Substances differ greatly in their tendencies to form precipitates when mixed in moderate concentrations. The photos in **Figure 13** show the behavior of some anions in the presence of certain cations. Note that some of the combinations have produced precipitates and some have not. The solubility product can be used to predict whether a precipitate forms when two solutions are mixed.

SAMPLE PROBLEM D

Will a precipitate form if 20.0 mL of 0.010 M $BaCl_2$ is mixed with 20.0 mL of 0.0050 M Na_2SO_4?

SOLUTION

1 ANALYZE

Given: concentration of $BaCl_2 = 0.010$ M
volume of $BaCl_2 = 20.0$ mL
concentration of $Na_2SO_4 = 0.0050$ M
volume of $Na_2SO_4 = 20.0$ mL

Unknown: whether a precipitate forms

2 PLAN

The two possible new pairings of ions are NaCl and $BaSO_4$. Of these, $BaSO_4$ is a sparingly soluble salt. It will precipitate if the ion product $[Ba^{2+}][SO_4^{2-}]$ in the combined solution exceeds K_{sp} for $BaSO_4$. From the list of solubility products in **Table 3,** the K_{sp} is found to be 1.1×10^{-10}. The solubility equilibrium equation follows.

$$BaSO_4(s) \rightleftharpoons Ba^{2+}(aq) + SO_4^{2-}(aq)$$

The solubility equilibrium expression is written as follows.

$$K_{sp} = [Ba^{2+}][SO_4^{2-}] = 1.1 \times 10^{-10}$$

First $[Ba^{2+}]$ and $[SO_4^{2-}]$ in the above solution must be found. Then the ion product is calculated and compared with the K_{sp}.

3 COMPUTE

Calculate the mole quantities of Ba^{2+} and SO_4^{2-} ions.

$$0.020 \cancel{L} \times \frac{0.010 \text{ mol } Ba^{2+}}{1 \cancel{L}} = 0.000\,20 \text{ mol } Ba^{2+}$$

$$0.020 \cancel{L} \times \frac{0.0050 \text{ mol } SO_4^{2-}}{1 \cancel{L}} = 0.000\,10 \text{ mol } SO_4^{2-}$$

Calculate the total volume of solution containing Ba^{2+} and SO_4^{2-} ions.

$$0.020 \text{ L} + 0.020 \text{ L} = 0.040 \text{ L}$$

Calculate the Ba^{2+} and SO_4^{2-} ion concentrations in the combined solution.

$$\frac{0.000\,20 \text{ mol } Ba^{2+}}{0.040 \text{ L}} = 5.0 \times 10^{-3} \text{ mol/L } Ba^{2+}$$

$$\frac{0.000\,10 \text{ mol } SO_4^{2-}}{0.040 \text{ L}} = 2.5 \times 10^{-3} \text{ mol/L } SO_4^{2-}$$