

21.2 Calculating Concentration of Solutions

READ



What's the difference between regular and extra-strength cough syrup? Is the rubbing alcohol in your parents' medicine cabinet 70% isopropyl alcohol, or is it 90% isopropyl alcohol? The differences in these and many other pharmaceuticals is dependent upon the concentration of the solution. Chemists, pharmacists, and consumers often find it necessary to distinguish between different concentrations of solutions. Concentration is commonly expressed as of solute per mass of solution, known as *mass percent*.

$$\text{Mass percent} = \frac{\text{Mass of solute}}{\text{Total mass of solution}} \times 100$$

Remember that a solution is defined as a mixture of two or more substances that is homogenous at the molecular level. The solvent is the substance that is present in the greatest amount. All other substances in the solution are known as solutes.

EXAMPLES



- What is the mass percent concentration of a solution made up of 12 grams of sugar and 300. grams of water?

Solution:

In this case, the solute is sugar (12 g), and the total mass of the solution is the mass of the sugar plus the mass of the water, (12 g + 300. g).

Substituting into the formula, where c = the percent concentration, we have:

$$c = \frac{12 \text{ g}}{12 \text{ g} + 300 \text{ g}} \times 100 = \frac{12 \text{ g}}{312 \text{ g}} \times 100 = 3.8\%$$

The concentration of a solution of 12 grams of sugar and 300. grams of water is 3.8%.

- How many grams of salt and water are needed to make 150 grams of a solution with a concentration of 15% salt?

Solution:

Here, we are given the concentration (15%) and the total mass of the solution (150 g). We are trying to find the mass of the solute (salt). Substituting into the same formula, where m is the mass of the salt, we have:

$$15\% = \frac{m}{150 \text{ g}} \times 100, \text{ so } 0.15 = \frac{m}{150 \text{ g}}, \text{ and } 0.15 \times (150 \text{ g}) = m = 22.5 \text{ g}$$

Since the total mass of the solution is 150 grams, and we now know that 22.5 grams are salt, that leaves:

$$150 \text{ grams solution} - 22.5 \text{ grams salt} = 127.5 \text{ grams of water}$$

To make 150 grams of a solution with a concentration of 15% salt, you would need 22.5 grams of salt and 127.5 grams of water.



PRACTICE



Find the mass percent concentration of each solution or mixture.

1. 5 grams of salt in 75 grams of water
2. 40 grams of cinnamon in 2,000 grams of flour
3. 1.5 grams of chocolate milk mix in 250 grams of 1% milk

Find the mass of the solute in each situation.

4. 1,000 grams of a 40% salt water solution
5. 30 grams of a 12.5% sugar water solution
6. 555 grams of a 25% sand and soil “solution”

Carefully read and answer each of the following questions.

7. Dawn is mixing 450 grams of dishwashing liquid with 600 grams of water to make a solution for her little brother to blow bubbles. What is the concentration of the dishwashing liquid?
8. How many grams of glucose are needed to prepare 250 grams of a 5% glucose and water solution?
9. Jill mixes 4 grams of vanilla extract into the 800 grams of cake batter she has prepared. What is the concentration of vanilla in her “solution” of cake batter?
10. **Challenge:** Find the amount of red food coloring (in grams) necessary to add to 50 grams of water to prepare a 15% solution of red food coloring in water.