

## F325 – Equilibria, Energetics & Elements

### Enthalpy and Entropy

1. (a)  $1s^2 2s^2 2p^6 3s^2 3p^6$  1
- (b)  $S^-(g)$  1
- (c) The negative  $S^-$  ion  
repels the electron being added 1  
1
- (d) (i) Enthalpy of atomisation of sulphur 1  
(ii) Second ionisation enthalpy of calcium 1  
(iii) Second electron affinity of sulphur 1
- (e) Electron more strongly attracted 1  
nearer to the nucleus or attracted by  $Ca^+$  ion 1
- (f) Correct cycle 1  
e.g.  $+178 + 279 + 590 + 1145 - 200 + E - 3013 + 482 = 0$  1  
 $= 539$  1  
Allow one mark for  $-539$

[11]

2. (a)  $\Delta H_1$  formation (1)  
 $\Delta H_2$  atomisation / sublimation (of Cs not Cl) (1)  
 $\Delta H_5$  electron affinity (of Cl) (1) 3
- (b)  $-433 = 79 + 376 + 121 - 364 + \Delta H_6$  (1)  
 $\Delta H_6 = -645 \text{ (kJ mol}^{-1}\text{)}$  (1) 2  
both marks for correct answer alone  
allow 1 mark for +645 or 645
- (c) Cs has larger radius / larger atom (not ion) / more shells /  
more orbitals / more sub-shells (1)  
correct reference to shielding (1)  
less powerful attraction (of nucleus) for (outer)  $e^-$  in Cs (1) 3

[8]

3. (a) (i) diagram shows in top box  $\text{Rb}^+(\text{g}) + \text{e}^- + \text{I}(\text{g}) / \text{e}^-$  must be there **(1)**  
 diagram shows in lower box  $\text{Rb}(\text{s}) + \frac{1}{2} \text{I}_2(\text{s})$  **(1)** 2
- (ii)  $\Delta H_1 =$  electron affinity (of iodine)/allow correct symbols  
 including  $\text{I}_2, \text{I}^-$ , **(1)**  
 $\Delta H_2 =$  lattice enthalpy / energy (of RbI) **(1)** 2
- (iii)  $\Delta H_1 = -(+402) - (+107) - (+85.8) + (-328) - (-609)$  **(1)**  
 $= -314 \text{ (kJ mol}^{-1}\text{)}$  **(1)** 2  
 give 1 mark for +313.8 or +314  
 assume + if no sign given  
 significant figure penalty for 310

**[6]**

4. (i) **A** is (enthalpy change) of formation**(1)**  
**B** is lattice enthalpy **(1)** 2
- (ii) negative sign (only if a calculation) **(1)**  
 $883 \text{ kJ mol}^{-1}$  **(1)**  
 (only give both marks if working and answer correct)  
 hydration / solvation enthalpies (of  $\text{Li}^+$  and  $\text{Cl}^-$ ) **(1)** 3

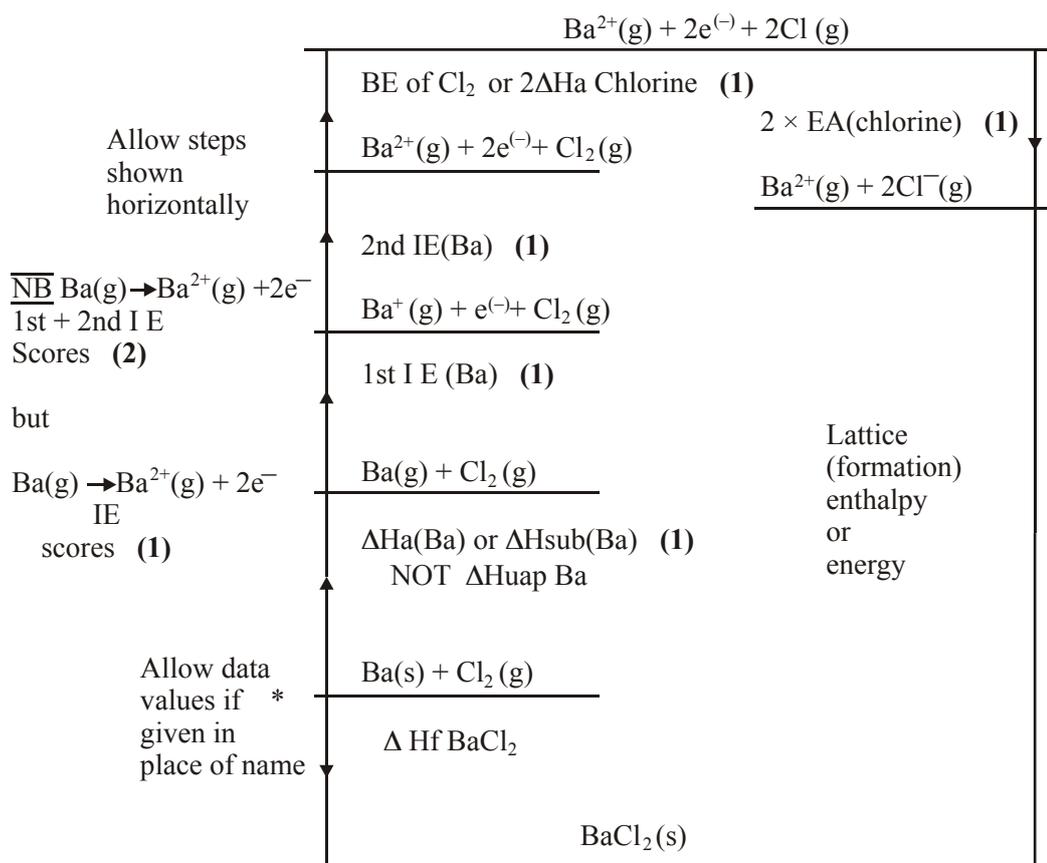
**[5]**

5. (a) Particles are in maximum state of order 1  
*(or perfect order or completely ordered or perfect crystal or minimum disorder or no disorder)*  
*(entropy is zero at 0 k by definition)*
- (b) (Ice) melts 1  
*(or freezes or changes from solid to liquid or from liquid to solid)*
- (c) Increase in disorder 1  
 Bigger (at  $T_2$ ) 1  
 Second mark only given if first mark has been awarded

- (d) (i) Moles of water =  $1.53/18$  (= 0.085) 1  
 Heat change per mole =  $3.49/0.085 = 41.1$  ( $\text{kJ mol}^{-1}$ ) 1  
*(allow 41 to 41.1, two sig. figs.)*  
*(penalise -41 (negative value), also penalise wrong units but allow kJ only)*
- (ii)  $\Delta G = \Delta H - T\Delta S$  1
- (iii)  $\Delta H = T\Delta S$  or  $\Delta S = \Delta H/T$  1  
*(penalise if contradiction)*
- $\Delta S = 41.1/373 = 0.110$   $\text{kJ K}^{-1} (\text{mol}^{-1})$  (or  $110$  ( $\text{J K}^{-1} (\text{mol}^{-1})$ )) 1  
*(allow 2 sig. figs.)*  
*(if use value given of 45, answer is 0.12 (or 120 to 121)*  
*(if  $\Delta H$  is negative in (d) (i), allow negative answer)*  
*(if  $\Delta H$  is negative in (d) (i), allow positive answer)*  
*(if  $\Delta H$  is positive in (d) (i), penalise negative answer)*
- Correct units as above ( $\text{mol}^{-1}$  not essential) 1

**[10]**

6. (a) (i)



ONLY consider species involved in the step marked

(ii) Cycling clockwise about (\*)  
CE if step missing

$$\Delta H_a Ba + 1^{st} IE Ba + 2^{nd} IE Ba + 2\Delta H_a Cl + 2EA Cl + LE - \Delta H_f BaCl_2 = 0 \quad (1)$$

$$+180 + 503 + 965 + 2 \times 122 + 2EA - 2056 + 859 = 0 \quad (1)$$

$$EA = -695/2 = - (347 \text{ to } 348) \quad (1)$$

9

Ignore units

Calculation -1 for each error

Mark conseq.

Notes: -695 scores (2)

+ (347 to 348) scores (2)

- (286 to 287) scores (2)

+ (286 to 287) scores (1)

-573 scores (1)

+573 scores (0)

(b)  $\Delta S = \Sigma S \text{ products} - \Sigma S \text{ reactants}$   
 $= (63 + 223) - 124 = 162 \text{ (1)}$

$\Delta G = \Delta H - T\Delta S$  or  $\Delta H = T\Delta S$  or  $T = \Delta H/\Delta S \text{ (1)}$   
*or used correctly*

$\Delta H = 859 \times 10^3 \text{ (1)} = T \times 162$

$T = (5\,300 \text{ to } 5304) \text{ K (1)}$

*Penalise if units °C*

*-1 for each error + mark conseq.*

4

[13]

7. (a) (i) *Standard enthalpy change:*  $\Delta H_R = \Sigma \Delta H_f \text{ products} - \Sigma \Delta H_f \text{ reactants (1)}$

$\Delta H_R = (-804 - 394) - (-940) \text{ (1) N.B: If answer wrong statement worth 2}$

$= -258 \text{ (kJ mol}^{-1}\text{; ignore units completely) (1)}$

**Allow +258 (2) marks**

*Standard entropy change:*  $\Sigma \Delta S \text{ products} - \Sigma \Delta S \text{ reactants (1)}$

$\Delta S = (252 + 214) - (49.9 + 5.7 + [2 \times 223]) \text{ (1) N.B: If answer wrong statement worth 2}$

$= -35.6 \text{ (kJ mol}^{-1}\text{; ignore units completely) (1)}$

**Allow +35.6 (2) marks**

**Mark -36 AE minus one**

**Allow max one for +187**

(ii)  $T = \frac{\Delta H}{\Delta S}$  or  $T = \frac{\Delta H \text{ value from above}}{\Delta S \text{ value from above}} \text{ (1)}$

**Penalise wrong sign**

$T = \frac{-258 \times 1000}{-35.6} = 7245 \text{ to } 7250 \text{ (1)}$

**Ignore letter after value**

**Ignore  $\geq$  even if wrong way around**

**Mark answer conseq to  $\Delta H$  and  $\Delta S$  values from above**

**If negative temperature given max 2\***

**If °C used incorrectly max 2\***

**\* But only penalise one of these errors**

9

[9]

8. (a) (i) *Standard enthalpy change:*  $\Delta H_R = \Delta \Sigma H_f(\text{products}) - \Delta \Sigma H_f(\text{reactants})$  (1)  
**or cycle**

$$\Delta H_R = ([2 \times 0] + [3 \times -393.5]) - (-824.2 + [3 \times -110.5])$$

$$= -24.8 \text{ (kJ mol}^{-1}\text{)} \quad (1)$$

**Allow + 24.8 max one**

*Standard entropy change:*  $\Delta S = \Sigma S(\text{products}) - \Sigma S(\text{reactants})$  (1)

$$\Delta S = ([2 \times 27.3] + [3 \times 213.6]) - (87.4 + [3 \times 197.6])$$

$$= (54.6 + 640.8) - (87.4 + 592.8)$$

$$= 15.2 \text{ (JK}^{-1}\text{mol}^{-1}\text{)} \quad (1)$$

**Allow -15.2 max one**

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

$\Delta H$  negative and  $-T\Delta S$  is negative (or  $\Delta S$  positive or or correct calc) (1)

Hence  $\Delta G$  is always negative (or feasible when  $\Delta G \leq 0$ ) (1)

9

(b)  $\Delta G = 0 = \Delta H - T\Delta S$  Hence  $\Delta H = T\Delta S$  (1)

$$T = \Delta H / \Delta S = 492.7 \times 1000 / 542.6$$

$$= 908 \text{ K} \quad (1)$$

**penalise missing 1000 by one mark**

3

(c)  $\Delta G(b) = \Delta G(a)$

$$(492.7 \times 10^3 - T \times 542.6) = (-24.8 \times 10^3 - T \times 15.2)$$

$$517.5 \times 10^3 = 527.4 T$$

$$T = 981.2 \text{ K} \quad (1)$$

**Allow 980 - 982**

**Penalise missing 1000 by one mark**

3

[15]

9. (a)  $\Delta H_a = \Sigma \Delta H_f \text{ products} - \Sigma \Delta H_f \text{ reactants}$  or

$$= \Delta H_f \text{CO}_2 - (\Delta H_f \text{CH}_4 + 2 \Delta H_f \text{H}_2\text{O})$$

$$= -393.5 + (74.8 + [2 \times 241.8])$$

$$= +164.9 \text{ kJ mol}^{-1}$$

3

(b) (i) The number of moles of gas increases from 3 to 5 (1)

More moles gas gives more disorder (1)

(ii)  $\Delta S = \Sigma S \text{ products} - \Sigma S \text{ reactants}$  (1)

$$= (213.6 + [4 \times 130.6]) - (186.2 + [2 \times 188.7])$$

$$= +172.4 \text{ JK}^{-1} \text{ mol}^{-1}$$

5

(c) (i)  $\Delta G = \Delta H - T\Delta S$  or  $\Delta H = T\Delta S$  (1)  
 $T = 164.9 \times 1000/172.4$  (1)  
 $= 956.5 \text{ K}$  (1)

*Marked consequentially*

(ii) Above this temperature (1)  
 this reaction is feasible or spontaneous (1)

5

[13]

10. (a)  $\Delta H^\ominus = \Delta H^\ominus = \sum \Delta H_f^\ominus (\text{products}) - \sum \Delta H_f^\ominus (\text{reactants})$  (1)  
 $= -201 + 110$   
 $= -91 \text{ kJmol}^{-1}$  (1)

$\Delta S^\ominus = \Delta S^\ominus = \sum S^\ominus (\text{products}) - \sum S^\ominus (\text{reactants})$  (1)  
 $= +240 - 2 \times 131 - 198$   
 $= -220 \text{ JK}^{-1} \text{ mol}^{-1}$  (1)

4

(b) *Feasible reaction* One for which  $\Delta G \leq 0$  (1)

*Temperature*  $\Delta G = \Delta H - T\Delta S$  (1)  
 For  $\Delta G = 0$ ,  $T = \Delta H/\Delta S = -91 \times 1000/(-220)$   
 $= 414 \text{ K}$  (1)

3

[7]

11. (a)  $\Delta H^\ominus = \sum \Delta H_f^\ominus (\text{products}) - \sum \Delta H_f^\ominus (\text{reactants})$  (1)  
 $= 2 \times (-396) - 2 \times (-297)$   
 $= -198 \text{ kJ mol}^{-1}$  (1)

$\Delta S^\ominus = \sum S^\ominus (\text{products}) - \sum S^\ominus (\text{reactants})$  (1)  
 $= 2 \times (257) - 204 - 2 \times (248)$   
 $= -186 \text{ JK}^{-1} \text{ mol}^{-1}$  (1)

$\Delta G^\ominus = \Delta H^\ominus - T\Delta S^\ominus$  (1)  
 $= -198 - 298(-186/1000)$  (1)  
 $= -143 \text{ kJ mol}^{-1}$  (1)

7

(b) One for which  $\Delta G \leq 0$  (1)

$T = \frac{\Delta H}{\Delta S}$  when  $\Delta G = 0$  (1)  
 $= \frac{-198 \times 1000}{-186} = 1100 \text{ K}$  (1)

3

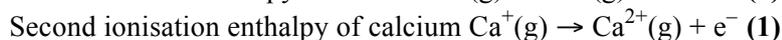
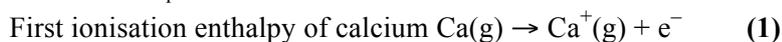
[10]

12. (i) fewer moles of gas (1)  
more 'order' in system (1)  
dependent on idea of fewer moles for first mark 2
- (ii)  $25\text{ }^{\circ}\text{C} = 298\text{ K}$  (1)  
$$\Delta S = \frac{-188}{1000} \text{ or } (\Delta H \times 1000) \text{ (1)}$$
mark is for ensuring  $\Delta H$  or  $\Delta S$  are both expressed in terms of J or kJ  
$$\Delta G = -196 - 298(-188 \times 10^{-3})$$
$$= -140 \text{ kJ mol}^{-1} \text{ or } -139976 \text{ J mol}^{-1} \text{ (1)}$$
ignore sig. figs  
sign and unit must be correct in final answer  
 $\Delta G$  -ve  $\therefore$  reaction feasible (1) 4

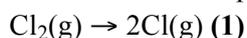
[6]

13. (a) (i) Steps

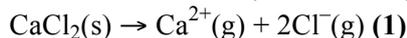
Sublimation/atomisation enthalpy or



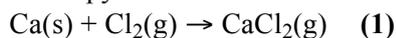
Dissociation enthalpy/bond energy/ $2 \times \Delta H_a$  chlorine



Lattice dissociation (or formation) enthalpy



Enthalpy of formation of calcium chloride



7

(ii) 2nd IE needed when  $\text{CaCl}_2$  formed or only 1st IE for  $\text{CaCl}$  (1)

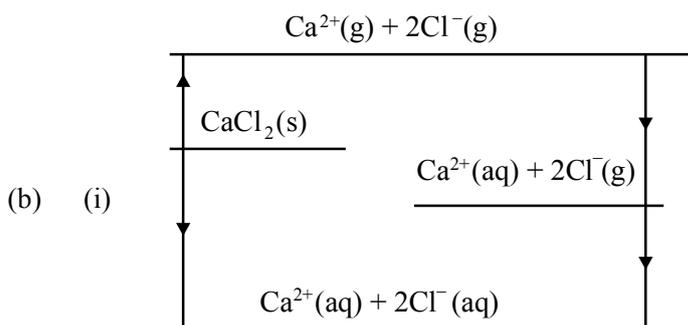
BE of  $\text{Cl}_2$  needed when  $\text{CaCl}_2$  formed but BE/2 for  $\text{CaCl}$

(or equivalent) (1)

$2 \times$  electron affinity when  $\text{CaCl}_2$  formed but  $1 \times$  EA for  $\text{CaCl}$  (1)

LE of  $\text{CaCl}_2$  greater (or different) than LE  $\text{CaCl}$  (1)

4



$+LE + (\Delta H_{\text{hyd}}\text{Ca}^{2+}) + 2(\Delta H_{\text{hyd}}\text{Cl}^-) - \Delta H_{\text{soln}} \text{CaCl}_2 = \text{CaCl}_2 = 0$  or correct cycle (1)

$$\Delta H_{\text{soln}} \text{CaCl}_2 = 2255 - 1650 - 768 \quad (1)$$

$$= -163 \text{ kJ mol}^{-1} \quad (1)$$

3

(ii) Marked consequentially to answer in (c)(i)

Solubility decreases (1)

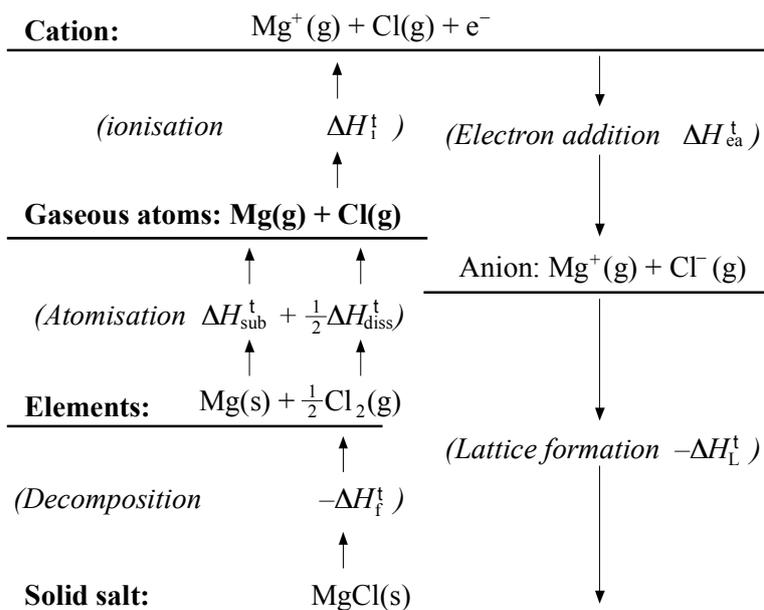
Enthalpy of solution negative or exothermic (1)

Equilibrium displaced as predicted by Le Chatelier (1)

3

[17]

14.



6 steps  
-1 for each error

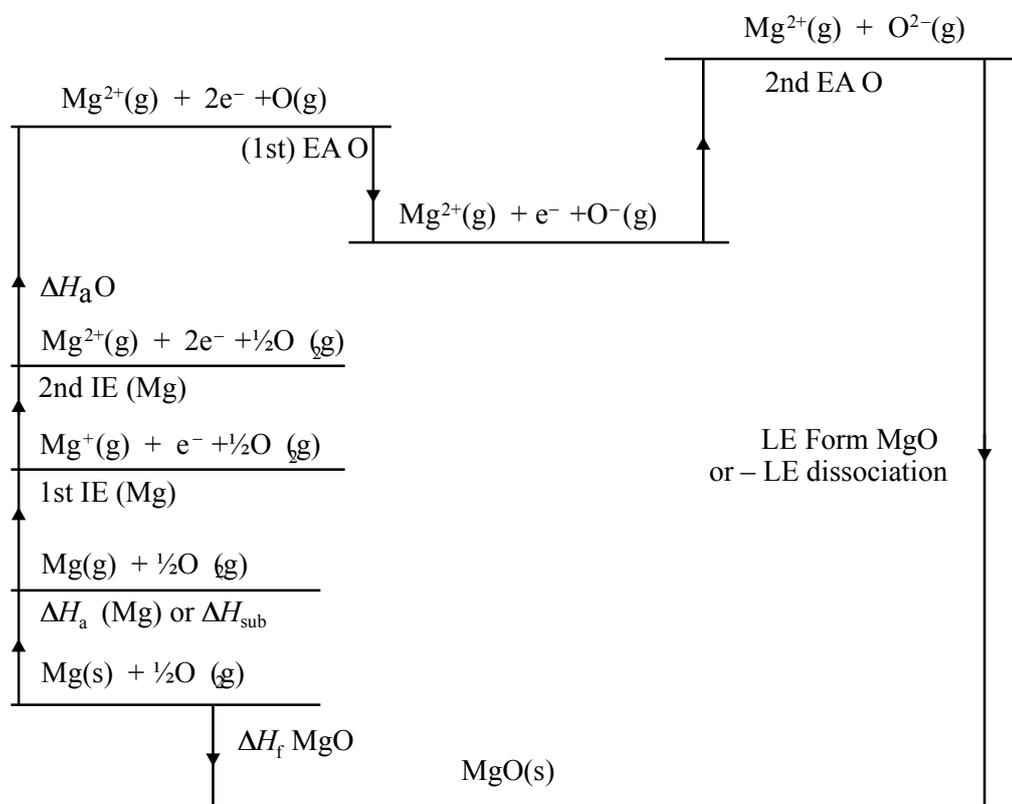
		4
$0$	$= -\Delta H_{\text{f}}^{\ominus} + \Delta H_{\text{sub}}^{\ominus} + \Delta H_{\text{diss}}^{\ominus} + \Delta H_{\text{f}}^{\ominus} + \Delta H_{\text{ea}}^{\ominus} + \Delta H_{\text{f}}^{\ominus}$	
$\Delta H_{\text{f}}^{\ominus}$	$= \Delta H_{\text{sub}}^{\ominus} + \Delta H_{\text{diss}}^{\ominus} + \Delta H_{\text{f}}^{\ominus} + \Delta H_{\text{ea}}^{\ominus} + \Delta H_{\text{f}}^{\ominus}$	
$\Delta H_{\text{f}}^{\ominus}$	$= +146 + 121 + 736 - 364 - 753$	
$\Delta H_{\text{f}}^{\ominus}$	$= -114 \text{ kJ mol}^{-1}$ (3)	[-1 for each error] 2
$\Delta H^{\ominus}$	$= \Delta H_{\text{f}}^{\ominus} (\text{MgCl}_2) - \Delta H_{\text{f}}^{\ominus} (\text{MgCl}) = -653 - 2(-114) = -425 \text{ kJ mol}^{-1}$	1
$\Delta S^{\ominus} \approx 0$	since 2 mol solid $\rightarrow$ 2 mol solid	1
if $\Delta S^{\ominus} = 0$ ,	then $\Delta G^{\ominus} = \Delta H^{\ominus}$	1
So $\Delta G^{\ominus}$ for the reaction is $< 0$ (at all $T$ )–	hence $\text{MgCl}_2$ is always favoured over $\text{MgCl}$	1

[10]

- 15 (a) Heat (energy)/ internal energy change (not energy change) (1)  
 Measured at constant pressure (1)

2

(b)



8

Notes:- Ignore electrons in cycle

Penalise missing labels by max 2

Penalise missing state symbols in 'active step' by max 2

Penalise incorrect chemistry every time

Allow steps written horizontally

Calculation:

$$\Delta H_a \text{Mg} + 1^{\text{st}} \text{IE Mg} + 2^{\text{nd}} \text{IE Mg} + \Delta H_a \text{O} + 1^{\text{st}} \text{EA O} + 2^{\text{nd}} \text{EA O} + \text{LE Form} - \text{MgO } \Delta H_f \text{MgO} = 0 \quad (1)$$

$$\text{Hence; } 148 + 738 + 1451 + 249 - 141 + 798 + \text{LE} + 602 = 0 \quad (1)$$

(NB This scores 2)

$$\text{LE formation MgO} = -3845 \text{ (kJ mol}^{-1}\text{)} \quad (1)$$

(Allow +3845 Max 2)

(c) For the reaction  $\text{MgCl}_2(\text{s}) + \frac{1}{2}\text{Cl}_2(\text{g}) \rightarrow \text{MgCl}_3(\text{s})$

$$\begin{aligned}\Delta H_r &= \Delta H_f \text{MgCl}_3 - \Delta H_f \text{MgCl}_2 \\ &= +3904 - (-653) = 4557 \text{ (kJ mol}^{-1}\text{)} \quad \text{(1)}\end{aligned}$$

$\Delta S$  is negative/ entropy decreases (as order increases) (1)

$$\Delta G = \Delta H - T\Delta S \quad \text{(1)}$$

$\Delta G$  must (always) be positive (since  $\Delta H_r$  and  $-T\Delta S$  are both positive) (1)

Reaction never/not feasible (or equivalent) (1)

5

[15]

16.  $\Delta S = \Sigma S \text{ products} - \Sigma S \text{ reactants}$

1

$$\Delta S = (259 + 187) - (201 + 161)$$

1

$$\Delta S = 84 \text{ (JK}^{-1} \text{ mol}^{-1}\text{)} \quad \text{(Ignore units)}$$

1

*Allow -84 to score (1) mark*

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

1

$$= -21.6 - 298 \times 84/1000$$

$$= -46.6 \text{ kJ mol}^{-1} \text{ or } -46\,600 \text{ J mol}^{-1}$$

1

*Allow (2) for -46.6 without units*

*(Mark  $\Delta G$  consequentially to incorrect  $\Delta S$ )*

*(e.g.  $\Delta S = -84$  gives  $\Delta G = +3.4 \text{ kJ mol}^{-1}$ )*

1

[6]

17. (a) Reaction 1

$$\Delta H = \Sigma \Delta H_f \text{ products} - \Sigma \Delta H_f \text{ reactants} \quad (1)$$

$$= (\Delta H_f \text{CO}) - (\Delta H_f \text{CH}_4 + \Delta H_f \text{H}_2\text{O})$$

$$= (-110.5) - (-74.8 - 241.8) = +206.1 \text{ (kJ mol}^{-1}\text{)} \quad (1)$$

$$\Delta S = \Sigma S \text{ products} - \Sigma S \text{ reactants} \quad (1)$$

$$= (197.6 + [3 \times 130.6]) - (186.2 + 188.7) = 214.5 \text{ (J K}^{-1}\text{mol}^{-1}\text{)} \quad (1)$$

$$\Delta G = \Delta H - T\Delta S \quad (1)$$

$$0 = +206.1 - T \times 214.5/1000 \quad (1)$$

$$T = 206.1 \times 1000/214.5 = 960.8 \text{ (K)} \quad (1)$$

(allow 961)

Penalise incorrect units in calculation of temperature by 2 marks

Mark T consequentially

Reaction 2

$$\Delta H = 2\Delta H_f \text{NH}_3 = -92.2 \text{ (kJ mol}^{-1}\text{)} \quad (1)$$

$$\Delta S = (2 \times 192.3) - (191.6 + [3 \times 130.6]) = -198.8 \text{ (J K}^{-1}\text{mol}^{-1}\text{)} \quad (1)$$

$$\Delta G = 0 = -92.2 + T \times 198.8/1000$$

$$T = 92.2 \times 1000/198.8 = 463.8 \text{ (k)} \quad (1)$$

(allow 464)

Mark T consequentially

Note:- Allow first calculation max 7 and second calculation max 3

10

(b) Reaction 1 at higher temperatures

equilibrium yield increased/forward reaction favoured as reaction endothermic (1)

rate of reaction increased (1)

a compromise temperature used based on high cost of high temperature (1)

Reaction 2 at higher temperatures

equilibrium yield reduced/backward reaction favoured as reaction exothermic (1)

rate of reaction increased (1)

a compromise temperature used based on overall yield (1)

Mark consequentially to  $\Delta H$  values in (a)

max 5

[15]

18. (a) Spontaneous when  $\Delta G < 0$  or  $\Delta G = 0$  (1)

$$\Delta G = \Delta H - T\Delta S \text{ (1)}$$

$$\text{Calculation of } \Delta H; \Delta H_{\text{reaction}} = \Sigma\Delta H_{\text{Products}} - \Sigma\Delta H_{\text{Reactants}} \text{ (1)}$$

$$= (2 \times -110.5) - (-3935) = +172.5 \text{ Allow } 172 - 173 \text{ kJ mol}^{-1} \text{ (1)}$$

$$\text{Calculation of } \Delta S; \Delta S_{\text{reaction}} = \Sigma\Delta S_{\text{Products}} - \Sigma\Delta S_{\text{Reactants}} \text{ (1)}$$

$$= (2 \times 197.6) - (5.7 + 213.6) = 175.9 \text{ J mol}^{-1} \text{ K}^{-1} \text{ (1)}$$

$$\text{Calculation of } T \quad \Delta G = 172.5 - T \times 175.9/1000 = 0 \text{ (1)}$$

$$T \times 175.9/1000 = 172.5$$

$$T = 172.5 \times 1000/175.9 = 980.7 \text{ K (1)}$$

8

(b) Calculation of  $\Delta H_{\text{Vaporisation}}$ :

$$3675 \text{ J vaporise } 1.50 \text{ g water}$$

$$3675 \times 18/1.50 \text{ vaporise } 1.00 \text{ mole water}$$

$$= 44.1 \text{ kJ mol}^{-1} \text{ (1)}$$

$$\text{Calculation of } \Delta S; \quad \Delta G = 0 = 44.1 - 373 \times \Delta S/1000 \text{ or } \Delta S = \Delta H/T \text{ (1)}$$

$$\Delta S = 44.1 \times 1000/373 = 118.2 \text{ J mol}^{-1} \text{ K}^{-1} \text{ (1)}$$

3

[11]

19. (a)  $\Delta H_f^\ominus = \Sigma \Delta H_f^\ominus (\text{products}) - \Delta H_f^\ominus (\text{reactants})$  (1)  
 $= (-110.5) - (-271.9) = +161.4$  [Allow 161 – 161.5]  $\text{kJ mol}^{-1}$  (1)  
 $\Delta S^\ominus = \Sigma S^\ominus (\text{products}) - \Sigma S^\ominus (\text{reactants})$  (1)  
 $= (27.3 + 197.6) - (58.5 + 5.7) = +160.7$   
 [Allow 160.6 – 161]  $\text{J mol}^{-1} \text{K}^{-1}$  (1)  
 $\Delta G = \Delta H - T\Delta S$  [Stated or correctly used] (1)  
 $\Delta G = +161.4 - 450 \times 160.7/1000$  (1)  
 $= +89.1$  [Allow 88.5 – 89.1]  $\text{kJ mol}^{-1}$ . (1)  
 $\Delta H_f^\ominus = (-393.5) - (-271.9 - 110.5) = -11.1 \text{ kJ mol}^{-1}$ . (1)  
 $\Delta S^\ominus = (213.6 + 27.3) - (58.5 + 197.6) = -15.2 \text{ J mol}^{-1} \text{K}^{-1}$ . (1)  
 $\Delta G = -11.1 + 450 \times 15.2/1000 = -4.26$  [Allow -4.3]  $\text{kJ mol}^{-1}$ . (1) 10
- (b) Feasible when  $\Delta G \leq 0$  or  $\Delta G$  is negative (1)  
 Process 1 is more feasible as temperature is increased (1)  
 Because  $\Delta S$  is positive or  $-T\Delta S$  is negative or  $T\Delta S$  is positive (1)  
 Process 2 is less feasible as temperature is increased (1)  
 Because  $\Delta S$  is negative or  $-T\Delta S$  is positive or  $T\Delta S$  is negative (1) 5

[15]