

# 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  $^{34}\text{S}$ . [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 / $\text{kJ mol}^{-1}$
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	$\text{SO}_2$	CaO
Standard enthalpy of formation / $\text{kJ mol}^{-1}$	-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:  
 $\underline{\quad}\text{H}^+(\text{aq}) + \underline{\quad}\text{I}^-(\text{aq}) + \underline{\quad}\text{H}_2\text{O}_2(\text{aq}) \rightarrow \underline{\quad}\text{I}_2(\text{aq}) + \underline{\quad}\text{H}_2\text{O}$  [1]  
 ii Explain why this is a redox reaction. [3]

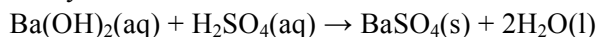
- b** Calcium iodide is a soluble ionic compound.
- i** Use the enthalpy values in the table below to calculate the standard enthalpy of solution of calcium iodide. Draw a Hess's cycle to help explain your answer and give the answer to 3 significant figures. [5]

	Enthalpy change / $\text{kJ mol}^{-1}$
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  $\text{BeI}_2$  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.



- 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  $-83 \text{ kJ mol}^{-1}$  whilst the value for magnesium chloride is  $-171 \text{ kJ mol}^{-1}$ . Explain this difference. [3]

Total = 13