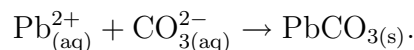


Chemistry 2720 Fall 2005 Quiz 2 Solution

The reaction is



For this reaction,

$$\begin{aligned}\Delta \bar{H}^{\circ} &= \Delta \bar{H}_{f(\text{PbCO}_3)}^{\circ} - \left(\Delta \bar{H}_{f(\text{Pb}^{2+})}^{\circ} + \Delta \bar{H}_{f(\text{CO}_3^{2-})}^{\circ} \right) \\ &= -699.1 - [0.92 + (-675.23)] \text{ kJ/mol} = -24.8 \text{ kJ/mol}.\end{aligned}$$

The lead (II) ion is clearly the limiting reagent: We have a smaller volume of lead acetate solution, and it's less concentrated. The number of moles of lead (II) ion is

$$n_{\text{Pb}^{2+}} = (0.200 \text{ L})(0.04 \text{ mol/L}) = 0.008 \text{ mol}.$$

Since lead carbonate is sparingly soluble, we will get almost exactly this number of moles of lead carbonate. The heat generated by the reaction is therefore

$$q_{\text{rxn}} = (-24.8 \text{ kJ/mol})(0.008 \text{ mol}) = -198 \text{ J}.$$

We have a total of 700 mL of water, so about 700 g. The heat balance is

$$q = 0 = q_{\text{rxn}} + q_{\text{H}_2\text{O}},$$

from which we have, finally,

$$\begin{aligned}q_{\text{H}_2\text{O}} &= m_{\text{H}_2\text{O}} \tilde{C}_{P(\text{H}_2\text{O})} \Delta T = -q_{\text{rxn}}. \\ \therefore \Delta T &= \frac{-q_{\text{rxn}}}{m_{\text{H}_2\text{O}} \tilde{C}_{P(\text{H}_2\text{O})}} = \frac{198 \text{ J}}{(700 \text{ g})(4.184 \text{ J K}^{-1} \text{g}^{-1})} = 0.07 \text{ K}.\end{aligned}$$

The temperature increases, but only by 0.07°C.