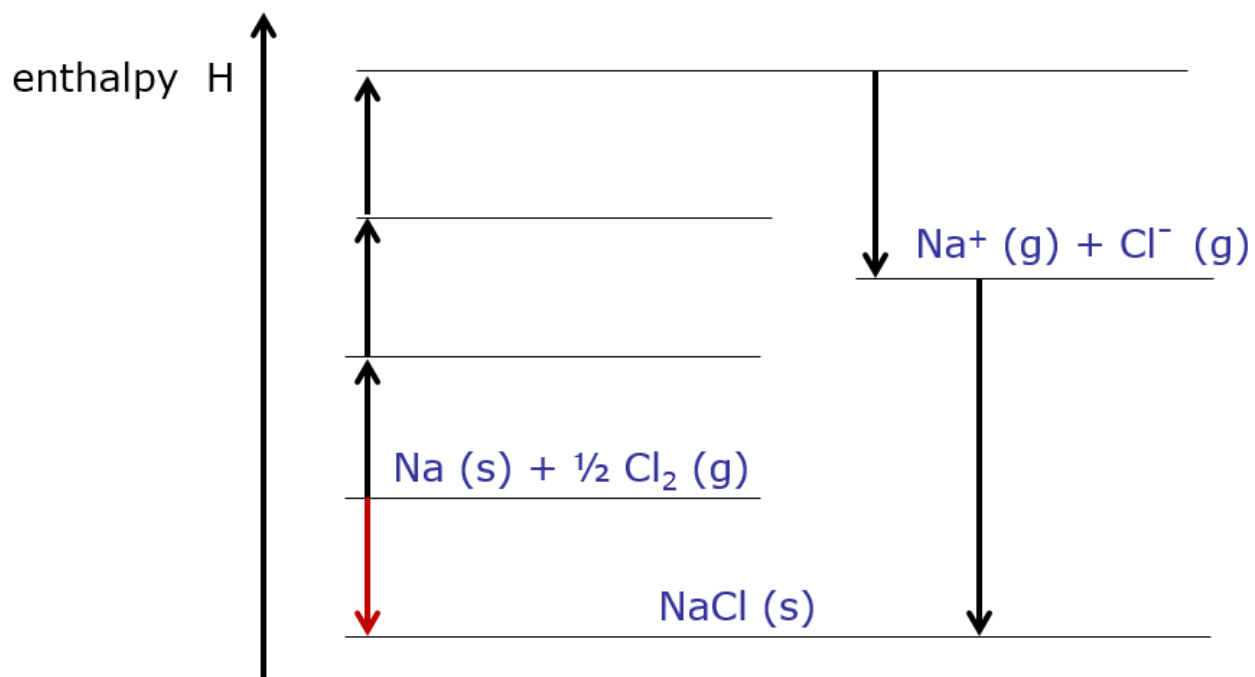




BORN-HABER CYCLE

e.g. for sodium chloride:





Q1: Which equation correctly represents the enthalpy of formation of magnesium chloride?

- 1) $\text{Mg}^{2+}_{(g)} + 2\text{Cl}^{-}_{(g)} \rightarrow \text{MgCl}_{2(s)}$
- 2) $\text{Mg}_{(s)} + 2\text{Cl}_{(g)} \rightarrow \text{MgCl}_{2(s)}$
- 3) $\text{Mg}_{(s)} + \text{Cl}_{2(g)} \rightarrow \text{MgCl}_{2(s)}$

Q2: Which equation correctly represents the first enthalpy of ionization of sodium?

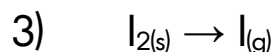
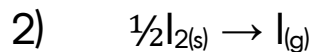
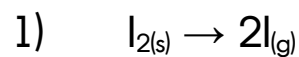
- 1) $\text{Na}_{(g)} \rightarrow \text{Na}^{+}_{(g)}$
- 2) $\text{Na}_{(g)} \rightarrow \text{Na}^{+}_{(g)} + \text{e}^{-}$
- 3) $\text{Na}_{(s)} \rightarrow \text{Na}^{+}_{(g)} + \text{e}^{-}$

Q3: Which equation correctly represents the lattice formation enthalpy of calcium chloride?

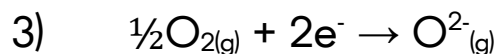
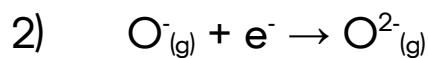
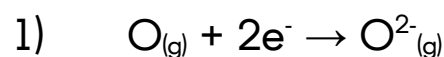
- 1) $\text{Ca}^{2+}_{(g)} + 2\text{Cl}^{-}_{(g)} \rightarrow \text{CaCl}_{2(s)}$
- 2) $\text{Ca}^{+}_{(g)} + \text{Cl}^{-}_{(g)} \rightarrow \text{CaCl}_{(s)}$
- 3) $\text{CaCl}_{2(s)} \rightarrow \text{Ca}^{2+}_{(g)} + 2\text{Cl}^{-}_{(g)}$



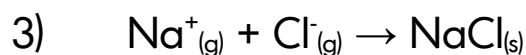
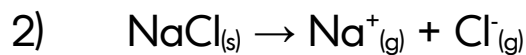
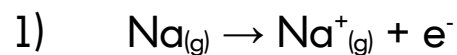
Q4: Which equation correctly represents the enthalpy of atomization of iodine?



Q5: Which equation correctly represents the second enthalpy of electron affinity of oxygen?



Q6: Which of the following changes is exothermic?





Q7: Which of the following changes is endothermic?

- 1) $\text{O}_{(g)} + e^{-} \rightarrow \text{O}^{-}_{(g)}$
- 2) $\text{O}^{-}_{(g)} + e^{-} \rightarrow \text{O}^{2-}_{(g)}$
- 3) $\text{Mg}_{(s)} + \text{O}_{2(g)} \rightarrow \text{MgO}_{(s)}$

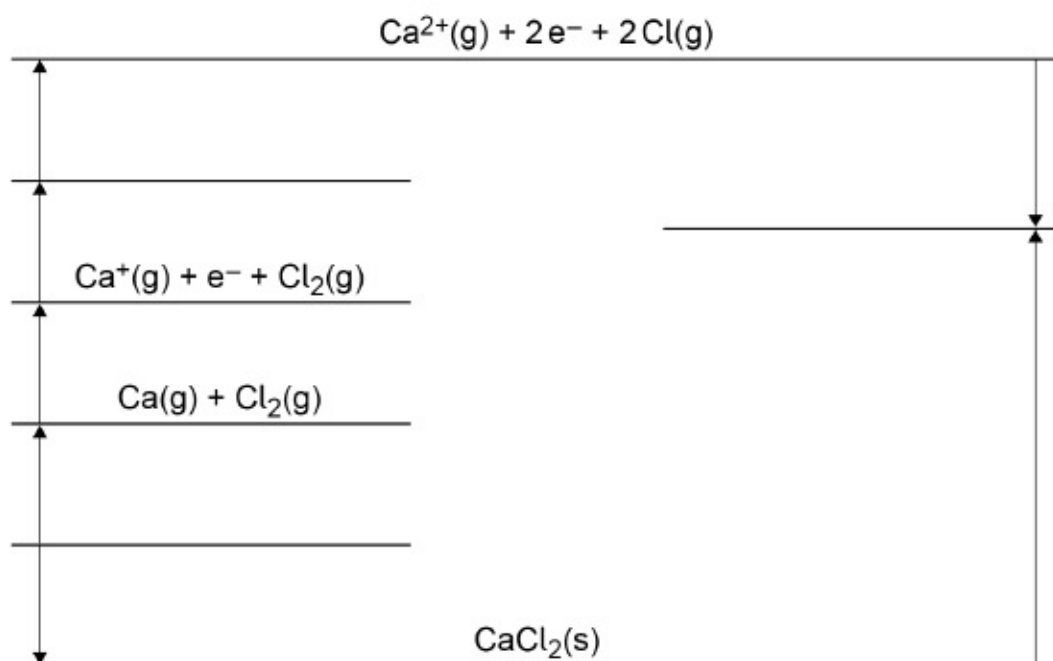


0 1 . 1 State the meaning of the term enthalpy change.

[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]

