Math Tutor CALCULATING SOLUTION CONCENTRATION

You can use the relationship below to calculate the concentration in molarity of any solution.

$$\text{molarity of solution (M)} = \frac{\text{moles of solute (mol)}}{\text{volume of solution (L)}}$$

Suppose you dissolve 20.00 g of NaOH in some water and dilute the solution to a volume of 250.0 mL (0.2500 L). You don't know the molarity of this solution until you know how many moles of NaOH were dissolved. You know that the number of moles of a substance can be found by dividing the mass of the substance by the mass of 1 mol (molar mass) of the substance. The molar mass of NaOH is 40.00, so the number of moles of NaOH dissolved is

$$20.00 \text{ g NaOH} \times \frac{1 \text{ mol NaOH}}{40.00 \text{ g NaOH}} = 0.5000 \text{ mol NaOH}$$

Now you know that the solution has 0.5000 mol NaOH dissolved in 0.2500 L of solution, so you can calculate molarity.

$$\text{molarity of NaOH} \times \frac{\text{mol NaOH}}{\text{L solution}} = \frac{0.5000 \text{ mol NaOH}}{0.2500 \text{ L solution}} = 2.000 \text{ mol/L} = 2.000 \text{ M NaOH}$$

Problem-Solving TIPS

- Remember that balances measure mass, not moles, so you often have to convert between mass and moles of solute when making or using solutions.

SAMPLE

A 0.5000 L volume of a solution contains 36.49 g of magnesium chloride, $MgCl_2$. What is the molarity of the solution?

You know the volume of the solution, but you need to find the number of moles of the solute $MgCl_2$ by the following conversion.

$$\text{mass } MgCl_2 \times \frac{1 \text{ mol } MgCl_2}{\text{molar mass } MgCl_2} = \text{mol } MgCl_2$$

$$36.49 \text{ g } MgCl_2 \times \frac{1 \text{ mol } MgCl_2}{95.20 \text{ g } MgCl_2} = 0.3833 \text{ mol } MgCl_2$$

Now you can calculate mol $MgCl_2$ per liter of solution (molarity).

$$\frac{0.3833 \text{ mol } MgCl_2}{0.5000 \text{ L solution}} = 0.7666 \text{ M } MgCl_2$$

PRACTICE PROBLEMS

1. What is the molarity of a solution that contains 0.0350 mol of sodium sulfate, Na_2SO_4, dissolved in 50.0 mL of solution?

2. What is the molarity of a solution that contains 45.00 g of cadmium nitrate, $Cd(NO_3)_2$, dissolved in 400.0 mL of solution?