Dimensional Analysis

Factor Label Method

English Unit	SI Unit	Relationship
Mile	Kilometer	1 mile = 1.609 Km
Foot	Meter	1 ft = .305 M
Inch	Centimeter	1 inch = 2.54 Cm
Pound	Grams	1 lb = 453.59 G
Ounce	Grams	1 oz = 28.35 G
Gallon	Liter	1 gallon = 3.79 L

Math practice for DA:

$7 \times {}^{3}/_{4} = ?$

set up as fractions:

$$\frac{7}{1} \times \frac{3}{4} = \frac{21}{4} = 5.25$$

try one more:

$12 \times {}^{7}/_{24} = ?$

$$\frac{12}{1} \times \frac{7}{24} = \frac{84}{24} = 3.5$$

or factor out (simplify) first

$$\frac{\cancel{12}^{1}}{1} \times \frac{7}{\cancel{24}_{2}} = \frac{7}{2} = 3.5$$

We can also factor out labels or units

63 in. X 1 ft./12 in.

$$\frac{63\ \cancel{\text{in.}}}{1} \times \frac{1\ \text{ft}}{12\ \cancel{\text{in.}}} = \frac{63}{12}\ \text{ft} = 5.25\ \text{ft}$$

Steps to Dimensional Analysis

1. **Define the "given" and "goal"**

Ex. Problem:

How many centimeters are in 27 inches?

2. **Identify relationship between these.**

2.54 cm = 1 inch

3. **Arrange relationship into two possible conversion factors**

$\frac{2.54\text{ cm}}{1\text{ inch}}$ or $\frac{1\text{ inch}}{2.54\text{ cm}}$

4. **Pick a conversion factor so units will cancel**

ex: How many centimeters are in 27 inches?

*Units always cancel on the diagonal

start "given" → $\frac{27\text{in}}{1} \times \frac{2.54\text{ cm}}{1\text{ inch}} = 68.6\text{cm}$ ← "goal" (units)

or

chemists use "picket fence"

$$\begin{array}{|c|c|} 27\text{ in.} & 2.54\text{ cm} \\ \hline 1 & 1\text{ inch} \end{array} = 68.6\text{ cm}$$

Why does this work? (conversion) top = bottom

$12 \times \frac{754}{754} = 12$

$\frac{754}{754} = 1$

$12 \times 1 = 12$

How many eggs in 4.75 dozen?

relationship?

1 dz = 12 eggs

$$4.75\ \text{dz} \left| \frac{12\ \text{eggs}}{1\ \text{dz}} \right. = 57\ \text{eggs}$$

How many feet in 4 meters?

relationship: 1 foot = 0.305 meters

$$4\ \text{m} \left| \frac{1\ \text{ft}}{0.305\ \text{m}} \right. = 13.1\ \text{ft}$$

Solve with dimensional analysis

55 mm = _____ m

relationship:
1000 mm = 1 m

2 step DA - try it!

How many feet in a 850 centimeters?

relationship: 1 foot = 0.305 meters

relationship: 1 meter = 100 cm

$$\frac{850\,\text{cm}}{1} \times \frac{1\,\text{m}}{100\,\text{cm}} \times \frac{1\,\text{ft}}{0.305\,\text{m}} = 27.9\,\text{ft}$$

$850(\times 1 \times 1) \div 100 \div 0.305$

patterns...

What 2 patterns are present?
Solve it.

Convert 35 meters to miles.

$$\frac{35\ \cancel{m}}{} \left| \frac{100\ \cancel{cm}}{1\ \cancel{m}} \right| \frac{1\ \cancel{in}}{2.54\ \cancel{cm}} \left| \frac{1\ \cancel{ft}}{12\ \cancel{in}} \right| \frac{1\ \text{mile}}{5280\ \cancel{ft}} = \text{miles}$$

1. Cross out units that cancel above. - diagonal

2. Describe the relationship of top and bottom number:
(top must = bottom in each section)

How many moles in 57.3g of Al?

$$57.3\ \text{g Al} \times \frac{1\ \text{mol}}{27\ \text{g}} = 2.12\ \text{mol Al}$$

27g = 1 mole

How many grams in 32.3 mol Al?

$$32.3\ \text{mol Al} \times \frac{27\ \text{g}}{1\ \text{mol}} = 872.1\ \text{g Al}$$

How many atoms are in 32.3 mol?

$$32.3\ \text{mol Al} \times \frac{6.02 \times 10^{23}\ \text{atom}}{1\ \text{mol}} = 1.94 \times 10^{25}\ \text{atoms of Al}$$

1 mol = 6.02×10^{23}