How to Solve Problems Using Dimensional Analysis

Dimensional analysis is a process that uses conversions to solve problems. There are several points to remember when solving problems using this method:

1. The conversion ratios must equal one, and can be written with either value on top:

   Example: \( \frac{1 \text{ km}}{1000 \text{ m}} = 1 \) or \( \frac{1000 \text{ m}}{1 \text{ km}} = 1 \)

2. Conversions are often written using the word *per*. These can be re-written as ratios:

   Example: \( \frac{1000 \text{ m}}{1 \text{ km}} \)

3. Most important rules to remember:

   **Set up your conversion ratio to cancel out the original unit** and convert to the desired unit. This means if the unit you are converting from is in the numerator, the conversion ratio should be set up with this unit in the denominator. This will cancel out the unit you are converting. Keep doing this until you get to units you want for your answer.

   **Always label units** for each step. This will help ensure you do not make mistakes.

   **Cross out units that have been canceled out** and make sure that your final answer has been correctly converted to the new unit.

4. Solve by multiplying all the numbers in the numerators of the ratios and then dividing by all the numbers in the denominator of the ratios.

   Example: How many miles has a person run if he runs a 5 km race?
   
   Conversion factors: \( 1 \text{ km} = 0.62 \text{ mi} \)
   
   Answer: \( 5 \text{ km} \times \frac{0.62 \text{ mi}}{1 \text{ km}} = 3.1 \text{ mi} \)

   Example: How many kilometers per liter will a car get if it gets 30 mi/gal?
   
   Conversion factors: \( 1 \text{ km} = 0.62 \text{ mi}, 1 \text{ liter} = 0.26 \text{ gallons} \)
   
   Answer: \( \frac{30 \text{ mi}}{\text{ gal}} \times \frac{1 \text{ km}}{0.62 \text{ mi}} \times \frac{0.26 \text{ gal}}{1 \text{ L}} = 12.6 \frac{\text{ km}}{\text{ L}} \)

Continued
More Dimensional Analysis Tips

When starting to solve a dimensional analysis problem, focus on what the units are for the final answer.

Example:
Your car’s average gas mileage is 20 miles/gallon and you drive an average of 15,000 miles/year. How many gallons of gas do you use per year?
In this problem, you don’t want to start with the miles per gallon ratio, because it has gallons in the denominator and your answer will be in gallons/year, with gallons in the numerator.
Instead start with 15,000 miles/year because it has years in the denominator.

The ratio 20 miles per gallon can be inverted as needed to cancel out the appropriate units. If your car gets 20 miles per gallon, it also uses 1 gallon per 20 miles.

\[
15,000 \text{ miles} \times \frac{1 \text{ gallon}}{20 \text{ miles}} = 750 \text{ gallons/year}
\]