

Chemistry Lecture #76: Solutions, Percent by Mass and Volume

A solution is a homogeneous mixture of two or more substances. Water is often mixed with other substances to make a solution. Most of the time, smaller amounts of substances are dissolved into larger amounts of water. In this circumstance, water is the solvent, and the substance dissolved into water is the solute. The solvent is usually the substance in greater quantity, and the solute is the substance in lesser quantity.

A solution can be described as dilute or concentrated. A dilute solution has a relatively small amount of solute dissolved into it. A concentrated solution has a relatively large amount of solute dissolved into it. For example, a cup of coffee with one teaspoon of sugar is relatively more dilute than a cup of coffee with eight teaspoons of sugar dissolved into it.

One way to describe the concentration of a solution made of two liquids is percent by volume. This tells the volume of solute in 100 mL of the total of solution. For example, rubbing alcohol sold in stores often has a concentration of 70% percent isopropyl alcohol. This means that if you had 100 mL of the solution, 70 mL of it would be isopropyl alcohol.



Mathematically, percent by volume is

$$\text{Percent by volume} = \frac{\text{volume of solute}}{\text{volume of solution}} \times 100\%$$

A volume of 80.0 mL of ethanol is diluted to a volume of 250 mL with water. Find the percent by volume.

Volume of solute = 80.0 mL

Volume of solution = 250 mL percent by volume = ?

$$\text{Percent by volume} = \frac{\text{volume of solute}}{\text{volume of solution}} \times 100\%$$

$$\text{Percent by volume} = \frac{80.0 \text{ mL}}{250 \text{ mL}} \times 100\%$$

$$\text{Percent by volume} = 32\% \text{ (v/v)}$$

This means that if you had 100 mL of the solution, 32 mL of it would be ethanol.

If a solid is dissolved into a liquid, the concentration is measured in percent by mass. To calculate percent by mass, you need the mass of the solute (measured in grams) and the total mass of the solution.

$$\text{Percent by mass} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 100\%$$

Find the percent by mass if 7.00 g of NaCl is dissolved in a solution whose total mass is 80.0 g.

$$\text{Mass of solute} = 7.00 \text{ g}$$

$$\text{Mass of solution} = 80.0 \text{ g} \quad \text{percent by mass} = ?$$

$$\text{Percent by mass} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 100\%$$

$$\text{Percent by mass} = \frac{7.00 \text{ g}}{80.0 \text{ g}} \times 100\%$$

$$\text{Percent by mass} = 8.75\% \text{ (m/m)}$$

This means that if you had 100 g of solution, it would contain 8.75 g of NaCl

Suppose you want to make 2.000×10^3 g of a glucose solution that is 2.80% m/m. How much glucose do you need?

Mass of solute (glucose) = ? We'll substitute the letter "m"

Mass of solution = 2.000×10^3 g

Percent by mass = 2.80% (m/m)

$$\text{Percent by mass} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 100\%$$

$$2.80\% = \frac{m}{2.000 \times 10^3 \text{ g}} \times 100\%$$

$$m = 56.0 \text{ g of glucose}$$