Sections 2.4 (Atoms-First) and 8.4 (Chemistry-First) Percentage and Percentage Calculations

An Introduction to Chemistry

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Conversion Factors from Percentages and Percentage Calculations

- *Percentage by mass* is a value that tells us the number of mass units of the part for each 100 mass units of the whole.
- For example, our bodies contain about 8.0% by mass of blood. The part is blood, and the whole is body.
- The 8.0% by mass of blood tells us that that for every 100 kilograms of body, there are 8.0 kilograms of blood, or for every 100 pounds of body, there are 8.0 pounds of blood.
- In chemistry, it is common to assume that any percentage is a percentage by mass unless you are specifically told otherwise.

Conversion Factors from Percentages and Percentage Calculations

- For the conversion factors derived from percentages, we can use any mass units we want in the ratio as long as the units are the same for the part and for the whole.
- 8.0% by mass of blood in our bodies leads to the following:

$$\frac{8.0\text{ kg blood}}{100\text{ kg body}} \quad \text{or} \quad \frac{8.0\text{ g blood}}{100\text{ g body}} \quad \text{or} \quad \frac{8.0\text{ lb blood}}{100\text{ lb body}} \quad \text{or} \quad \ldots$$

Conversion Factors from Percentage by Volume

- *Percentage by volume* is a value that tells us the number of volume units of the part for each 100 volume units of the whole.
- Thus, when we are told that 3.2% by volume of our blood goes to our brain, this means that for every 100 liters of blood total, 3.2 liters of blood goes to the brain and that for every 100 millliliters of blood total, 3.2 millliliters of blood goes to the brain.

Conversion Factors from Percentage by Volume

- For the conversion factors derived from percentages by volume, we can use any volume units we want in the ratio as long as the units are the same for the part and for the whole.
- 3.2% blood to our brain leads to

$$\frac{3.2\text{ L blood to brain}}{100\text{ L blood total}} \quad \text{or} \quad \frac{3.2\text{ mL blood to brain}}{100\text{ mL blood total}} \quad \text{or}$$

$$\frac{3.2\text{ qt blood to brain}}{100\text{ qt blood total}} \quad \text{or} \quad \ldots$$

Conversion Factors from Percentages and Percentage Calculations

- Mass percentages and volume percentage can be used as unit analysis conversion factors to convert between units of the part and units of the whole.

For X% by mass

$$\frac{\text{X (any mass unit) part}}{\text{100 (same mass unit) whole}}$$

For X% by volume

$$\frac{\text{X (any volume unit) part}}{\text{100 (same volume unit) whole}}$$

Example 2.11 and 8.11: Your body is about 8.0% blood. If you weigh 145 pounds, what is the mass of your blood in kilograms?

- It's a good strategy to write down the values you are given, separating them from the words. We are given two things, 8.0% blood and 145 lb.
  - It's important to recognize that the percentage provides a ratio of two units. Because both *kg* and *lb* are mentioned in the problem, we could use either of the following conversion factors.

$$\frac{8.0\text{ lb blood}}{100\text{ lb body}} \quad \text{or} \quad \frac{8.0\text{ kg blood}}{100\text{ kg body}}$$

  - Because we see from the ratios above that two different things are mentioned, blood and body, it is important to identify the 145 lb as **145 lb body**.

Example 2.11 and 8.11: Your body is about 8.0% blood. If you weigh 145 pounds, what is the mass of your blood in kilograms?

- We want kg blood, which has a single unit, so we set it equal to the value given with a single unit. (Remember that the percentage hides a ratio of two units.)
- Next, we write the skeleton of the first conversion factor.

$$? \text{ kg blood} = 145 \text{ lb body} \left(\frac{}{\text{lb body}} \right)$$

Example 2.11 and 8.11: Your body is about 8.0% blood. If you weigh 145 pounds, what is the mass of your blood in kilograms?

- We can either use the first conversion factor below to convert from pounds of body to pounds of blood or we can first convert pounds to kilograms and then use the second conversion factor below to convert to kilograms of blood. .

$$\frac{8.0\ \text{lb blood}}{100\ \text{lb body}} \quad \text{or} \quad \frac{8.0\ \text{kg blood}}{100\ \text{kg body}}$$

$$?\ \text{kg blood} = 145\ \cancel{\text{lb body}} \left(\frac{8.0\ \cancel{\text{lb}}\ \text{blood}}{100\ \cancel{\text{lb body}}}\right)\left(\frac{453.6\ \cancel{\text{g}}}{1\ \cancel{\text{lb}}}\right)\left(\frac{1\ \text{kg}}{10^3\ \cancel{\text{g}}}\right) = 5.3\ \text{kg blood}$$

$$?\ \text{kg blood} = 145\ \cancel{\text{lb}}\ \text{body} \left(\frac{453.6\ \cancel{\text{g}}}{1\ \cancel{\text{lb}}}\right)\left(\frac{1\ \cancel{\text{kg}}}{10^3\ \cancel{\text{g}}}\right)\left(\frac{8.0\ \text{kg blood}}{100\ \cancel{\text{kg body}}}\right) = 5.3\ \text{kg blood}$$

Practice

- You can get some practice using percentages as conversion factors by working Exercise 2.9 (8.9) and end-of-chapter problems 68-73.