

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

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(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)

(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

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

Calculate the enthalpy of solution for potassium bromide.

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

- (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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- (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 $4.18 \text{ J K}^{-1} \text{ g}^{-1}$.

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(Total 13 marks)

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

Compound	MgCl ₂	CaCl ₂	MgO
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Lattice dissociation enthalpy / kJ mol ⁻¹	2493	2237	3889
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- (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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- (b) Explain why the lattice dissociation enthalpy of magnesium chloride is greater than that of calcium chloride.

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

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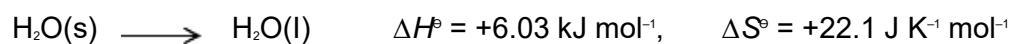
(f) Suggest why a value for the enthalpy of solution of magnesium oxide is **not** found in any data books.

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(Total 11 marks)

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



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

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(b) Use your knowledge of bonding to explain why ΔH^\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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(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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(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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(b) Explain why the electronegativity of fluorine is greater than the electronegativity of chlorine.

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

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

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(Total 12 marks)