

Name of the Student: _____

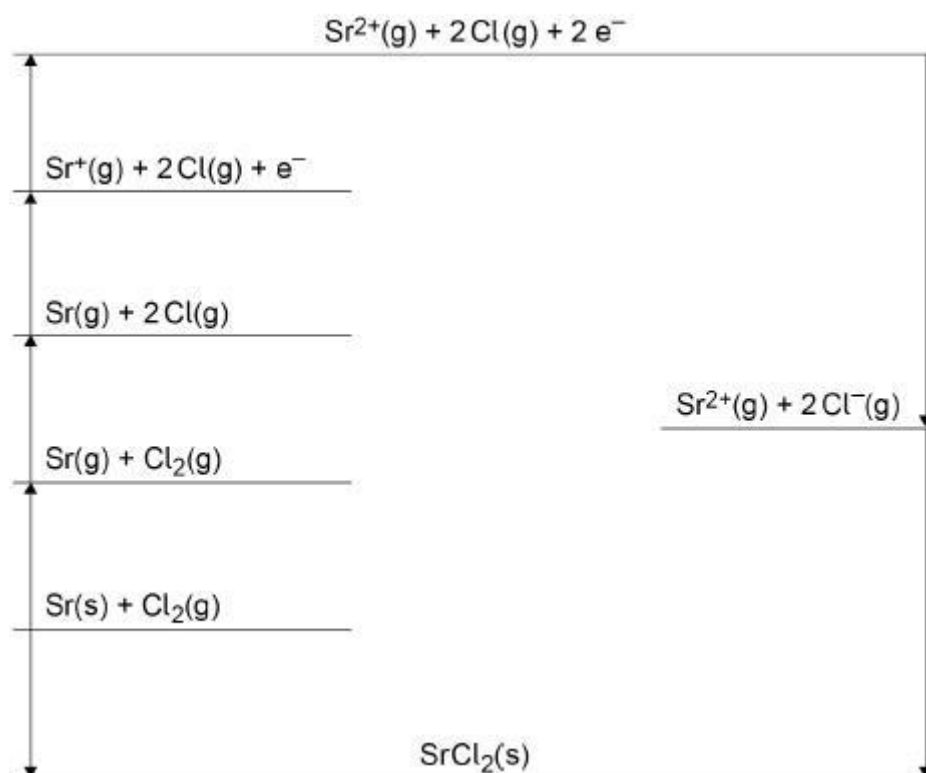
Max. Marks : 21 Marks

Time : 21 Minutes

Q1.

This question is about enthalpy changes.

- (a) The figure below shows a Born–Haber cycle for the formation of strontium chloride,
- SrCl_2

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

Electron affinity _____ kJ mol^{–1}

(3)

- (b) Draw a line from **each** substance to the enthalpy of lattice formation of that substance.

Substance	Enthalpy of lattice formation / kJ mol ^{–1}
MgCl ₂	–2018
MgO	–2493
BaCl ₂	–3889

(1)

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

- (c) State why there is a difference between the theoretical and experimental values.

(1)

- (d) **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)

- (e) 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.

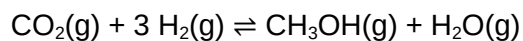
Enthalpy of hydration of bromide ions _____ kJ mol^{-1}

(3)

(Total 10 marks)

Q2.

Methanol is formed when carbon dioxide and hydrogen react.



The table contains enthalpy of formation and entropy data for these substances.

	CO₂(g)	H₂(g)	CH₃OH(g)	H₂O(g)
$\Delta_f H / \text{kJ mol}^{-1}$	–394	0	–201	–242
$S / \text{J K}^{-1} \text{mol}^{-1}$	214	131	238	189

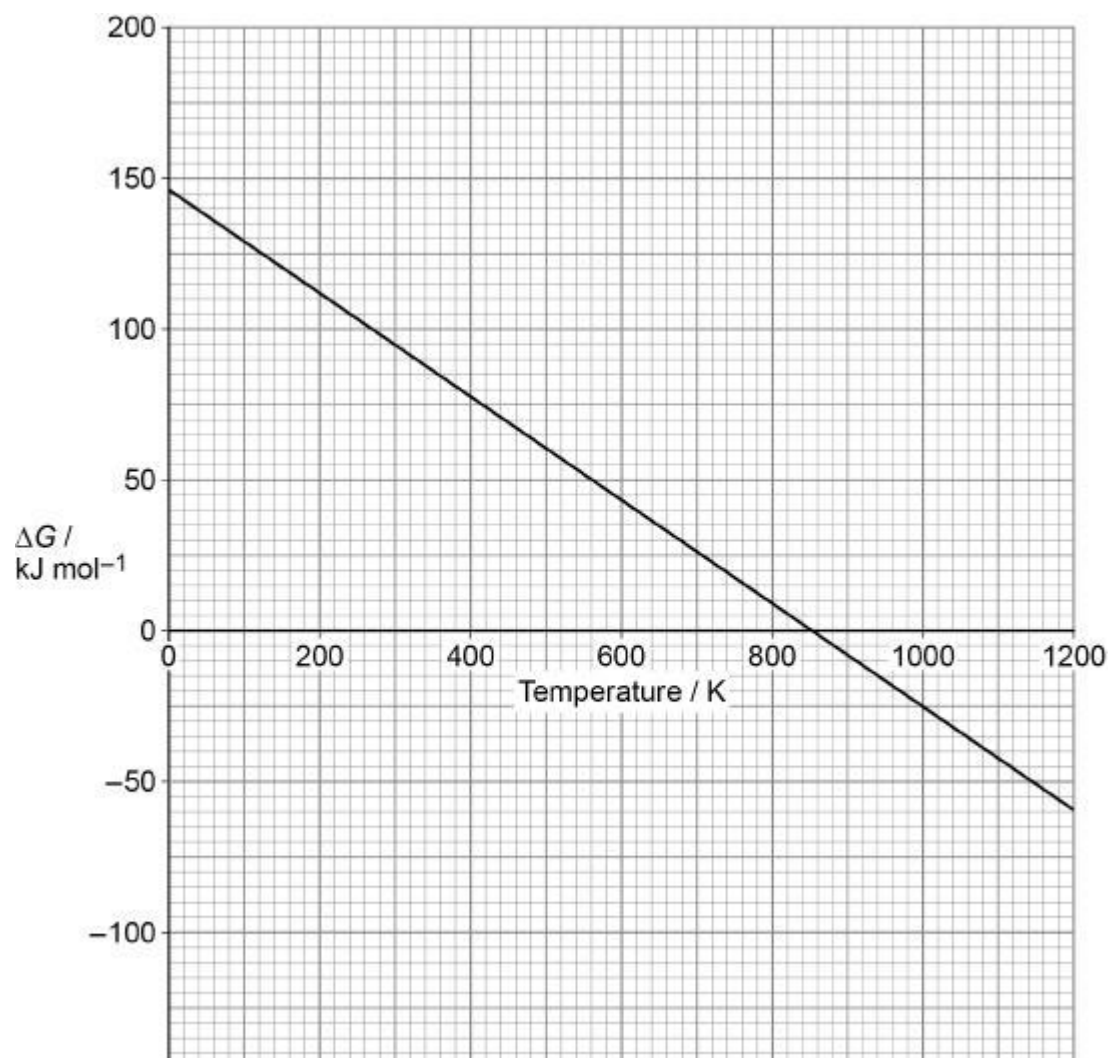
- (a) Use the equation and the data in the table above to calculate the Gibbs free-energy change (ΔG), in kJ mol^{-1} , for this reaction at 890 K

ΔG _____ kJ mol^{-1}

(6)

The graph below 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.



- (b) Use the values of the intercept and gradient from the graph 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.

$$\Delta H \text{ _____ } \text{kJ mol}^{-1}$$

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

(4)

- (c) State what the graph above shows about the feasibility of the reaction.

(1)
(Total 11 marks)