

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 BaCl₂ is mixed with 20.0 mL of 0.0050 M Na₂SO₄?

SOLUTION

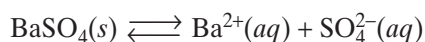
1 ANALYZE

Given: concentration of BaCl₂ = 0.010 M
 volume of BaCl₂ = 20.0 mL
 concentration of Na₂SO₄ = 0.0050 M
 volume of Na₂SO₄ = 20.0 mL

Unknown: whether a precipitate forms

2 PLAN

The two possible new pairings of ions are NaCl and BaSO₄. Of these, BaSO₄ is a sparingly soluble salt. It will precipitate if the ion product [Ba²⁺][SO₄²⁻] in the combined solution exceeds K_{sp} for BaSO₄. 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.



The solubility equilibrium expression is written as follows.

$$K_{sp} = [\text{Ba}^{2+}][\text{SO}_4^{2-}] = 1.1 \times 10^{-10}$$

First [Ba²⁺] and [SO₄²⁻] 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 Ba²⁺ and SO₄²⁻ ions.

$$0.020 \text{ L} \times \frac{0.010 \text{ mol Ba}^{2+}}{1 \text{ L}} = 0.00020 \text{ mol Ba}^{2+}$$

$$0.020 \text{ L} \times \frac{0.0050 \text{ mol SO}_4^{2-}}{1 \text{ L}} = 0.00010 \text{ mol SO}_4^{2-}$$

Calculate the total volume of solution containing Ba²⁺ and SO₄²⁻ ions.

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

Calculate the Ba²⁺ and SO₄²⁻ ion concentrations in the combined solution.

$$\frac{0.00020 \text{ mol Ba}^{2+}}{0.040 \text{ L}} = 5.0 \times 10^{-3} \text{ mol/L Ba}^{2+}$$

$$\frac{0.00010 \text{ mol SO}_4^{2-}}{0.040 \text{ L}} = 2.5 \times 10^{-3} \text{ mol/L SO}_4^{2-}$$