

Test yourself 4C

$$\begin{aligned} 1 \quad \Delta E &= m(\text{water}) \times \Delta T \times s \\ &= 100 \text{ g} \times 18.0 \text{ }^\circ\text{C} \times 4.18 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1} \\ &= 7524 \text{ J or } 7.524 \text{ kJ} \end{aligned}$$

$$\begin{aligned} n(\text{Zn}) &= \frac{m}{M} \\ &= \frac{0.250 \text{ g}}{65.4 \text{ g mol}^{-1}} \\ &= 3.823 \times 10^{-3} \text{ mol} \end{aligned}$$

$$\begin{aligned} \Delta_r H &= \frac{\Delta E}{n} \\ &= \frac{7.524 \text{ kJ}}{3.823 \times 10^{-3} \text{ mol}} \\ &= 1970 \text{ kJ mol}^{-1} \text{ (3 sig fig)} \end{aligned}$$

Since reaction is exothermic, $\Delta_r H = -1970 \text{ kJ mol}^{-1}$

$$\begin{aligned} 2 \text{ a } \Delta_r H^\circ &= [\Delta_f H^\circ(\text{CaO}) + \Delta_f H^\circ(\text{CO}_2)] - [\Delta_f H^\circ(\text{CaCO}_3)] \\ &= [-635.5 - 393] - [-1207] \\ &= +178.5 \text{ kJ mol}^{-1} \end{aligned}$$

$$\begin{aligned} \text{b } \Delta_r H^\circ &= [6 \times \Delta_f H^\circ(\text{H}_2\text{O}) + 4 \times \Delta_f H^\circ(\text{NO})] - [4 \times \Delta_f H^\circ(\text{NH}_3) + 5 \times \Delta_f H^\circ(\text{O}_2)] \\ &= [(6 \times -241.8) + (4 \times 90.25)] - [(4 \times -46.11) + (5 \times 0)] \\ &= -905.4 \text{ kJ mol}^{-1} \end{aligned}$$

- 3 a The amount of CuSO_4 is known because the final solution is colourless, indicating that all the Cu^{2+} has reacted. (OR because the unreacted zinc remaining shows that zinc was in excess.)

$$\begin{aligned}
 \text{b } n(\text{CuSO}_4) &= cV \\
 &= 0.125 \text{ mol L}^{-1} \times 100.0 \times 10^{-3} \text{ L} \\
 &= 0.0125 \text{ mol} \\
 \Delta T &= T_{\text{final}} - T_{\text{initial}} \\
 &= 20.5 \text{ }^\circ\text{C} - 16.0 \text{ }^\circ\text{C} \\
 &= 4.5 \text{ }^\circ\text{C} \\
 E &= m \times s \times \Delta T \\
 &= 100.0 \text{ g} \times 4.18 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1} \\
 &= 1881 \text{ J} \\
 \Delta H &= \frac{E}{n} \\
 &= \frac{-1881 \text{ J}}{0.0125 \text{ mol}} \\
 &= -150488 \text{ J} \\
 &= -150 \text{ kJ (3 sig. fig)}
 \end{aligned}$$

Test yourself 4D

