



Dimensional Analysis

key concepts:

- A conversion factor is always a factor of one constructed from a known equality.
- Multiple conversion factors are sometimes necessary when converting from one unit to another.
- **Temperature** conversions are simpler when the proper units are placed on the conversion factor.

<p>1 USD = 106.823 JPY (Japanese yen)</p>  $\frac{1 \text{ dollar}}{106.823 \text{ yen}} = \frac{106.823 \text{ yen}}{1 \text{ dollar}} = 1$ $50.00 \cancel{\text{ dollars}} \cdot \frac{106.823 \text{ yen}}{1 \cancel{\text{ dollar}}} = 5341 \text{ yen}$	<p>A conversion factor is always a factor of one constructed from a known equality. For example, 1 dollar = 106.823 yen, so 1 dollar / 106.823 yen = 106.823 yen / 1 dollar = 1.</p> <p>Conversion factors are useful for converting one quantity to another. For example, an amount in dollars could be converted to yen by multiplying by 106.823 yen / 1 dollar. The dollars in the numerator cancel with the dollars in the denominator, leaving yen. This method of converting quantities by multiplying by conversion factors to cancel units is called dimensional analysis.</p>
 <p>problem ? A car is traveling at 75 miles per hour. What is this velocity in meters per second?</p> $\text{rate} \left(\frac{\text{m}}{\text{s}} \right) = \frac{75 \cancel{\text{ mi}}}{1 \cancel{\text{ hr}}} \cdot \left(\frac{5280 \cancel{\text{ ft}}}{1 \cancel{\text{ mi}}} \right) \cdot \left(\frac{12 \cancel{\text{ in}}}{1 \cancel{\text{ ft}}} \right) \cdot \left(\frac{2.54 \cancel{\text{ cm}}}{1 \cancel{\text{ in}}} \right) \cdot \left(\frac{1 \text{ (m)}}{100 \cancel{\text{ cm}}} \right) \cdot \left(\frac{1 \cancel{\text{ hr}}}{60 \cancel{\text{ min}}} \right) \cdot \left(\frac{1 \text{ min}}{60 \cancel{\text{ s}}} \right)$ $= 34 \frac{\text{m}}{\text{s}}$	<p>Multiple conversion factors are sometimes necessary when converting from one unit to another.</p> <p>For example, miles per hour (mi/hr) can be converted to meters per second (m/s) by using multiple conversion factors to convert from miles to feet, feet to inches, inches to centimeters, centimeters to meters, hours to minutes, and minutes to seconds. It is always good to check that the units cancel properly. If not, a conversion factor might have the numerator and denominator reversed.</p>
$T(^{\circ}\text{C}) = \frac{5^{\circ}\text{C}}{9^{\circ}\text{F}} (T(^{\circ}\text{F}) - 32^{\circ}\text{F})$ $T(^{\circ}\text{F}) = \frac{9^{\circ}\text{F}}{5^{\circ}\text{C}} T(^{\circ}\text{C}) + 32^{\circ}\text{F}$ $T(\text{K}) = \frac{1 \text{ K}}{1^{\circ}\text{C}} T(^{\circ}\text{C}) + 273.15 \text{ K}$	<p>Temperature conversions are simpler when the proper units are placed on the conversion factor.</p> <p>For example, it is easier to make sure that the proper conversion formula is used if units are placed on the conversion factor from temperature in degrees Celsius (T(°C)) to temperature in degrees Fahrenheit (T(°F)). Temperature in degrees Celsius (T(°C)) can be converted to temperature on the Kelvin scale (T(K)) by adding 273.15 K.</p> <p>Units should always be carried along when making conversions.</p>