Lattice Enthalpy & Born-Haber Cycles A Level only

Question Paper 1

Level	A Level
Subject	Chemistry
Exam Board	OCR
Module	Physical Chemistry & Transition Elements
Topic	Lattice Enthalpy & Born-Haber Cycles
Paper	A Level only
Booklet	Question Paper 1

Time allowed: **41 minutes**

Score: **/30**

Percentage: **/100**

Grade Boundaries:
sical

A*	A	B	C	D	E
>85%	73%	60%	47%	34%	21%

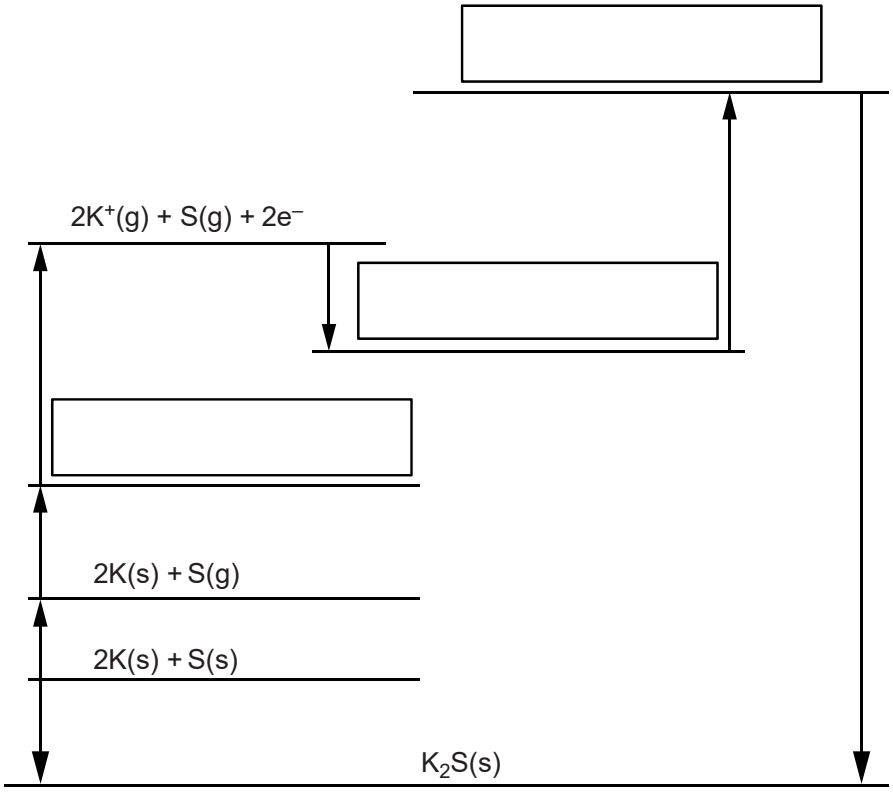
Born–Haber cycles can be used to calculate enthalpy changes indirectly.

(a) The table below shows enthalpy changes for a Born–Haber cycle involving potassium sulfide, K_2S.

	Enthalpy change /kJ mol^{-1}
Formation of potassium sulfide, K_2S	–381
1st electron affinity of sulfur	–200
2nd electron affinity of sulfur	+640
Atomisation of sulfur	+279
1st ionisation energy of potassium	+419
Atomisation of potassium	+89

(i) The incomplete Born–Haber cycle below can be used to determine the lattice enthalpy of potassium sulfide.

In the boxes, write the species present at each stage in the cycle.
Include state symbols for the species.



[3]

(ii) Define, in words, the term *lattice enthalpy*. [2]

(iii) Using the Born–Haber cycle, calculate the lattice enthalpy of potassium sulfide. [2]

(b) Several ionic radii are shown below.

Ion	Na^+	K^+	Rb^+	Cl^-	Br^-	I^-
Radius / pm	95	133	148	181	195	216

Predict the order of melting points for NaBr, KI and RbCl from lowest to highest.

Explain your answer.

Lowest melting point

Highest melting point

Explanation [3]

[Total: 10 Marks]

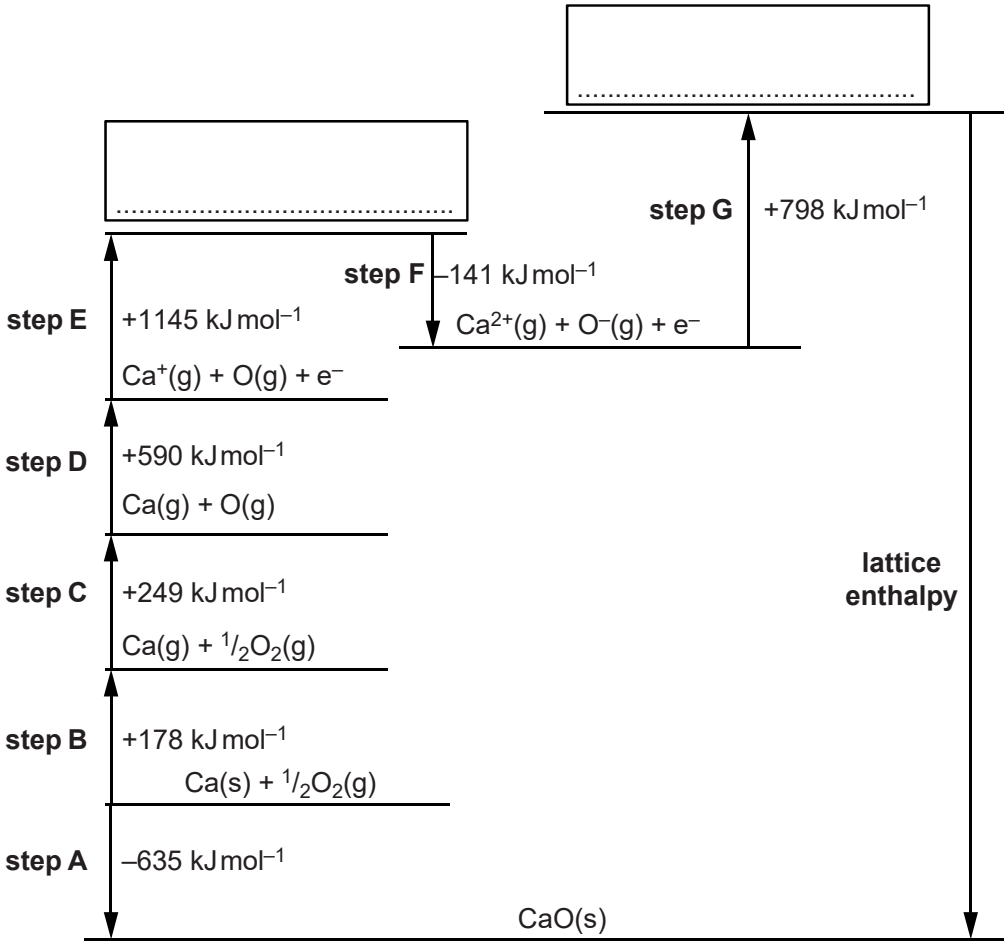
Born–Haber cycles can be used to determine lattice enthalpies of ionic compounds.

(a) Define, in words, the term *lattice enthalpy*. [2]

(b) The Born–Haber cycle below can be used to determine the lattice enthalpy of calcium oxide. The cycle includes the values for the enthalpy changes of the steps labelled **A–G**.

(i) Complete the Born–Haber cycle by adding the species present on the two dotted lines.

Include state symbols.



[2]

(ii) Name the enthalpy changes for the following steps in the Born–Haber cycle.

- **step A**
- **step C**
- **step G** [3]

(iii) Calculate the lattice enthalpy of calcium oxide. [2]

(c) Describe and explain the factors that affect the values of lattice enthalpies. [3]

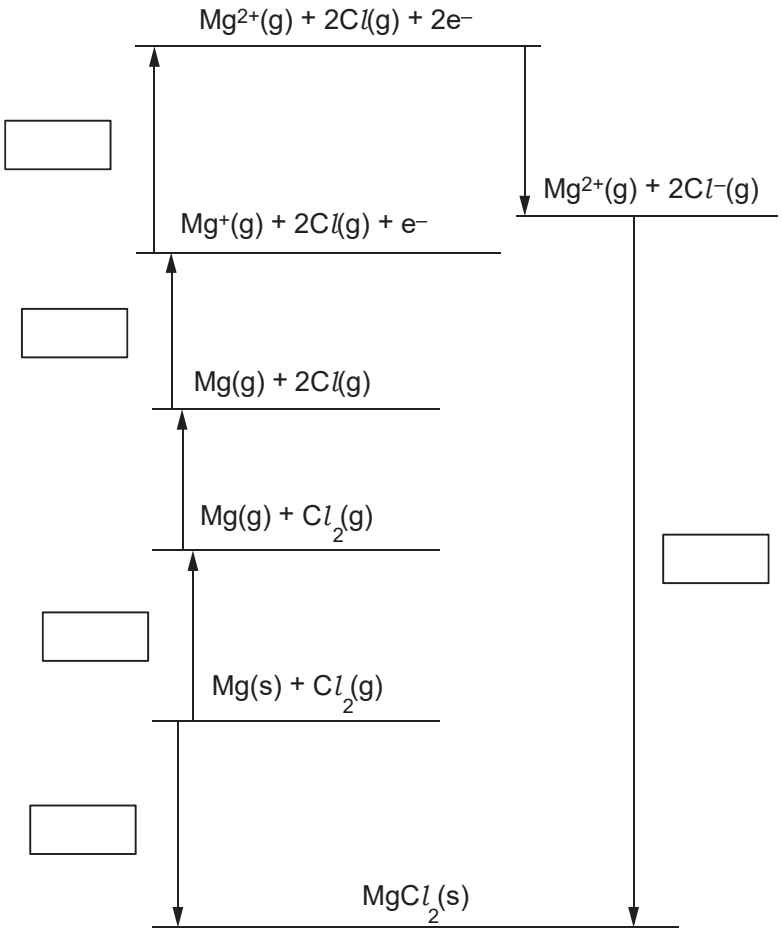
[Total 12 Marks]

Lattice enthalpy can be used as a measure of ionic bond strength. Lattice enthalpies are determined indirectly using an enthalpy cycle called a Born–Haber cycle.

The table below shows the enthalpy changes that are needed to determine the lattice enthalpy of magnesium chloride, $MgCl_2$.

letter	enthalpy change	energy/ $kJ\,mol^{-1}$
A	1st electron affinity of chlorine	–349
B	1st ionisation energy of magnesium	+736
C	atomisation of chlorine	+150
D	formation of magnesium chloride	–642
E	atomisation of magnesium	+76
F	2nd ionisation energy of magnesium	+1450
G	lattice enthalpy of magnesium chloride	

(a) On the cycle below, write the correct letter in each empty box.



[3]

(b) Use the Born–Haber cycle to calculate the lattice enthalpy of magnesium chloride. [2]

(c) Magnesium chloride has stronger ionic bonds than sodium chloride.

Explain why. [3]

[Total: 8 Marks]