

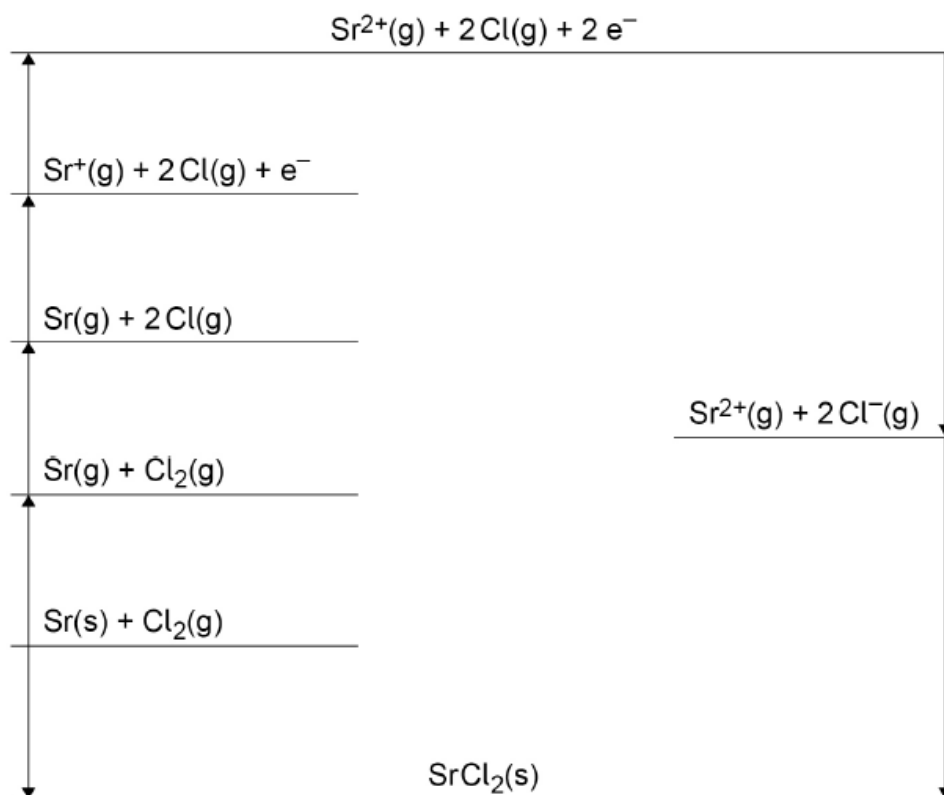
AQA – Energetics – A2 Chemistry P1

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}
MgCl₂	-2018
MgO	-2493
BaCl₂	-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

	$\text{Li}^+(\text{g})$	$\text{Na}^+(\text{g})$	$\text{K}^+(\text{g})$
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. No.10

1 0

Methanol is formed when carbon dioxide and hydrogen react.

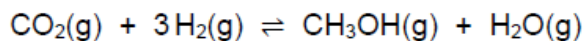


Table 5 contains enthalpy of formation and entropy data for these substances.

Table 5

	$\text{CO}_2(\text{g})$	$\text{H}_2(\text{g})$	$\text{CH}_3\text{OH}(\text{g})$	$\text{H}_2\text{O}(\text{g})$
$\Delta_f H / \text{kJ mol}^{-1}$	-394	0	-201	-242
$S / \text{J K}^{-1} \text{mol}^{-1}$	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

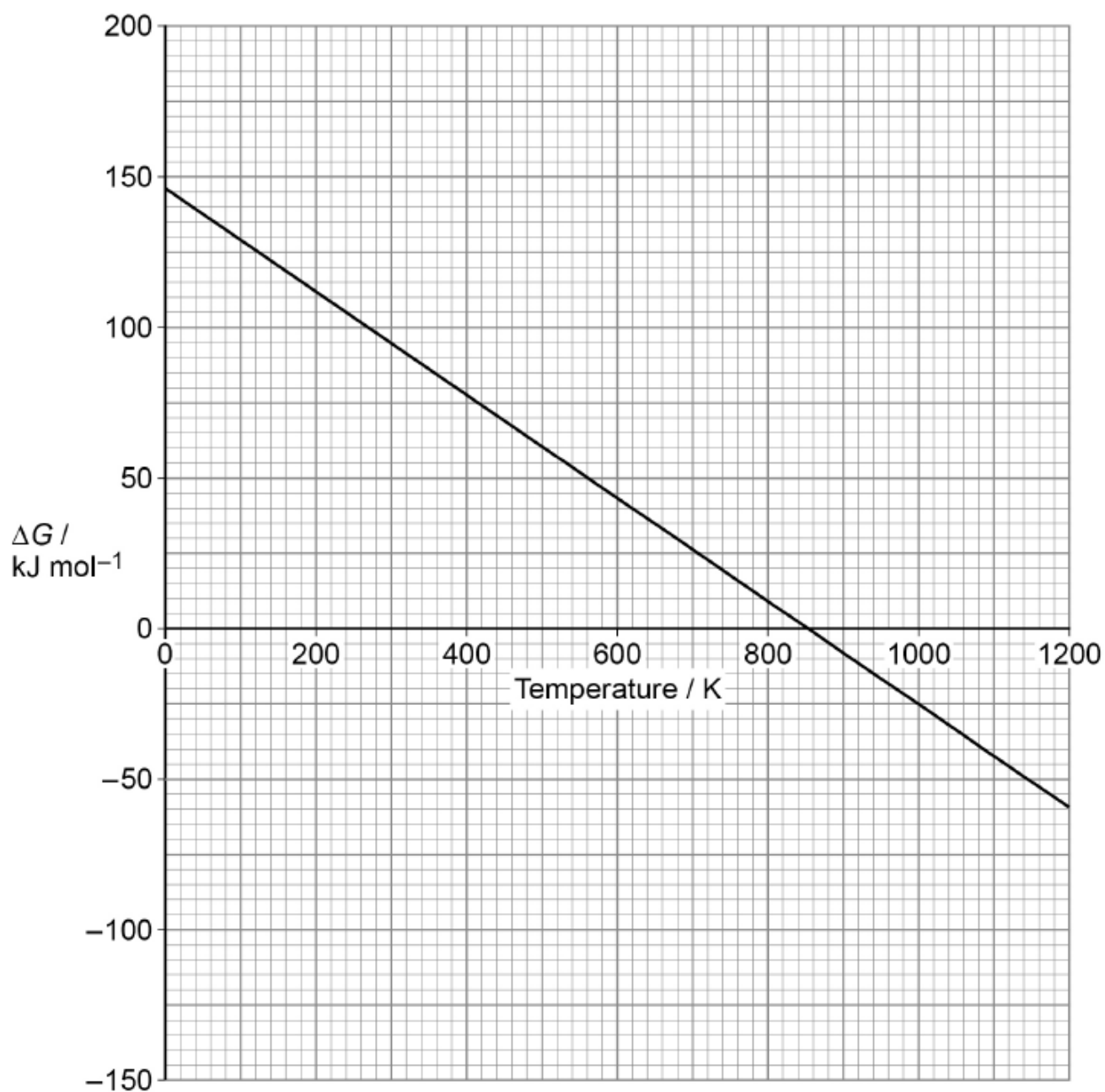
[6 marks]

 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 $\text{J K}^{-1} \text{mol}^{-1}$, for this reaction.

[4 marks]

ΔH _____ kJ mol^{-1}

ΔS _____ $\text{J K}^{-1} \text{mol}^{-1}$

1 0 . 3

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

[1 mark]

3. No.1

0 1

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

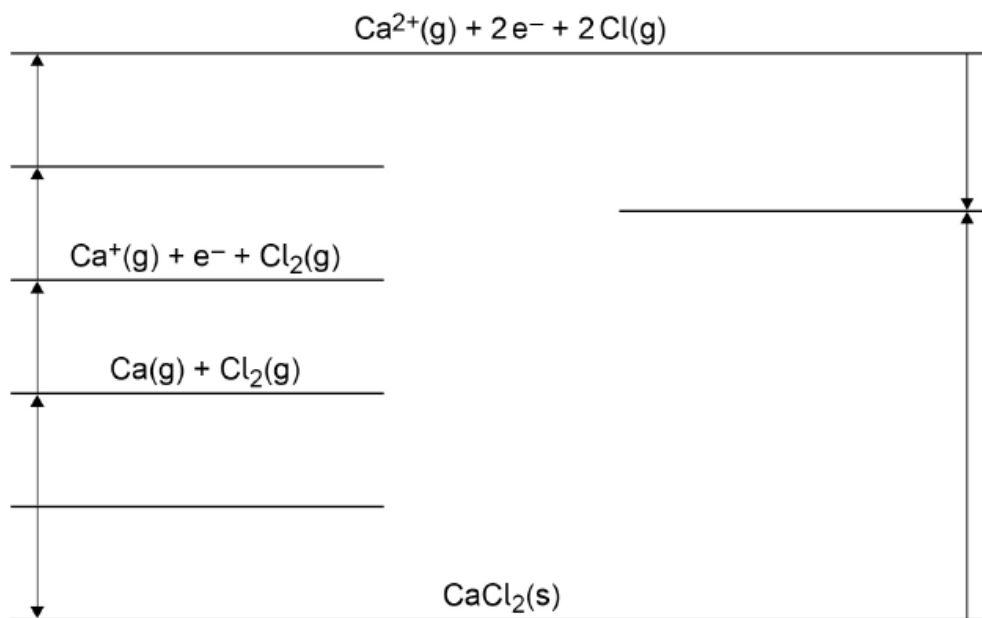
0 1 . 1

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 $\text{Mg}^{2+}(\text{g})$	−1920
Enthalpy of hydration of $\text{Cl}^{-}(\text{g})$	−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 $\text{Ca}^{2+}(\text{g})$ is $-1650 \text{ kJ mol}^{-1}$

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

[2 marks]

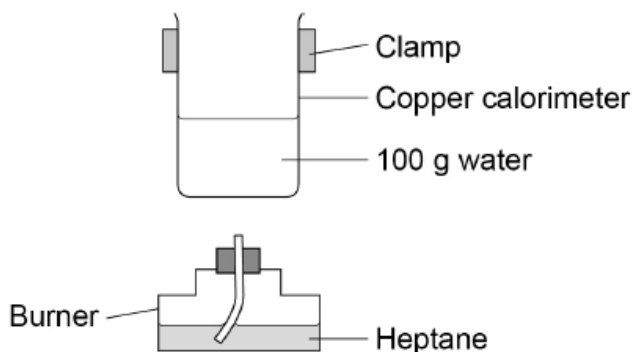
4. No.3

0 3

A student does an experiment to determine a value for the enthalpy of combustion of heptane.

Figure 2 shows some of the apparatus used.

Figure 2



0 3 . 1

Design a table to record all the readings necessary to determine an experimental value for the enthalpy of combustion for heptane in this experiment.

[2 marks]

0 3 . 2

The student considered using a glass beaker on a tripod and gauze instead of the clamped copper calorimeter.

Suggest **two** disadvantages of using a glass beaker on a tripod and gauze.

[2 marks]

Disadvantage 1 _____

Disadvantage 2 _____

03.3

Suggest **two** reasons why the value of enthalpy of combustion from this experiment is less exothermic than a data book value.

[2 marks]

Reason 1 _____

Reason 2 _____

03.4

Suggest **one** addition to this apparatus that would improve the accuracy of the enthalpy value obtained.

[1 mark]

5. No.5

0 5

A bomb calorimeter can be used for accurate determination of the heat change during combustion of a fuel.

A bomb calorimeter is a container of fixed volume that withstands the change in pressure during the reaction.

The fuel is mixed with pure oxygen in the calorimeter, ignited and the temperature change is recorded.

The total heat capacity (C_{cal}) of the calorimeter is calculated using a fuel for which the heat change is known.

In an experiment to calculate C_{cal} , 2.00 g of hexane ($M_r = 86.0$) is ignited. A temperature change (ΔT) of 12.4 °C is recorded.

Under the conditions of the experiment, 1.00 mol of hexane releases 4154 kJ of energy when combusted.

0 5 . 1

The heat energy released in the calorimeter, $q = C_{\text{cal}}\Delta T$

Calculate the heat capacity (C_{cal}) in kJ K⁻¹

[3 marks]

C_{cal} _____ kJ K⁻¹

0 5 . 2

When the experiment is repeated with 2.00 g of octane ($M_r = 114.0$) the temperature change recorded is 12.2 °C

Calculate the heat change, in kJ mol⁻¹, for octane in this combustion reaction.

If you were unable to calculate a value for C_{cal} in Question 05.1, use 6.52 kJ K⁻¹ (this is **not** the correct value).

[2 marks]

Heat change _____ kJ mol⁻¹

05.3

State why the heat change calculated from the bomb calorimeter experiment is **not** an enthalpy change.

[1 mark]

05.4

The thermometer used to measure the temperature change of $12.2\text{ }^{\circ}\text{C}$ in Question 05.2 has an uncertainty of $\pm 0.1\text{ }^{\circ}\text{C}$ in each reading.

Calculate the percentage uncertainty in this use of the thermometer.

Suggest **one** change to this experiment that decreases the percentage uncertainty while using the same thermometer.

[2 marks]

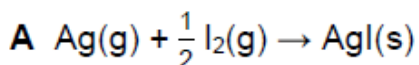
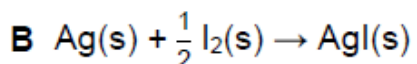
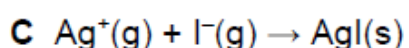
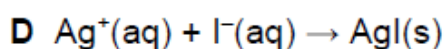
Percentage uncertainty _____

Change _____

6. No.9

Which reaction has an enthalpy change equal to the standard enthalpy of formation of silver iodide?

[1 mark]

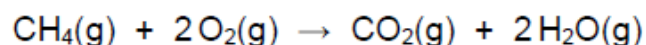
☐☐☐☐

7. No.10

Some bond enthalpies are given.

Bond	C–H	O–H	O=O	C=O
Bond enthalpy/ kJ mol ⁻¹	412	463	496	743

Which is the enthalpy change of this reaction in kJ mol⁻¹?



[1 mark]

A +698

☐

B +228

☐

C -228

☐

D -698

☐

8. No.18

A mixture of 2 dm^3 of hydrogen and 1 dm^3 of oxygen is at room temperature.

Which statement is correct?

[1 mark]

- A** There is no reaction to form water because the molecules do not collide with sufficient energy.
- B** There is no reaction to form water because the molecules do not collide with sufficient frequency.
- C** The mean velocity of the hydrogen molecules is less than that of the oxygen molecules.
- D** The partial pressure of each gas is the same.

☐☐☐☐

9. No.19

Which statement about the distribution curve of molecular energies in an ideal gas at a given temperature is correct?

[1 mark]

- A** There are no molecules with zero energy.
- B** The curve is symmetrical about the maximum.
- C** Changing the temperature has no effect on the position of the maximum.
- D** Most molecules have the mean energy.

☐☐☐☐