AQA – Energetics – A2 Chemistry P1

1. June/ 2020/Paper_1/No.1

0 1 This question is about enthalpy changes.

0 1 . 1 **Figure 1** shows a Born–Haber cycle for the formation of strontium chloride, $SrCl_2$

Figure 1

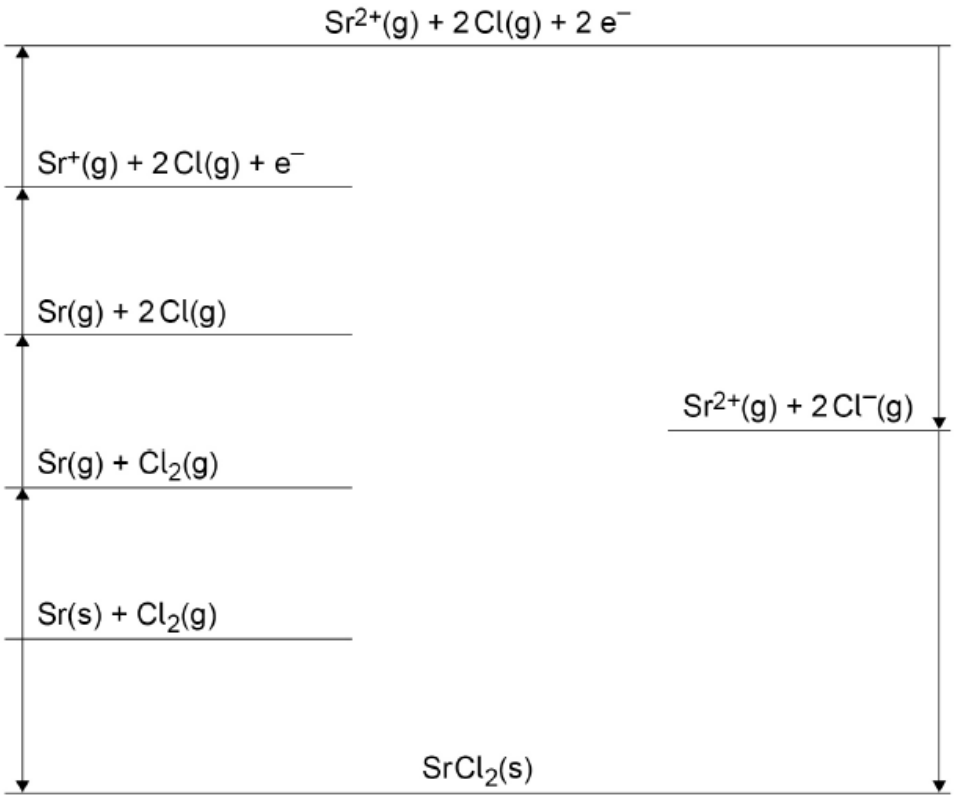


Table 1 shows some thermodynamic data.

Table 1

	Enthalpy change / kJ mol^{-1}
First ionisation energy of strontium	+548
Second ionisation energy of strontium	+1060
Enthalpy of atomisation of chlorine	+121
Enthalpy of atomisation of strontium	+164
Enthalpy of formation of strontium chloride	–828
Enthalpy of lattice formation of strontium chloride	–2112

Use the data in **Table 1** to calculate a value for the electron affinity of chlorine.

[3 marks]

Electron affinity _____ kJ mol^{-1}

0 1 . 2 Draw a line from **each** substance to the enthalpy of lattice formation of that substance.

[1 mark]

Substance	**Enthalpy of lattice formation / kJ mol^{-1}**
$MgCl_2$	–2018
MgO	–2493
$BaCl_2$	–3889

Table 2 shows the theoretical lattice enthalpy, based on a perfect ionic model, and an experimental value for the enthalpy of lattice formation of silver chloride.

Table 2

	Theoretical	Experimental
Enthalpy of lattice formation / kJ mol^{-1}	–770	–905

0 1 . 3 State why there is a difference between the theoretical and experimental values.

[1 mark]

0 1 . 4 **Table 3** shows enthalpy of hydration values for ions of some Group 1 elements.

Table 3

	$Li^+(g)$	$Na^+(g)$	$K^+(g)$
Enthalpy of hydration / kJ mol^{-1}	–519	–406	–322

Explain why the enthalpy of hydration becomes less exothermic from Li^+ to K^+

[2 marks]

0 1 . 5 Calcium bromide dissolves in water.

Table 4 shows some enthalpy data.

Table 4

	Enthalpy change / kJ mol^{-1}
Enthalpy of solution of calcium bromide	–110
Enthalpy of lattice formation of calcium bromide	–2176
Enthalpy of hydration of calcium ions	–1650

Use the data in **Table 4** to calculate the enthalpy of hydration, in kJ mol^{-1}, of bromide ions.

[3 marks]

Enthalpy of hydration of bromide ions _____ kJ mol^{-1}

2. June/ 2020/Paper_1/No.10

1 0 Methanol is formed when carbon dioxide and hydrogen react.

$$CO_2(g) + 3\,H_2(g) \rightleftharpoons CH_3OH(g) + H_2O(g)$$

Table 5 contains enthalpy of formation and entropy data for these substances.

Table 5

	$CO_2(g)$	$H_2(g)$	$CH_3OH(g)$	$H_2O(g)$
$\Delta_f H$ / kJ mol^{-1}	–394	0	–201	–242
S / J K^{-1} mol^{-1}	214	131	238	189

1 0 . 1 Use the equation and the data in **Table 5** to calculate the Gibbs free-energy change (ΔG), in kJ mol^{-1}, for this reaction at 890 K

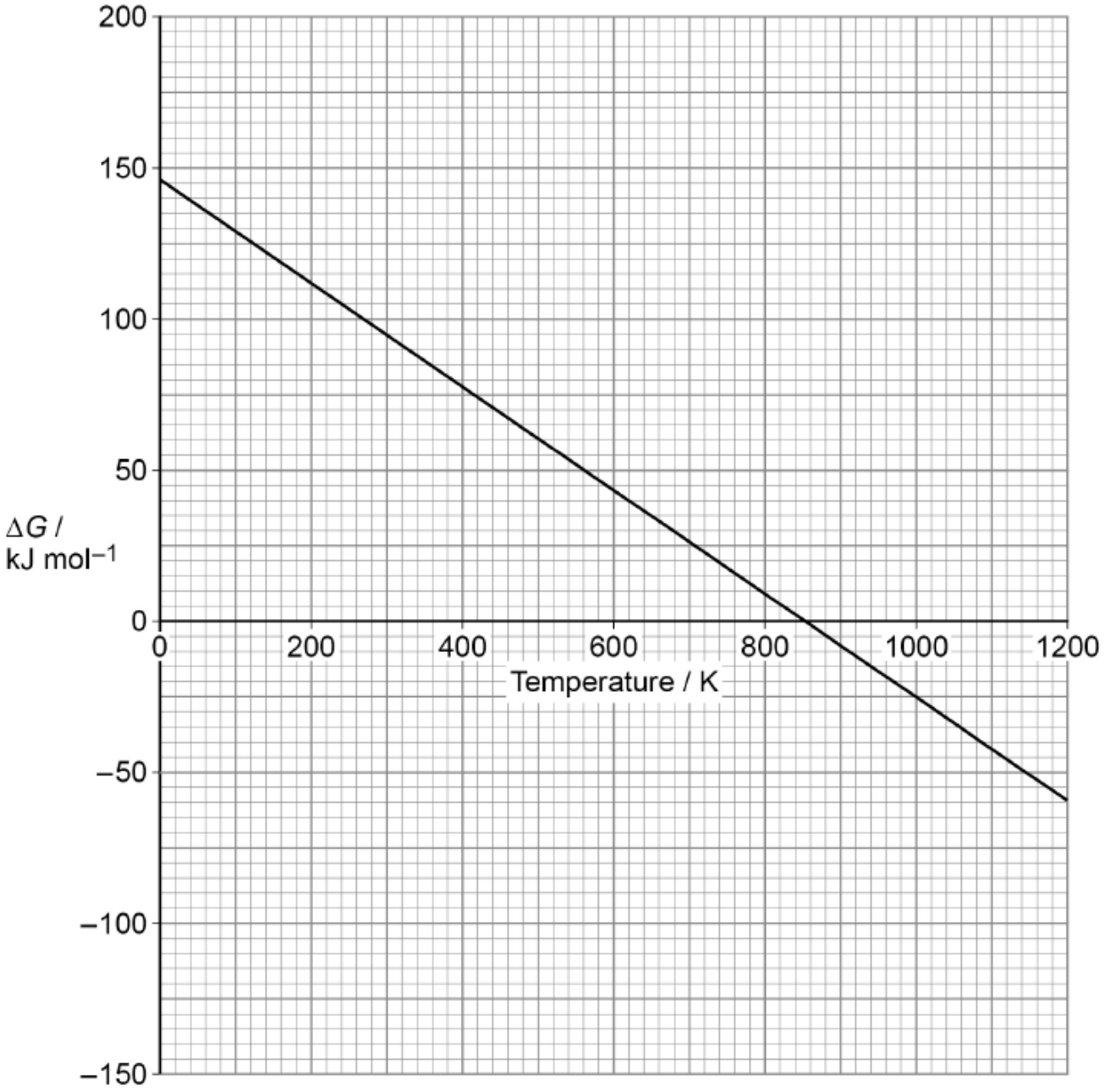
[6 marks]

ΔG _____ kJ mol^{-1}

Figure 4 shows how the Gibbs free-energy change varies with temperature in a different gas phase reaction.

The straight line graph for this gas phase reaction has been extrapolated to zero Kelvin.

Figure 4



1 0 . 2 Use the values of the intercept and gradient from the graph in **Figure 4** to calculate the enthalpy change (ΔH), in kJ mol^{-1}, and the entropy change (ΔS), in J K^{-1} mol^{-1}, for this reaction.

[4 marks]

ΔH _____ kJ mol^{-1}

ΔS _____ J K^{-1} mol^{-1}

1 0 . 3 State what **Figure 4** shows about the feasibility of the reaction.

[1 mark]

_____

_____

_____

3. June/ 2019/Paper_1/No.1

0 1 **Figure 1** shows an incomplete Born–Haber cycle for the formation of caesium iodide. The diagram is not to scale.

Figure 1

Table 1 gives values of some standard enthalpy changes.

Table 1

Name of enthalpy change	$\Delta H^{\ominus}$ / kJ mol^{-1}
Enthalpy of atomisation of caesium	+79
First ionisation energy of caesium	+376
Electron affinity of iodine	–314
Enthalpy of lattice formation of caesium iodide	–585
Enthalpy of formation of caesium iodide	–337

0 1 . 1 Complete **Figure 1** by writing the formulas, including state symbols, of the appropriate species on each of the two blank lines.

[2 marks]

0 1 . 2 Use **Figure 1** and the data in **Table 1** to calculate the standard enthalpy of atomisation of iodine.

[2 marks]

Standard enthalpy of atomisation of iodine _____ kJ mol^{-1}

0 1 . 3 The enthalpy of lattice formation for caesium iodide in **Table 1** is a value obtained by experiment.
The value obtained by calculation using the perfect ionic model is –582 kJ mol^{-1}

Deduce what these values indicate about the bonding in caesium iodide.

[1 mark]

0 1 . 4 Use data from **Table 2** to show that this reaction is **not** feasible at 298 K

$$CsI(s) \rightarrow Cs(s) + \frac{1}{2}I_2(s) \qquad \Delta H^{\ominus} = +337 \text{ kJ mol}^{-1}$$

Table 2

	CsI(s)	**Cs(s)**	**I_2(s)**
$S^{\ominus}$ / J K^{-1} mol^{-1}	130	82.8	117

[4 marks]

4. June/ 2021/Paper_1/No.1

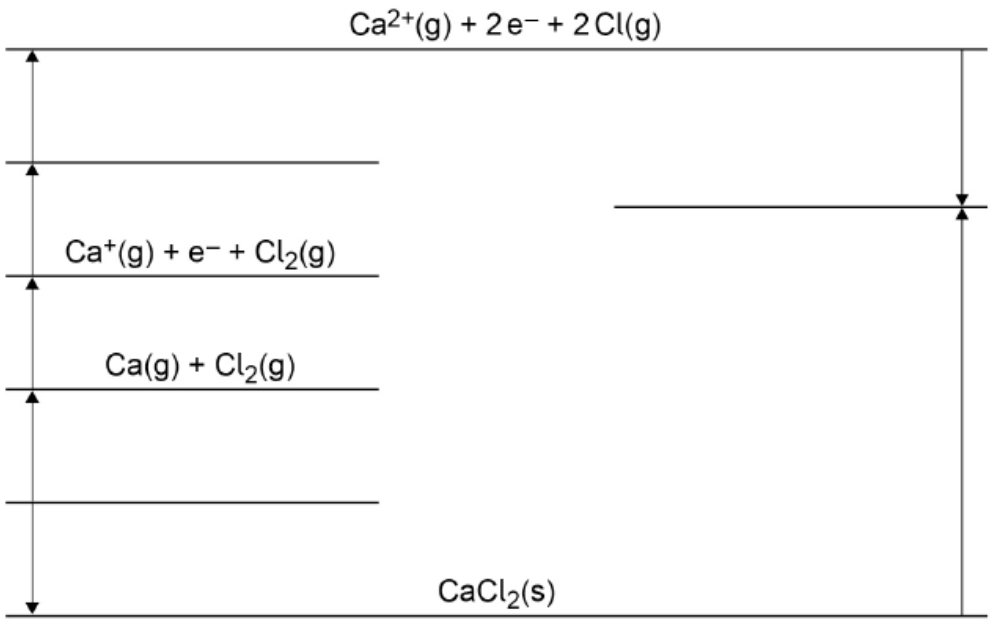
0 1 This question is about enthalpy changes for calcium chloride and magnesium chloride.

0 1 . 1 State the meaning of the term enthalpy change.

[1 mark]

Figure 1 shows an incomplete Born–Haber cycle for the formation of calcium chloride.

Figure 1



0 1 . 2 Complete **Figure 1** by writing the formulas, including state symbols, of the appropriate species on each of the three blank lines.

[3 marks]

0 1 . 3 **Table 1** shows some enthalpy data.

Table 1

	Enthalpy change / kJ mol^{-1}
Enthalpy of formation of calcium chloride	–795
Enthalpy of atomisation of calcium	+193
First ionisation energy of calcium	+590
Second ionisation energy of calcium	+1150
Enthalpy of atomisation of chlorine	+121
Electron affinity of chlorine	–364

Use **Figure 1** and the data in **Table 1** to calculate a value for the enthalpy of lattice dissociation of calcium chloride.

[2 marks]

Enthalpy of lattice dissociation _____ kJ mol^{-1}

0 1 . 4 Magnesium chloride dissolves in water.

Give an equation, including state symbols, to represent the process that occurs when the enthalpy of solution of magnesium chloride is measured.

[1 mark]

0 1 . 5 **Table 2** shows some enthalpy data.

Table 2

	Enthalpy change / kJ mol^{-1}
Enthalpy of lattice dissociation of $MgCl_2$	+2493
Enthalpy of hydration of $Mg^{2+}(g)$	–1920
Enthalpy of hydration of $Cl^-(g)$	–364

Use your answer to Question **01.4** and the data in **Table 2** to calculate a value for the enthalpy of solution of magnesium chloride.

[2 marks]

Enthalpy of solution _____ kJ mol^{-1}

0 1 . 6 The enthalpy of hydration of $Ca^{2+}(g)$ is –1650 kJ mol^{-1}

Suggest why this value is less exothermic than that of $Mg^{2+}(g)$

[2 marks]