) +2 state becomes mores stable down the group and +4 becomes less stable. [1]

(c) (i) Add (a little) sodium hydroxide solution (1) to each solution.
A white precipitate (1) of aluminium / lead(II) hydroxide (1) is seen.
When more sodium hydroxide solution is added these precipitates (dissolve giving a colourless solution). (1) [4]

QWC Legibility of text: accuracy of spelling, punctuation and grammar; clarity of meaning. [1]

(ii) Yellow precipitate (1) $Pb^{2+} + 2I^- \rightarrow PbI_2$ [2]

(d) (i) The bonding of **aluminium** in the monomer has not completed the octet / suitable diagram / 6 electrons in its outer shell (1)
When the dimer is formed this octet of bonded electrons is formed (1)



(1) [3]

(ii) (As a catalyst) in the chlorination of benzene / making ionic liquids [1]

(iii) I The number of (gaseous) species is increasing, leading to less order [1]

II For the reaction to be just spontaneous $\Delta G = 0$ (1)

substituting $0 = 60\,000 - 88\,T$

$T = 60\,000 / 88 = 682$ K / 409°C (1) [2]

(e) $K_c = \frac{[[Al(H_2O)_5(OH)]^{2+}(aq)][[H^+](aq)]\}}{[[Al(H_2O)_6]^{3+}(aq)]}$

$\therefore \quad 1.26 \times 10^{-5} = [H^+]^2 / 0.10$

$\therefore \quad [H^+]^2 = 1.26 \times 10^{-6}$ [1]

$\therefore \quad [H^+] = \sqrt{1.26 \times 10^{-6}} = 1.12 \times 10^{-3}$ / 0.00112 (1)

- error carried forward

$pH = -\log_{10}[H^+] = -\log_{10} 1.12 \times 10^{-3} = 2.95$ (1) [3]

Total [20]