Q1.(a) Define the term *lattice enthalpy of dissociation*.

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(2)

(b) Lattice enthalpy can be calculated theoretically using a **perfect ionic model**.

Explain the meaning of the term *perfect ionic model*.

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(Extra space) ....

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(1)

(c) Suggest **two** properties of ions that influence the value of a lattice enthalpy calculated using a perfect ionic model.

Property 1 ....

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Property 2 ....

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(2)

(d) Use the data in the table to calculate a value for the lattice enthalpy of dissociation for silver chloride.

Enthalpy change	**Value / kJ mol^{-1}**
Enthalpy of atomisation for silver	+289

First ionisation energy for silver	+732
Enthalpy of atomisation for chlorine	+121
Electron affinity for chlorine	−364
Enthalpy of formation for silver chloride	−127

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(3)

(e) Predict whether the magnitude of the lattice enthalpy of dissociation that you have calculated in part (d) will be less than, equal to or greater than the value that is obtained from a perfect ionic model. Explain your answer.

Prediction compared with ionic model ....

Explanation ....

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(2)
(Total 10 marks)

Q2. The enthalpy of hydration for the chloride ion is −364 kJ mol^{-1} and that for the bromide ion is −335 kJ mol^{-1}.

(a) By describing the nature of the attractive forces involved, explain why the value for the enthalpy of hydration for the chloride ion is more negative than that for the bromide ion.

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(3)

(b) The enthalpy of hydration for the potassium ion is −322 kJ mol^{-1}. The lattice enthalpy of dissociation for potassium bromide is +670 kJ mol^{-1}.

Calculate the enthalpy of solution for potassium bromide.

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(2)

(c) The enthalpy of solution for potassium chloride is +17.2 kJ mol^{-1}.

(i) Explain why the free-energy change for the dissolving of potassium chloride in water is negative, even though the enthalpy change is positive.

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(Extra space) ....

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(3)

(ii) A solution is formed when 5.00 g of potassium chloride are dissolved in 20.0 g of water. The initial temperature of the water is 298 K.

Calculate the final temperature of the solution.

In your calculation, assume that only the 20.0 g of water changes in temperature and that the specific heat capacity of water is 4.18 J K^{-1} g^{-1}.

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(5)
(Total 13 marks)

Q3. This table contains some values of lattice dissociation enthalpies.

Compound	$MgCl_2$	$CaCl_2$	MgO

Lattice dissociation enthalpy / kJ mol^{-1}	2493	2237	3889

(a) Write an equation, including state symbols, for the reaction that has an enthalpy change equal to the lattice dissociation enthalpy of magnesium chloride.

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(1)

(b) Explain why the lattice dissociation enthalpy of magnesium chloride is greater than that of calcium chloride.

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(Extra space) ....

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(2)

(c) Explain why the lattice dissociation enthalpy of magnesium oxide is greater than that of magnesium chloride.

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(Extra space) ....

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(2)

(d) When magnesium chloride dissolves in water, the enthalpy of solution is −155 kJ mol^{-1}.
The enthalpy of hydration of chloride ions is −364 kJ mol^{-1}.

Calculate the enthalpy of hydration of magnesium ions.

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(Extra space) ....

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(3)

(e) Energy is released when a magnesium ion is hydrated because magnesium ions attract water molecules.

Explain why magnesium ions attract water molecules.
You may use a labelled diagram to illustrate your answer.

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(2)

(f) Suggest why a value for the enthalpy of solution of magnesium oxide is **not** found in any data books.

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(1)
(Total 11 marks)

Q4. Consider the following process that represents the melting of ice.

$H_2O(s) \longrightarrow H_2O(l)$ $\Delta H^\ominus = +6.03$ kJ mol^{-1}, $\Delta S^\ominus = +22.1$ J K^{-1} mol^{-1}

(a) State the meaning of the symbol $^\ominus$ in $\Delta H^\ominus$.

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(b) Use your knowledge of bonding to explain why $\Delta H^\ominus$ is positive for this process.

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(c) Calculate the temperature at which $\Delta G^\ominus = 0$ for this process. Show your working.

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.... **(3)**

(d) The freezing of water is an exothermic process. Give **one** reason why the temperature of a sample of water can stay at a constant value of 0 °C when it freezes.

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(e) Pure ice can look pale blue when illuminated by white light. Suggest an explanation for this observation.

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(2)
(Total 9 marks)

Q5. Some thermodynamic data for fluorine and chlorine are shown in the table.
In the table, X represents the halogen F or Cl.

	Fluorine	**Chlorine**
Electronegativity	4.0	3.0
Electron affinity / kJ mol^{-1}	–348	–364
Enthalpy of atomisation / kJ mol^{-1}	+79	+121
Enthalpy of hydration of X^-(g) / kJ mol^{-1}	–506	–364

(a) Explain the meaning of the term *electron affinity*.

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(2)

(b) Explain why the electronegativity of fluorine is greater than the electronegativity of chlorine.

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(Extra space) ....

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(2)

(c) Explain why the hydration enthalpy of the fluoride ion is more negative than the hydration enthalpy of the chloride ion.

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(2)

(d) The enthalpy of solution for silver fluoride in water is -20 kJ mol^{-1}.

The hydration enthalpy for silver ions is -464 kJ mol^{-1}.

(i) Use these data and data from the table to calculate a value for the lattice enthalpy of dissociation of silver fluoride.

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(3)

(ii) Suggest why the entropy change for dissolving silver fluoride in water has a positive value.

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(1)

(iii) Explain why the dissolving of silver fluoride in water is always a spontaneous process.

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(2)
(Total 12 marks)