F325 Enthalpy and Entropy test ms

1. (a) stages in Born Haber cycle all correct (-1 per error)

Stages all correctly labelled (-1 per error)

6

(b) $= \Delta H_{at}(Na) + \Delta H_{at}(Br) + \Delta H_{IE1}(Br) + \Delta H_{EA1}(Br) + \Delta H_{LE}(NaBr)$

$= -367\ kJmol^{-1}$

3

[9]

2. (i) enthalpy / en

when 1 mol of ionic solid / crystalline solid / crystals / compound / solid (**not** molecules) (is formed from) **(1)**

its gaseous ions
(must be stated, **not** transferred by inference from (ii) **(1)** 2

(ii) $Na^+(g) + Cl^-(g) \rightarrow NaCl(s)$
allow $NaCl(s) \rightarrow Na^+(g) + Cl^-(g)$ if definition reversed **(1)** 1

(iii) larger (cations) **not** atoms, Li, Na **(1)**

same charge on the cation / ratio of charge:size decreases / lower charge density **not** effective nuclear charge **(1)**

therefore weaker attractions between cation and anion **(1)**
(must clearly mean attraction between cation and anion) 3

(iv) smaller (cations) **not** atoms, Mg, Na
allow this mark if 'repeated error' from (iii) **(1)**

greater charge on the Group 2 cation / ratio of charge: size increases / higher charge density **(1)**

therefore stronger attractions between cation and anion **(1)**
(must clearly mean attraction between cation and anion) 3

[9]

3. Definition – maximum 3 marks

$Mg^{2+}(g) + 2Cl^{-}(g) \rightarrow MgCl_2(s)$ **(1)**
The enthalpy change that accompanies the formation of
one mole of a solid (compound) **(1)**;
from its constituent gaseous ions **(1)**

Allow *marks from an equation*
Allow *energy released / energy change*
Not *energy required*
Allow *ionic compound / salt*

Born-Haber cycle – maximum 5 marks

Correct formulae on cycle **(1)**
Correct state symbols **(1)**
Use of 2 moles of Cl(g) ie 246 **(1)**
Use of 2 moles of $Cl^{-}(g)$ 1.e. 698 **(1)**
-2526 kJ mol^{-1} **(1)**

Every formula must have the correct state symbol at least once
Allow *-2403 / -2875 (2)*
Allow *-2752* ***(1)***
Unit ***required***

Comparison – maximum 3 marks

Any three from
Na^{+} has a larger radius than Mg^{2+} / ora **(1)**
Br^{-} has a larger radius than Cl^{-} / ora **(1)**
Na^{+} has a lower charge than Mg^{2+} / ora **(1)**
Strongest attraction is between Mg^{2+} and Cl^{-} / $MgCl_2$ has
the strongest attraction between its ions / ora **(1)**

Penalise the use of incorrect particle only once within the answer.
Penalise it the first time an incorrect particle is mentioned

And QWC
One mark for correct spelling, punctuation and grammar in at least two sentences

[12]

4. (i) $CaCl_2(s) \rightarrow Ca^{2}+ (aq) + 2Cl^{-} (aq)$ **(1)**

$Ca^{2+} (g) + 2Cl^{-} (g) \rightarrow CaCl_2(s)$ **(1)**

$Ca^{2+}(g) \rightarrow Ca^{2+} (aq)$ **(1)**

State symbols must be shown

(ii)

			$\Delta H^{\ominus}$/kJ mol^{-1}
$CaCl_2 (s)$	$\rightarrow$	$Ca^{2+} (aq) + 2Cl^{-} (aq)$	–123
$Ca^{2+ (aq)}$	$\rightarrow$	$Ca^{2+}(g)$	+1650
$Ca^{2+ (g)} + 2Cl^{- (g)}$	$\rightarrow$	$CaCl_2 (s)$	–2255
$2Cl^{- (g)}$	$\rightarrow$	$2Cl^{- (aq)}$	–728

$\Delta H_{hyd} (Cl^{-}(g) = \frac{-728}{2} = -364$ kJ mol^{-1}

3 equations **(3)** answer **(1)**

OR via cycle: 3 steps **(3)** answer **(1)** 7

[7]

5. (a) Steam condenses to w

$\therefore \Delta H = T\Delta S$ **(1)**

$\Delta S = 189 - 70 = 119$ JK^{-1} mol^{-1} **(1)**

$\therefore \Delta H = 373 \times 119 = 44$ KJ mol^{-1} **(1)** 4

(b) spontaneous reaction when $\Delta G \leq 0$ **(1)**

$CH_4(g) + H_2O(g) \rightarrow CO(g) + 3H_2(g)$ **(1)**

$\Delta S = 198 + 3 \times 131 - 189 - 186 = 216$ JK^{-1} mol^{-1} **(1)**

the entropy change in $-T\Delta S$ **(1)**

makes ΔG -ve once T is high enough **(1)** 6

(c) diamond $\rightarrow$ graphite $\Delta S = +3$ JK^{-1} mol^{-1} **(1)**

since $\Delta H < 0$, ΔG is always < 0 **(1)**

kinetics: large E_a makes reaction too slow **(1)** 3

(d) $CaO(s) + CO_2(g) \rightarrow CaCO_3(s)$

$\Delta S = 90 - 40 - 214 = -164$ JK^{-} mol^{-1} **(1)**

$\Delta G = 0$, $\Delta H = T\Delta S$

$T_s = \frac{178 \times 1000}{164} = 1085$ K **(1)** 2

[15]

Or

Na^+ has a lower charge density than Mg^{2+} / ora **(1)**

Br^- has a lower charge density than Cl^- / ora **(1)**
Strongest attraction between ions which have the highest charge density / $MgCl_2$ has the strongest attraction between its ions / ora **(1)**

And QWC

One mark for correct spelling, punctuation and grammar in at least two sentences **(1)**

12
[12]