

1. The lattice enthalpy of calcium chloride can be calculated using **three** of the enthalpy changes below.

Which enthalpy change is **not** required?

- A enthalpy change of solution of calcium chloride
- B enthalpy change of hydration of Cl^- ions
- C enthalpy change of formation of calcium chloride
- D enthalpy change of hydration of Ca^{2+} ions

Your answer

[1]

2. This question is about the chemistry of the elements in Group 2 and the halogens.

- (a) A student prepares an aqueous solution of magnesium chloride by reacting magnesium with excess hydrochloric acid.

Write an equation, including state symbols, for this reaction and state the observation(s) the student should make whilst carrying out this experiment.

equation:

observation(s):

[2]

- (b) Lattice enthalpies give an indication of the strength of ionic bonding.

How would the lattice enthalpies of magnesium chloride and calcium chloride differ?

Explain your answer.

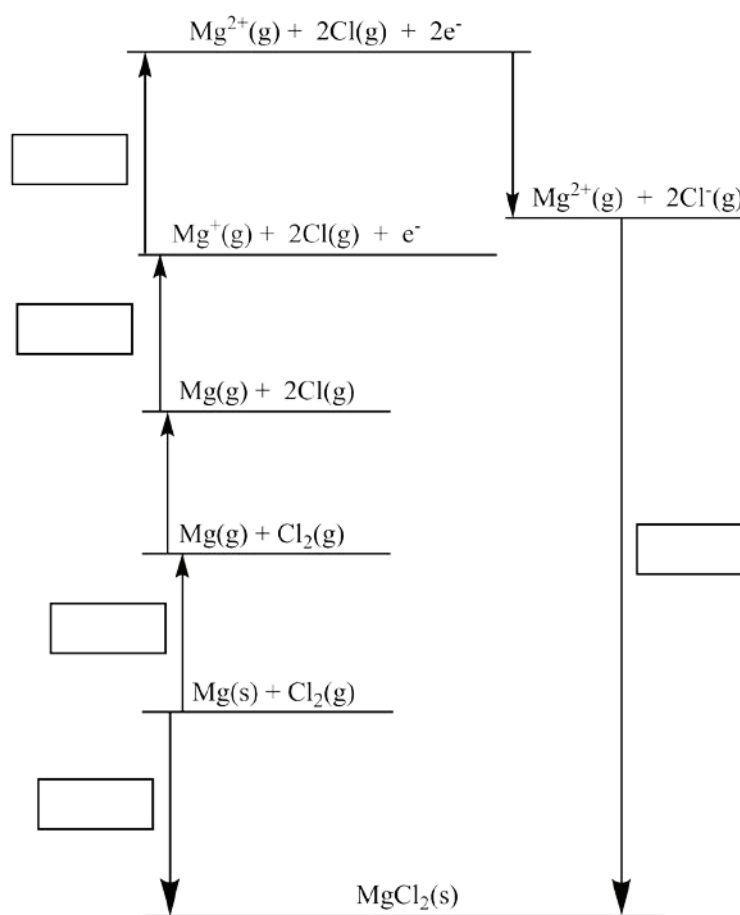
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[3]

- (c) 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	

- (i) On the cycle below, write the correct letter in each box.



- (ii) Use the Born–Haber cycle to calculate the lattice enthalpy of magnesium chloride.

lattice enthalpy = kJ mol^{-1} [2]

- (d)* Describe and explain the relative reactivity of the halogens, chlorine, bromine and iodine, in their redox reactions with halides, using reactions on a test-tube scale.

Include reaction equations and observations in your answer.

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3. Which enthalpy change(s) is/are endothermic?
- 1 The bond enthalpy of the C–H bond
 - 2 The second electron affinity of oxygen
 - 3 The standard enthalpy change of formation of magnesium

- A** 1, 2 and 3
- B** Only 1 and 2
- C** Only 2 and 3
- D** Only 1

Your answer

[1]

4. This question is about enthalpy changes.

(a) **Table 16.1** shows enthalpy changes that can be used to determine the enthalpy change of hydration of fluoride ions, F^- .

Enthalpy change	Energy / kJ mol^{-1}
Hydration of Ca^{2+}	-1609
Solution of CaF_2	+13
Lattice enthalpy of CaF_2	-2630

Table 16.1

(i) Explain what is meant by the term *enthalpy change of hydration*.

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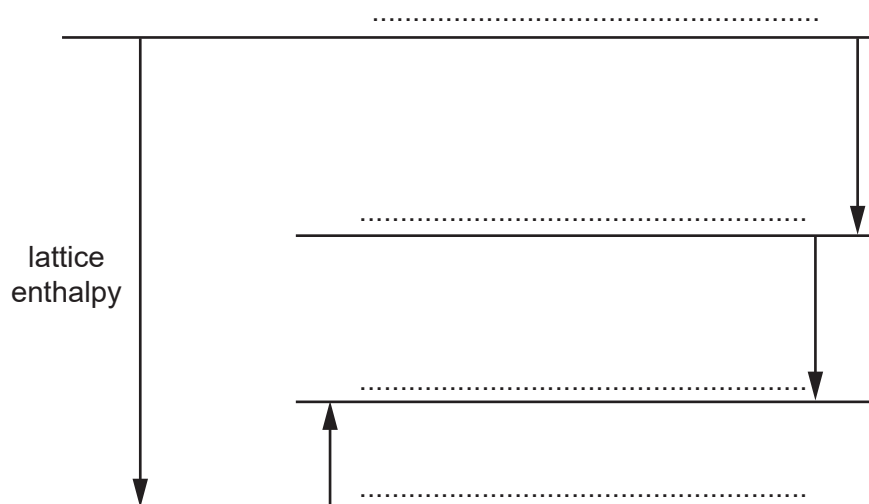
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(ii) The enthalpy change of hydration of F^- can be determined using the enthalpy changes in **Table 16.1** and the incomplete energy cycle below.

On the dotted lines, add the species present, including state symbols.



[4]

- (iii) Calculate the enthalpy change of hydration of fluoride ions, F^- .

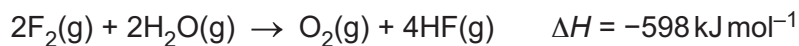
enthalpy change of hydration = kJ mol^{-1} [2]

- (iv) Predict how the enthalpy changes of hydration of F^- and Cl^- would differ.

Explain your answer.

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..... [2]

(b) Fluorine reacts with steam as shown in the equation below.



Average bond enthalpies are shown in the table.

Bond	Average bond enthalpy / kJ mol^{-1}
O-H	+464
O=O	+498
H-F	+568

(i) Explain what is meant by the term *average bond enthalpy*.

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(ii) Calculate the bond enthalpy of the F-F bond.

bond enthalpy = kJ mol^{-1} [3]