Chapter 19: Lattice energy

Homework questions

1 **a** The isotopic abundances of sulfur are shown in the table below:

	Isotopes			
Relative atomic mass	32	33	34	36
Relative abundance / %	95	0.76	4.22	0.01

i Define the term 'relative atomic mass'. [3]

ii Calculate the relative atomic mass of sulfur to 1 decimal place. [2]

iii State the names and numbers of the subatomic particles present in the isotope of sulfur ^{34}S. [2]

b Calcium and sulfur react to form the ionic compound calcium sulfide. Draw a dot-and-cross diagram, including outer electrons only, to show the bonding in calcium sulfide. [3]

The lattice energy of calcium sulfide can be calculated using the enthalpy values given below.

	Enthalpy / kJ mol^{-1}
Enthalpy of atomisation of calcium	+176.6
Enthalpy of atomisation of sulfur	+238.1
First and second ionisation energy of calcium	+1690
First and second electron affinities of sulfur	+485
Standard enthalpy of formation of calcium sulfide	–482

c Write the equations that represent the following processes:

i the enthalpy of atomisation of sulfur [1]

ii the second electron affinity of sulfur. [1]

d Explain why the first electron affinity of sulfur is exothermic whilst the second is endothermic. [3]

e Draw a Born–Haber cycle showing these changes and the lattice energy. [4]

f Calculate the lattice energy for calcium sulfide. [2]

g Write the balanced symbol equation for the combustion of 1 mol of calcium sulfide. [1]

h Using the enthalpy changes of formation listed in the table below, calculate the enthalpy change for the combustion of 1 mol of calcium sulfide. [2]

Substance	CaS	SO_2	CaO
Standard enthalpy of formation / kJ mol^{-1}	–482.4	–296.8	–635.1

Total = 24

2 Iodine is an element from Group 17 of the Periodic Table.

a Iodine is found in seaweed and is extracted when an acidified solution of seaweed extract is treated with hydrogen peroxide.

i Complete the equation below:

$$\_\_H^+(aq) + \_\_I^-(aq) + \_\_H_2O_2(aq) \rightarrow \_\_I_2(aq) + \_\_H_2O$$ [1]

ii Explain why this is a redox reaction. [3]

b Calcium iodide is a soluble ionic compound.

i Use the enthalpy values in the table below to calculate the standard enthalpy of solution of calcium iodide. Draw a Hess's cycle to help explain your answer and give the answer to 3 significant figures. [5]

	Enthalpy change / kJ mol^{-1}
Lattice energy	–2038
Standard enthalpy of hydration of calcium ion	–1561.5
Standard enthalpy of hydration of iodide ion	–306.7

ii Draw diagrams to show the how the water molecules arrange themselves around the calcium and iodide ions. [3]

iii Solid magnesium salts contain more water of crystallisation than calcium salts. Explain why. [3]

c Explain why the compound BeI_2 has a great deal more covalent character than calcium iodide. [3]

d Explain how the iodide ion could be identified in a solution of calcium iodide. [3]

e Iodine is much more soluble in cyclohexane than it is in water.

i What colour is the solution of iodine in cyclohexane? [1]

ii Explain why it is more soluble in cyclohexane than in water. [3]

Total = 25

3 Barium sulfate is very insoluble in water. It is produced when sulfuric acid is titrated against barium hydroxide. The indicator used for the titration is phenolphthalein.

$Ba(OH)_2(aq) + H_2SO_4(aq) \rightarrow BaSO_4(s) + 2H_2O(l)$

a Explain the following observations:

i the conductivity of the mixture decreases as the sulfuric acid is added [2]

ii the conductivity is at a minimum when the end-point of the titration is reached and the indicator changes colour [2]

iii if more sulfuric acid is added the conductivity increases again. [2]

b Barium hydroxide is formed when water is added to barium oxide.

i Give the ionic equation for the reaction of water with the oxide ion. [1]

ii Explain why the lattice energy for barium oxide is less negative than that for magnesium oxide. [3]

c The standard enthalpy of solution of barium chloride is −83 kJ mol^{-1} whilst the value for magnesium chloride is −171 kJ mol^{-1}. Explain this difference. [3]

Total = 13