

Name of the Student: \_\_\_\_\_

Max. Marks : 25 Marks

Time : 25 Minutes

## Mark Schemes

Q1.

- (a) (i)  $\Delta H = \Sigma(\text{enthalpies formation products}) - \Sigma(\text{enthalpies formation reactants})$   
*Or correct cycle with enthalpy changes labelled* 1
- $= -111 - (-75 - 242)$  1
- $= (+)206 \text{ (kJ mol}^{-1}\text{)}$   
*-206 scores 1 only*  
*Units not essential if ans in kJ mol<sup>-1</sup> but penalise incorrect units* 1
- (ii)  $\Delta S = \Sigma(\text{entropies of products}) - \Sigma(\text{entropies reactants})$
- $= 198 + 3 \times 131 - (186 + 189)$  1
- $= (+) 216 \text{ (J K}^{-1} \text{ mol}^{-1}\text{)}$   
 OR  
 $0.216 \text{ kJ K}^{-1} \text{ mol}^{-1}$   
*Units not essential but penalise incorrect units* 1
- (b) When  $\Delta G = 0$  OR  $\Delta H = T\Delta S$  1
- $T = \Delta H / \Delta S$   
*M2 also scores M1* 1
- $= 206 \times 1000 / 216$   
*Allow error carried forward from (a)(i) and (a)(ii)*  
*Ignore unexplained change of sign from - to +* 1
- $= 954 \text{ K}$   
*Allow 953 – 955, Units of K essential, must be +ve*  
*If values from (a)(i) and (a)(ii) lead to negative value in M3 allow M1 to M3 but do not allow negative temperature for M4*  
*If negative value changed to positive for M4, allow M4* 1
- (c) To speed up the rate of reaction OR wtte

Allow so that more molecules have energy greater than the activation energy

IF T in (b) > 1300 allow answers such as;

to reduce energy cost

to slow down reaction

do NOT allow to increase rate

1

(d) (i) **Method 1**

$$\Delta G = \Delta H - T\Delta S$$

$$\Delta G = -41 - (1300 \times -42 / 1000) \text{ (M1)}$$

If 42 and not 42 / 1000 used can score M3 only

but allow  $\Delta G = -41 \times 1000 - (1300 \times -42) \text{ (M1)}$

1

$$= +13.6 \text{ kJ mol}^{-1}$$

$$= 13600 \text{ J mol}^{-1} \text{ (M2)}$$

Units essential

1

$\Delta G$  must be negative for the reaction to be feasible.

OR  $\Delta G$  is positive so reaction is not feasible

1

**Method 2**

For reaction to be feasible  $\Delta G$  must be negative or zero

1

$$T \text{ when } \Delta G = 0 = \Delta H / \Delta S = 976 \text{ K}$$

1

$\Delta S$  is -ve so  $\Delta G$  must be +ve at temperatures above 976 K / at 1300 K

1

(ii) If the temperature is lowered

(Ignore reference to catalyst and / or pressure)

Alternative mark scheme (if T is calculated)

Allow T reduced to 976 K or lower M1

1

$\Delta G$  will become (more) negative because

the  $-T\Delta S$  term will be less positive /  $T\Delta S > \Delta H$

At this temperature (the reaction becomes feasible because)  $\Delta G \leq 0$

M2

1

[15]

Q2.

- (a) Enthalpy change (to separate) 1 mol of an (ionic) substance into its ions

*If ionisation or hydration / solution, CE = 0*

*If atoms / molecules / elements mentioned, CE = 0*

*Allow heat energy change but not energy change alone.*

*If forms 1 mol ions, lose M1*

1

Forms ions in the gaseous state

*If lattice formation not dissociation, allow M2 only.*

*Ignore conditions.*

*Allow enthalpy change for*

$MX(s) \rightarrow M^+(g) + X^-(g)$  (or similar) for M1 and M2

1

- (b) Any **one** of:

- Ions are point charges
- Ions are perfect spheres
- Only electrostatic attraction / bonds (between ions)
- No covalent interaction / character
- Only ionic bonding / no polarisation of ions

*If atoms / molecules mentioned, CE = 0*

1 max

- (c) (Ionic) radius / distance between ions / size

*Allow in any order.*

*Do not allow charge / mass or mass / charge.*

1

(Ionic) charge / charge density

*Do not allow 'atomic radius'.*

1

- (d)  $\Delta H_L = \Delta H_a(\text{chlorine}) + \Delta H_a(\text{Ag}) + \text{I.E.}(\text{Ag}) + \text{EA}(\text{Cl}) - \Delta H_f^\ominus$

*Or cycle*

*If  $\text{AgCl}_2$ , CE=0 / 3*

1

$$= 121 + 289 + 732 - 364 + 127$$

1

$$= (+) 905 \text{ (kJ mol}^{-1}\text{)}$$

*Allow 1 for -905*

*Allow 1 for (+)844.5 (use of 121 / 2)*

*Ignore units even if incorrect.*

1

- (e) M1 Greater

*Do not penalise  $\text{AgCl}_2$*

1

M2 (Born-Haber cycle method allows for additional) covalent interaction

*Allow  $\text{AgCl}$  has covalent character.*

*Only score M2 if M1 is correct*

**OR**

M1 Equal

M2 AgCl is perfectly ionic / no covalent character

1

**[10]**