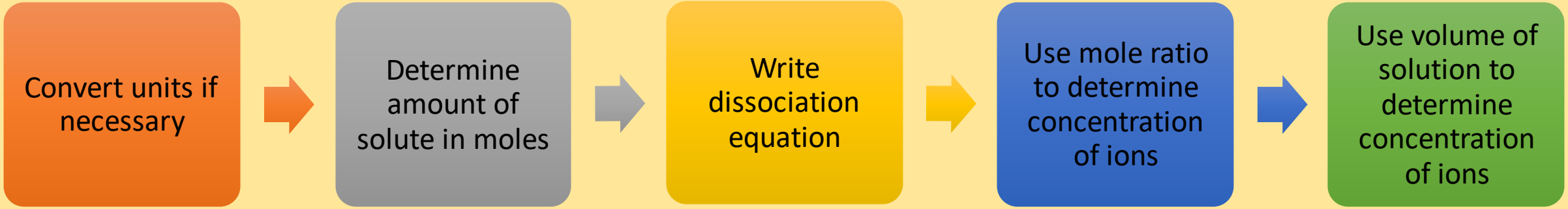
A student creates a solution of barium chloride by dissolving 17.1 g of $BaCl_2$ in 250 mL of water. What are the concentrations of barium and chloride ions in the solution?



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

1. List known and unknown values

Known

$m_{BaCl_2} = 17.1\ g$; $V_{BaCl_2} = 250\ mL$; Molar Mass$_{BaCl_2} = 208.23\ g/mol$

Unknown

$c_{Ba^{2+}} = ?$

$c_{Cl^-} = ?$

Note: Use the periodic table to determine the molar mass of $BaCl_2$

2. Convert Units to L

Known

$m_{BaCl_2} = 17.1\ g$; $V_{BaCl_2} = 250\ mL$; Molar Mass$_{BaCl_2} = 208.23\ g/mol$

Unknown

$c_{Ba^{2+}} = ?$

$c_{Cl^-} = ?$

$$\frac{x}{250\ mL} = \frac{1\ L}{1000\ mL}$$

$x = 0.250\ L$

Therefore, the volume of barium chloride solution is 0.250 L

3. Solve for the amount, in moles, of $BaCl_2$ in 17.1 g.

$$n_{BaCl_2} = \frac{m_{BaCl_2}}{M_{BaCl_2}}$$

$$n_{BaCl_2} = \frac{17.1\ g}{208.23\ g/mol}$$

$$n_{BaCl_2} = 0.0821\ mol$$

Therefore, in 17.1 g of barium chloride there are 0.821 moles.

4. Write the dissociation equation.

$$\mathbf{BaCl_2\ (s) \dashrightarrow Ba^{2+}\ (aq) + 2Cl^-\ (aq)}$$

Therefore, 1 mol of barium chloride dissociates into 1 mol of Ba^{2+} ions and 2 moles of Cl^- ions.

5. Use the mole ratio from the dissociation equation to determine the amount of Ba^{2+} ions and Cl^- ions in solution.

$BaCl_2$ (s) --> Ba^{2+} (aq) + 2Cl^- (aq)

$$\frac{1\ \text{mol}_{Ba^{2+}}}{1\ \text{mol}_{BaCl_2}} = \frac{x\ \text{mol}_{Ba^{2+}}}{0.821\ \text{mol}_{BaCl_2}}$$

$$x\ \text{mol}_{Ba^{2+}} = 0.821\ \text{mol}$$

$$\frac{2\ \text{mol}_{Cl^-}}{1\ \text{mol}_{BaCl_2}} = \frac{x\ \text{mol}_{Cl^-}}{0.821\ \text{mol}_{BaCl_2}}$$

$$x\ \text{mol}_{Cl^-} = 1.64\ \text{mol}$$

Therefore, 0.821 mole of Ba^{2+} ions are in solution and 1.64 moles of Cl^- ions are in solution.

5. Use the volume of solution to determine the concentration of ions in solution.

$$c_{Ba^{2+}} = \frac{n_{Ba^{2+}}}{V_{BaCl_2}}$$

$$c_{Ba^{2+}} = \frac{0.821\ mol}{0.250\ L}$$

$$c_{Ba^{2+}} = 3.28\ mol/L$$

$$c_{Cl^-} = \frac{n_{Cl^-}}{V_{BaCl_2}}$$

$$c_{Cl^-} = \frac{1.64\ mol}{0.250\ L}$$

$$c_{Cl^-} = 6.56\ mol/L$$

Therefore, 17.1 g of barium chloride in 250 mL of water dissociates to produce ion concentrations of 3.28 mol/L of Ba^{2+} and 6.56 mol/L of Cl^-.