

1 (a) Solutions of Group 2 hydrogencarbonates,  $M(\text{HCO}_3)_2$ , decompose on heating to give the corresponding metal carbonate, carbon dioxide and water.

(i) Write an equation for the decomposition of strontium hydrogencarbonate,  $\text{Sr}(\text{HCO}_3)_2$ .  
 ..... [1]

(ii) The thermal stability of Group 2 carbonates increases down the group.  
 Explain this trend.  
 .....  
 .....  
 .....  
 ..... [2]

(b) The hydroxides and fluorides of Group 2 elements show similar trends in solubility.  
 Describe the trend in the solubility of the fluorides of calcium, strontium and barium.  
 Explain your answer.  
 .....  
 least soluble ..... most soluble  
 explanation .....  
 .....  
 .....  
 .....  
 ..... [4]

(c) (i) Define enthalpy change of hydration,  $\Delta H_{\text{hyd}}$ .  
 .....  
 ..... [1]

(ii) State the main factors that affect the magnitude of enthalpy change of hydration.  
 Explain your answer.  
 .....  
 .....  
 ..... [2]

(d) Table 1.1 shows various energy changes.

**Table 1.1**

| energy change   | value / $\text{kJ mol}^{-1}$ |
|---|------------------------------|
| lattice energy of $\text{MgF}_2$  | -2957                        |
| enthalpy change of hydration, $\Delta H_{\text{hyd}}$ , of $\text{Mg}^{2+}$ | -1926                        |
| enthalpy change of hydration, $\Delta H_{\text{hyd}}$ , of $\text{F}^-$     | -505                         |

Use data from Table 1.1 to calculate the enthalpy change of solution,  $\Delta H_{\text{sol}}$ , for  $\text{MgF}_2(\text{s})$ .  
 It may be helpful to draw a labelled energy cycle. Show your working.

$\Delta H_{\text{sol}}$  of  $\text{MgF}_2(\text{s}) = \dots\dots\dots \text{kJ mol}^{-1}$  [2]

(e) Mercury(I) fluoride,  $\text{Hg}_2\text{F}_2$ , is sparingly soluble in water.  
 The cation in  $\text{Hg}_2\text{F}_2$  exists as the diatomic ion  $\text{Hg}_2^{2+}$  with a covalent Hg–Hg bond.  
 (i) Write the expression for the solubility product,  $K_{\text{sp}}$ , of  $\text{Hg}_2\text{F}_2$ . Include the units.  
 $K_{\text{sp}} =$  .....  
 units ..... [2]

(ii) The solubility of  $\text{Hg}_2\text{F}_2$  is  $9.20 \times 10^{-3} \text{ mol dm}^{-3}$  at 298 K.  
 Calculate the value of  $K_{\text{sp}}$  of  $\text{Hg}_2\text{F}_2$  at 298 K.  
 $K_{\text{sp}} = \dots\dots\dots$  [1]