Chapter 19: Lattice energy

Homework marking scheme

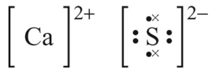
1 **a** **i** Relative atomic mass is the weighted mean average mass of an atom [1]
relative to 1/12th [1]
the mass of a ^{12}C atom. [1]

ii weighted mean average = $\frac{32 \times 95 + 33 \times 0.76 + 34 \times 4.22 + 36 \times 0.01}{100}$ [1]

= 32.1 [1]

iii The ^{34}S atom contains 16 protons, 16 electrons [1]
and 18 neutrons. [1]

b



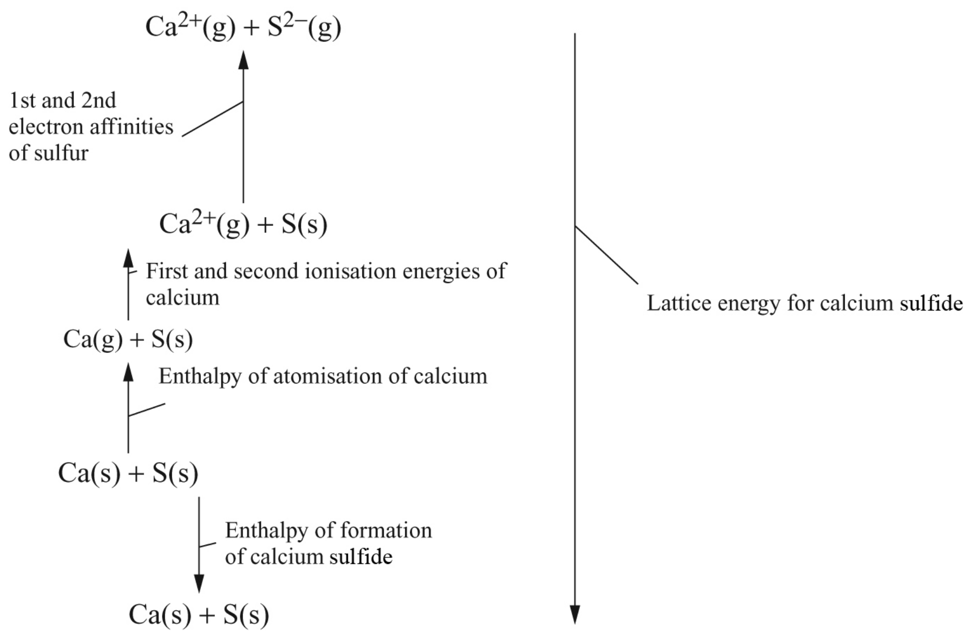
correctly labelled calcium ion with either no electrons or eight electrons [1]
correctly labelled sulfide ion with eight electrons in its outer shell [1]
two of the eight electrons in the sulfide ion need to be different to the other six. [1]

c **i** S(s) → S(g) (note that the state symbols are essential here). [1]

ii $S^-(g) + e^- \rightarrow S^{2-}(g)$ (note that the state symbols are essential here). [1]

d In the first electron affinity the electron is being accepted by a neutral atom. [1]
In the second electron affinity the electron is being accepted by a negative ion and is therefore repelled. [1]
Therefore, energy is required for the negative ion to accept the second electron and so this is an endothermic change. [1]

e



correct labelling of ionisation energies [1]
correct labelling of electron affinities and enthalpies of atomisation [1]
correct labelling of the lattice energy and enthalpy of formation [1]
all the arrows in the correct directions [1]

f Lattice energy = −482 − 176.6 − 238.1 − 590 − 110 + 199.5 − 684.5 [1]
= −2082 kJ mol^{-1} [1]

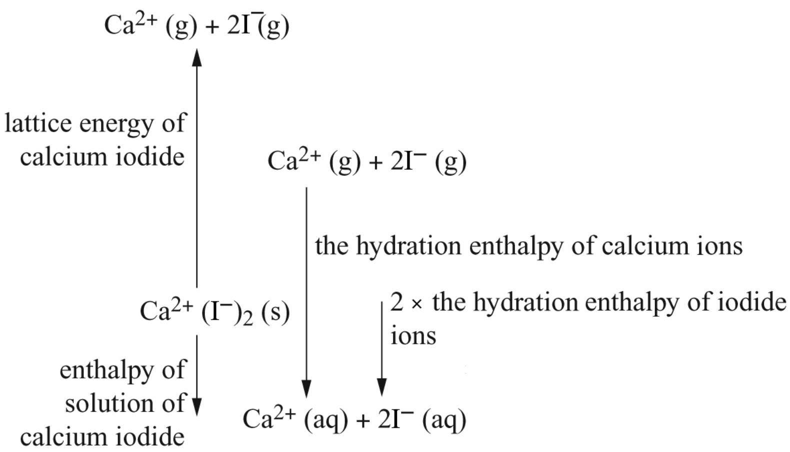
g $CaS(s) + 1½O_2(g) \rightarrow CaO(s) + SO_2(g)$ [1]

h enthalpy change of reaction = ΔH_f(products) − ΔH_f(reactants)
= −635.1 + (−296.8) − (−482.4) [1]
= −449.5 kJ mol^{-1} [1]

2 **a** **i** $2H^+ + 2I^- + H_2O_2 \rightarrow I_2 + 2H_2O$ [1]

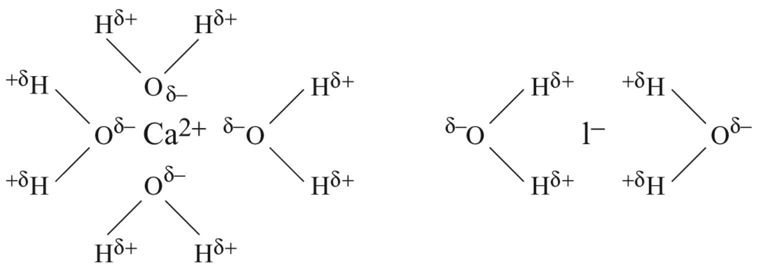
ii The oxidation number of the oxygen in hydrogen peroxide decreases from −1 to −2 and is therefore reduced. [1]
The oxidation number of the iodine in the iodide iron is −1
this increases to 0 and is therefore oxidised. [1]
This is, therefore, a redox reaction. [1]

b **i**



correct labelling of enthalpy of solution and lattice energy [1]
correct labelling of hydration enthalpy of iodide ions and hydration enthalpy of calcium ions [1]
calculation of enthalpy of solution = +2038 − 1561.5 − 613.4 [1]
= −137 kJ mol^{-1} [2]
lose 1 mark if not stated to 3 significant figures.

ii



correct orientation of water molecules around Ca^{2+} [1]
correct orientation of water molecules around I^- [1]
correct dipoles on the water molecules. [1]

iii The magnesium iron is smaller than the calcium ion [1]
therefore, the charge density on the positive ion is greater [1]
therefore, greater attraction for the dipoles on the water molecules and greater hydration. [1]

c The beryllium iron has a very high charge density [1]
the iodide ion is large and polarisable. [1]
The outer electrons of the iodide ions are pulled towards the beryllium ion so the electrons are shared, forming a covalent bond. [1]

d Add aqueous silver nitrate solution [1]
yellow precipitate is formed. [1]
The yellow precipitate is insoluble in ammonia solution. [1]

e **i** purple [1]

ii Iodine is an nonpolar molecule and is therefore more soluble in nonpolar solvents than polar solvents. [1]
Cyclohexane is a nonpolar solvent [1]
and water is a polar solvent. [1]

3 **a** **i** The products are not composed of free ions [1]
therefore, fewer ions to carry the current and the conductivity decreases. [1]

ii The conductivity of the solution depends on how many free ions are available for conducting the current. [1]
Water hardly ionises at all or gives very few ions and barium sulfate is very insoluble therefore, there are no free ions. [1]

iii Sulfuric acid contains hydrogen ions and sulfate ions. [1]
If excess sulfuric acid is added then more ions are added to the solution. [1]

b **i** $H_2O + O^{2-} \rightarrow 2OH^-$ [1]

ii The magnesium ion is smaller than the barium ion and therefore has a greater charge density [1]
therefore, its attraction for the oxide ion is greater [1]
and the lattice energy is more exothermic and therefore more negative. [1]

c The magnesium ion is smaller than the barium ion and therefore has a greater charge density. [1]
Even though more energy would be required to convert the solid into gaseous ions [1]
the hydration enthalpy of the magnesium ion would be sufficiently more negative to make its enthalpy of solution more negative. [1]