SECTION B

Answer **all** the questions.

16   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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   .... **[2]**
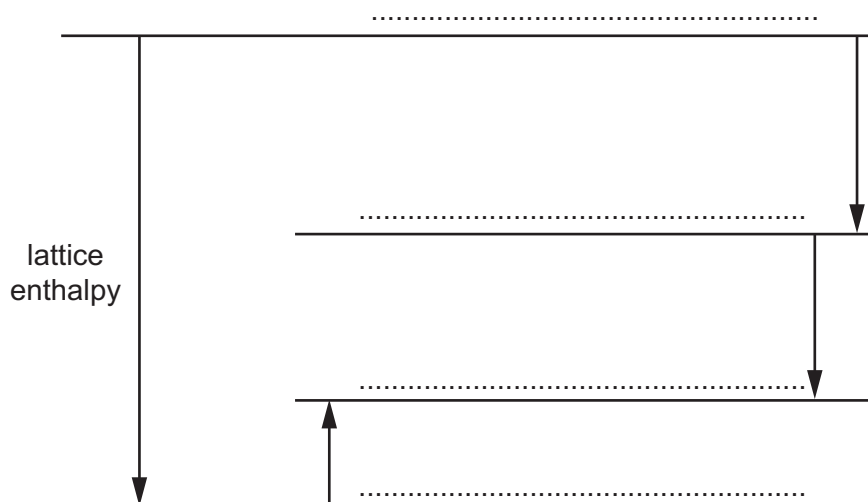
   (ii) The enthalpy change of hydration of F^- can be determined using the enthalpy changes in **Table 16.1** and the incomplete energy cycle below.

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

   ....

   lattice
   enthalpy

   ....

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   [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.

$$2F_2(g) + 2H_2O(g) \rightarrow O_2(g) + 4HF(g) \qquad \Delta H = -598\,kJ\,mol^{-1}$$
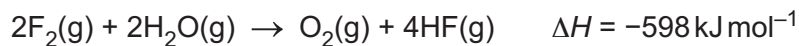
Average bond enthalpies are shown in the table.

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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.... **[2]**

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

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