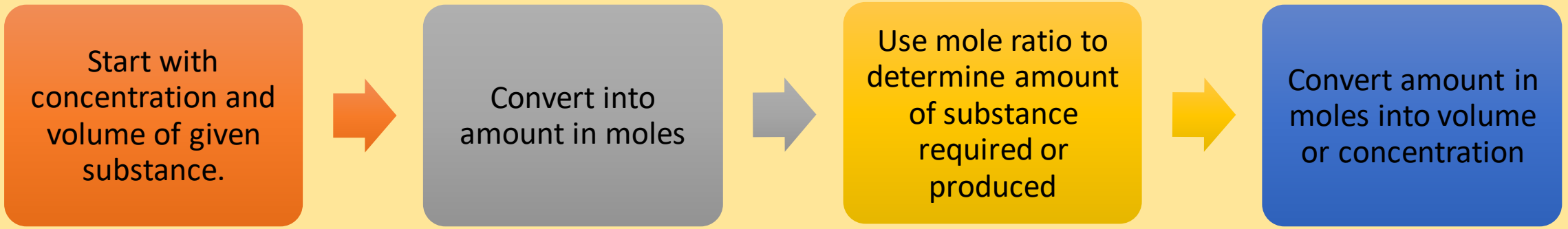
Given the following reaction that produces solid barium sulfate and aqueous sodium chloride determine the volume of 0.42 mol/L Na_2SO_4 that is required to react completely with all of the barium ions in 500.0 mL of a 0.100 mol/L $BaCl_2$ solution

$BaCl_2$ (aq) + Na_2SO_4 (aq) --> $BaSO_4$ (s) + 2 NaCl (aq)



NOTE: Slides contain audio explanation. Click on the speaker icon to play audio on each slide.

1. List known and unknown values

Known

$c_{Na_2SO_4} = 0.42 v mol/L$; $c_{BaCl_2} = 0.100$ mol/L; $V_{BaCl_2} = 500.0$ mL

Unknown

$V_{Na_2SO_4} = ?$

2. Convert Units to L

Known

$c_{Na_2SO_4} = 0.42vmol/L$; $c_{BaCl_2} = 0.100\ mol/L$; $V_{BaCl_2} = 500.0\ mL$

Unknown

$V_{Na_2SO_4} = ?$

$$\frac{x}{500\ mL} = \frac{1\ L}{1000\ mL}$$

$x = 0.500\ L$

Therefore, the volume of barium chloride solution is 0.500 L

3. Solve for the amount, in moles, of $BaCl_2$ in 0.500 L of 0.100 mol/L solution

$$c = \frac{n}{V}$$

$$n = cV$$

$$n = (0.100\ \text{mol/L})(0.500\ \text{L})$$

$$n = 0.0500\ \text{mol}$$

Therefore, 0.0500 mol of barium chloride are present in 0.500 L of a 0.1 mol/L solution.

4. Use the mole ratio to determine the amount of Na_2SO_4 required to react with 0.0500 mol $BaCl_2$

$$\frac{1\ \text{mol}_{Na_2SO_4}}{1\ \text{mol}_{BaCl_2}} = \frac{x\ \text{mol}_{Na_2SO_4}}{0.0500\ \text{mol}_{BaCl_2}}$$

$$x\ \text{mol}_{Na_2SO_4} = 0.0500\ \text{mol}_{Na_2SO_4}$$

Therefore, 0.0500 mol of Na_2SO_4 are required to react with 0.0500 mol of $BaCl_2$.

5. Determine the volume of 0.42 mol/L Na_2SO_4 solution that contains 0.0500 mol of Na_2SO_4

$$c_{Na_2SO_4} = \frac{n_{Na_2SO_4}}{V_{Na_2SO_4}}$$

$$V_{Na_2SO_4} = \frac{n_{Na_2SO_4}}{c_{Na_2SO_4}}$$

$$V_{Na_2SO_4} = \frac{0.0500\ mol}{0.42\ mol/L} = 0.119 = 0.12\ L$$

Therefore, the minimum volume of 0.42 mol/L Na_2SO_4 solution required to react with 500 mL of 0.100 mol/L $BaCl_2$ solution is 0.12 L