

Lesson 3: Proportional relationships and unit conversions

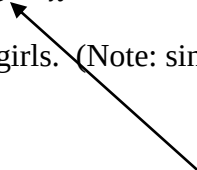
Proportions compare two ratios that are equal. A ratio compares two or more things.

e.g., $\frac{\text{Boys}}{\text{Girls}} = \frac{2}{3}$ Read “2 boys to 3 girls”

Q: What if there were 4 boys and the ratio above were still true?

A: $\frac{\text{Boys}}{\text{Girls}} = \frac{2}{3} = \frac{4}{x}$ Rule for solving: “multiply the pair and divide the spare”

X = 6 girls. (Note: since x is a denominator, we are solving for the number of girls)



Orally: The ratio that we are given to solve problems, like the one above, is referred to as a conversion factor.

The conversion factor is the ratio that is always true for a specific set of conditions (i.e., temperature, etc) and can be used to convert one unit into another unit.

e.g., Density: - compares the unit of mass to volume. If the density of ethanol is 1.05 g/mL (i.e., the conversion factor), then what volume would 3.00g of ethanol represent?

Step #1: Write your conversion factor in the form of a fraction (i.e., the ratio)

$$\frac{\text{mass}}{\text{volume}} = \frac{1.05 \text{ g}}{1.0 \text{ mL}} \quad \text{recall that “per millilitre” means 1.0 mL.}$$

Step #2: Write a proportion (i.e., two equivalent ratios). Plug – in what you know and solve for what you don’t.

$$\frac{\text{mass}}{\text{volume}} = \frac{1.05 \text{ g}}{1.0 \text{ mL}} = \frac{3.00 \text{ g}}{x} \quad x = 2.857 \text{ mL}$$

Since x is in the denominator (i.e., volume), the unit solved for must be mL.

e.g., Light travels at $3.0 \times 10^8 \text{ m/s}$. How far does light travel in 1min?

$$\frac{\text{distance}}{\text{time}} = \frac{3.0 \times 10^8 \text{ m}}{1.0 \text{ s}} = \frac{x}{60 \text{ s}} \quad \text{(Note: We may not substitute minutes into the ratio because the units must be identical)}$$

X = $1.8 \times 10^{10} \text{ m}$ Since x represents a distance, the units must be in metres.

e.g., Light travels at $3.0 \times 10^8 \text{ m/s}$. How far does light travel in 2 h?

Question: How many minutes in an hour?

Answer: 60min. Therefore the conversion factor is:

$$\frac{\text{Minutes}}{\text{Hours}} \frac{60 \text{ min}}{1 \text{ h}} = \frac{x}{2 \text{ h}} \quad \mathbf{x = 120 \text{ min.}}$$

Question: How many seconds in a minute?

Answer: 60s. Therefore the conversion factor is:

$$\frac{\text{Seconds}}{\text{Minutes}} \frac{60 \text{ s}}{1 \text{ min}} = \frac{x}{120 \text{ min}} \quad \mathbf{x = 7200 \text{ s}} \quad \text{(This is the number of seconds in 2 h)}$$

Recall the conversion factor for the speed of light: $3.0 \times 10^8 \text{ m/s}$

$$\text{Therefore: } \frac{\text{distance}}{\text{time}} = \frac{3.0 \times 10^8 \text{ m}}{1.0 \text{ s}} = \frac{x}{7200 \text{ s}} \quad \mathbf{x = 2.16 \times 10^{12} \text{ m}}$$

Q: What if the question wanted to know the number of kilometers in 2h?

A: Simply take your answer in metres and convert into kilometers. **i.e., $2.16 \times 10^9 \text{ km}$**

Allow students to try this one on their own.

e.g., Using the conversion factor for the speed of light, determine how far light travels in 4 years.

$$\frac{\text{Days}}{\text{years}} = \frac{365 \text{ days}}{1.0 \text{ year}} = \frac{x}{4 \text{ years}} \quad x = 1460 \text{ days}$$

$$\frac{\text{Hours}}{\text{Days}} = \frac{24 \text{ h}}{1.0 \text{ day}} = \frac{x}{1460 \text{ days}} \quad x = 35040 \text{ h}$$

$$\frac{\text{Minutes}}{\text{Hour}} = \frac{60 \text{ min}}{1.0 \text{ h}} = \frac{x}{35040 \text{ h}} \quad x = 2102400 \text{ min}$$

$$\frac{\text{Seconds}}{\text{Minutes}} = \frac{60 \text{ s}}{1.0 \text{ min}} = \frac{x}{2102400 \text{ min}} \quad x = 126144000 \text{ s}$$

$$\text{Therefore: } \frac{\text{distance}}{\text{time}} = \frac{3.0 \times 10^8 \text{ m}}{1.0 \text{ s}} = \frac{x}{126144000 \text{ s}} \quad x = 3.784 \times 10^{16} \text{ m}$$

e.g., There are 32.0 g/mol in oxygen gas. If you have 5.5 mol of oxygen, how many milligrams of oxygen do you have?

Orally: Understanding what a mol is, is not a requirement of being able to solve the math. We will discuss this unit in great detail later in the course.

$$\frac{\text{Mass}}{\text{Moles}} = \frac{32.0 \text{ g}}{1.0 \text{ mol}} = \frac{x}{5.5 \text{ mol}} \quad x = 176 \text{ g} = 176\,000 \text{ mg.}$$

Assignment: Page 14 from Hebden workbook Q #2 (all parts)