

Converting Units with Dimensional Analysis



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Honors Physical Science @ SHS

Let's begin with a
review of some
Math skills that are
necessary to do
dimensional
analysis.



Multiplying Fractions

NUMERATORS

$$\frac{3}{5} \times \frac{4}{9} \times \frac{7}{8} = \frac{84}{360} = 0.23$$

DENOMINATORS

To multiply fractions:

1. Find the product of all the numerators.
2. Find the product of all the denominators.
3. Divide the numerator by the denominator.

Multiplying Fractions with Units

$$\frac{35.6 \text{ L}}{1} \times \frac{1000 \text{ mL}}{1 \text{ L}} = \frac{35600 \text{ mL}}{1}$$

Whenever a unit appears in both the numerator and the denominator, the unit will cancel out.

Vocabulary Time!



Dimensional Analysis

The process of converting one unit to another through the use of conversion factors.

Conversion Factor

Any fraction that:

1. Has different units in its numerator and denominator
2. Has a one in its numerator or denominator
3. Has a total value of one.

Examples of Conversion Factors

12 inches
1 foot

1 gross
144 firecrackers

365.25 days
1 year

1000 meters
1 kilometer

500 sheets
1 ream

1 Liter
1000 mL

1 century
100 years

2 shoes
1 pair

12 eggs
1 dozen

Conversion Factors show the relationship between two different units.

You know that

1000 meters = 1 kilometer.

A conversion factors showing the relationship between meters and kilometers could be:

$$\frac{1000 \text{ m}}{1 \text{ km}} \quad \text{and} \quad \frac{1 \text{ km}}{1000 \text{ m}}$$

$$4567 \text{ m} = ? \text{ km}$$

Suppose you were given 4,567 meters and asked to convert it to kilometers.

How could you do it?

Do you multiply or divide?

By following 5 steps you can easily convert the meters to kilometers.

Step 1

Change your given (4567 meters) to a fraction by placing it over 1.

$$\frac{4567 \text{ m}}{1}$$

Step 2

Write a conversion factor that has the unit you wish to get rid of in the denominator and the unit you want to convert to in the numerator.

$$\frac{4567 \text{ m}}{1} \quad \frac{1 \text{ km}}{1000 \text{ m}}$$

Step 3

Multiply your given (4567 m) times the conversion factor.

When you do this the unit of your given cancels out and you are left with the unit you wish to convert to .

$$\frac{4567 \text{ m}}{1} \times \frac{1 \text{ km}}{1000 \text{ m}}$$

Step 4

Multiply the numerators together, then multiply the denominators together.

You end up with a fraction.

$$\frac{4567 \text{ m}}{1} \times \frac{1 \text{ km}}{1000 \text{ m}} = \frac{4567 \text{ km}}{1000}$$

Step 5

Change your fraction back to a decimal by dividing the numerator by the denominator. That gives you the digits in your answer. The only unit left carries over from the numerator.

$$\frac{4567 \text{ m}}{1} \times \frac{1 \text{ km}}{1000 \text{ m}} = \frac{4567 \text{ km}}{1000} = 4.567 \text{ km}$$

Using multiple conversion factors.

Sometimes you cannot convert one unit directly to another because you do not know a conversion factor for your two units.

When this occurs:

1. Convert your given to a base unit (m, L or g).
2. Convert your base unit to the unit you wish to end up with.

How many kilometers are in
1.567 cm?

Using multiple conversion factors.

$$\frac{1.567 \text{ cm}}{1}$$

Step 1: Write your given as a fraction.

Using multiple conversion factors.

$$\frac{1.567 \cancel{\text{cm}}}{1} \times \frac{1 \text{ m}}{100 \cancel{\text{cm}}}$$

Step 1: Write your given as a fraction.

Step 2: Write a conversion factor with centimeters in the denominator and the base unit (meters) in the numerator.

Using multiple conversion factors.

$$\frac{1.567 \text{ cm}}{1} \times \frac{1 \text{ m}}{100 \text{ cm}} \times \frac{1 \text{ km}}{1000 \text{ m}}$$

Step 1: Write your given as a fraction.

Step 2: Write a conversion factor with centimeters in the denominator and the base unit (meters) in the numerator.

Step 3: Write a conversion factor with meters in the denominator and kilometers is in the numerator.

Using multiple conversion factors.

$$\frac{1.567 \text{ cm}}{1} \times \frac{1 \text{ m}}{100 \text{ cm}} \times \frac{1 \text{ km}}{1000 \text{ m}} = \frac{1.567 \text{ km}}{100,000}$$

Step 1: Write your given as a fraction.

Step 2: Write a conversion factor with centimeters in the denominator and the base unit (meters) in the numerator.

Step 3: Write a conversion factor with meters in the denominator and kilometers in the numerator.

Step 4: Multiply through.

Using multiple conversion factors.

$$\frac{1.567 \cancel{\text{cm}}}{1} \times \frac{1 \cancel{\text{m}}}{100 \cancel{\text{cm}}} \times \frac{1 \text{ km}}{1000 \cancel{\text{m}}} = \frac{1.567 \text{ km}}{100,000}$$

Step 1: Write your given as a fraction.

Step 2: Write a conversion factor with centimeters in the denominator and the base unit (meters) in the numerator.

Step 3: Write a conversion factor with meters in the denominator and kilometers in the numerator.

Step 4: Multiply through.

Step 5: Divide through to convert to a decimal.

Using multiple conversion factors.

$$\frac{1.567 \cancel{\text{cm}}}{1} \times \frac{1 \cancel{\text{m}}}{100 \cancel{\text{cm}}} \times \frac{1 \text{ km}}{1000 \cancel{\text{m}}} = \frac{1.567 \text{ km}}{100,000}$$

$$\frac{1.567 \text{ km}}{100,000} =$$

$$0.00001567 \text{ km} =$$

$$1.567 \times 10^{-5} \text{ km}$$

Step 5: Divide through to convert to a decimal.

\$1 US = ? \$NZ

\$1.00 US = 0.89 Euros
 1.00 Euro = 12.07 Peso
 1.00 Pesos = \$0.72 HK
 \$4.49 HK = \$1.00 NZ



$$\begin{array}{c}
 \cancel{\$1.00 \text{ US}} \quad \cancel{0.89 \text{ Euros}} \quad \cancel{12.07 \text{ Peso}} \quad \cancel{\$0.72 \text{ HK}} \quad \cancel{\$1.00 \text{ NZ}} \\
 \hline
 1 \quad \cancel{\$1.00 \text{ US}} \quad \cancel{1.00 \text{ Euro}} \quad \cancel{1.00 \text{ Peso}} \quad \cancel{\$4.49 \text{ HK}}
 \end{array}$$

$$\frac{\$7.73 \text{ NZ}}{4.49} = \$1.72 \text{ NZ}$$

\$ 1 NZ = ? VND

\$1.00 NZ = 33.32 Rupees

9.36 Rupees = 1.00 Egyptian Pound

1.00 Egyptian Pound = 2,518 Vietnam Dong



$$\frac{\$1.00 \text{ NZ} \quad 33.32 \text{ PR} \quad 1.00 \text{ EP} \quad 2,518 \text{ Vietnam Dong}}{1 \quad \$1.00 \text{ NZ} \quad 9.36 \text{ PR} \quad 1.00 \text{ EP}}$$

$$\frac{83900 \text{ Vietnam Dong}}{9.36} = 8960 \text{ VN Dong}$$

Review:

Dimensional Analysis is a way to convert a measurements from one unit to another through the use of conversion factors.

Conversion Factors are fractions that have:

1. Different units in their numerator & denominator.
2. Have a 1 in either the numerator or denominator.
3. Have a total value of one.

When you are finish with DA, the only unit left will be in the numerator of the last conversion factor.

Often more than one conversion factor is required to change units.

Sometimes you must convert your given to a base unit (m, L, g) before you can convert it to another unit. Example $13.2 \text{ kg} = ?$ milligrams. You would first convert kg to g then g to mg.