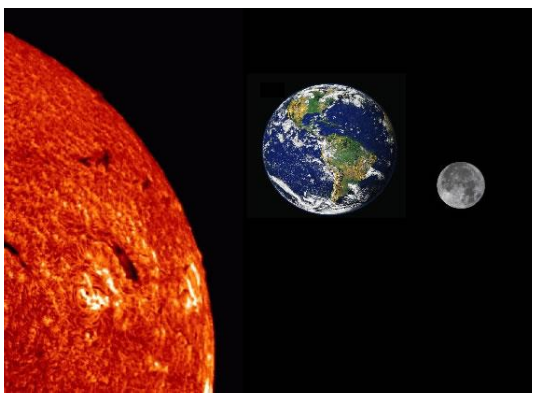
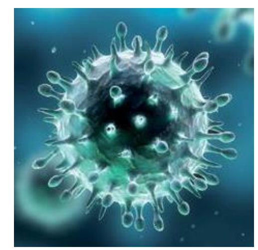
Metric Examples

Any US paper currency note ($1, $5, $10, $20) has a mass of 1 g; the mass of a nickel is 5 g; the mass of a penny is 2.5 grams.

A typical doorknob is ~1 m high.



The mass of the Earth is $6×10^{24}$ kg; the mass of the Moon is $7.3×10^{22}$ kg; the mass of the Sun is $1.99×10^{30}$ kg.



Diameter of Influenza virus is ~20 nm.

Typical airport runway length is 3.35 km; Boeing 767 jet is 64 m long.

The diameter of a CD or a DVD is 12 cm; the diameter of the center hole is 15 mm.

Scientific Notation

<u>Scientific notation</u> (also referred to as *"standard form"* or *"standard index form"*) is a **way of writing numbers** that are either too big or too small to be conveniently written in decimal form.

decimal point

$$6.02 \times 10^{23}$$

a real number with an absolute value between 1 and 10

an order of magnitude value written as a power of 10

- **One light year** is equal to about **5.88×10^{12} miles**
- **Natural spider silk** is about **3×10^{-6} meters thick**
- **Lake Superior volume** is about **1.21×10^{16} liters**

Conversion of Units

- **For <u>the same quantity measured</u>, we can convert units using an equivalence statement which shows the relationship between the units (this relationship is called a *conversion factor*).**

Imperial-Metric equivalence statements:

<u>Units of Length</u>

- 1 in = 2.54 cm
- 3.28 ft = 1 m
- 1 mi = 1.61 km

<u>Units of Weight</u>

- 1 oz = 28.35 g
- 1 lb = 454 g
- 2.2 lb = 1 kg

<u>Units of Capacity</u>

- 1.06 qt = 1 L
- 1 gal = 3.79 L

- **Units that measure *physical quantities* (like the examples above) always have a common zero.**
- **<u>Within the Metric System</u> itself, by design, conversion factors are always a power of 10.**

Dimensional Analysis

- **<u>Dimensional Analysis</u>** (also called *Factor-Label Method* or the *Unit Factor Method*) **is a problem-solving method that uses the fact that any number or expression can be <u>multiplied by one</u> *(Magic One)* without changing its value.**

- **To help with conversion of units, Magic One is built using the equivalence statement:**

Equivalence Statement(s)

1 in = 2.54 cm

2.2 lb = 1 kg

Magic One(s)

$$\frac{1\text{ in}}{2.54\text{ cm}} = 1 \qquad \frac{2.54\text{ cm}}{1\text{ in}} = 1$$

$$\frac{2.2\text{ lb}}{1\text{ kg}} = 1 \qquad \frac{1\text{ kg}}{2.2\text{ lb}} = 1$$

Example: Convert 130 lbs to kg

- **Step 1. Write the *original* measurement as a *unit fraction*:**

  130 lbs / 1

- **Step 2. Using the equivalence statement, build a *magic one* (building rule - the *numerator unit* is the unit you *want*, the *denominator unit* is the *original* unit you want to *eliminate*):**

  $$2.2\text{ lb} = 1\text{ kg} \Longrightarrow \frac{1\text{ kg}}{2.2\text{ lb}} = 1$$

- **Step 3: multiply your unit fraction by your magic one and write your answer in the new units:**

$$\frac{130\ \text{lbs}}{1} \cdot \boxed{\frac{1\ \text{kg}}{2.2\ \text{lbs}}} = \frac{130\ \text{kg}}{2.2} = 59.1\ \text{kg}$$

Example: The fuel tank of a plane can hold 876 liters of gas. How many gallons would it be?

Equivalency: 1 gallon = 3.8 liters

$$\frac{876\ \cancel{L}}{1} \cdot \boxed{\frac{1\ gal}{3.8\ \cancel{L}}} = \frac{876\ gal}{3.8} = \mathbf{230.5\ gal}$$

Exercise: As a practical joke, on the show Candid Camera, a gas station listed their price as **$1.79/L**. People gassing up thought they were getting a great deal, but then were outraged when their total owed came up. **WHY?**

What should we do?

Let's carefully examine:

"Listed their price as $1.79/L"

Equivalency: 1 gal = 3.79 L

$$\frac{\$1.79}{1\,\not{L}} \cdot \boxed{\frac{3.79\,\not{L}}{1\,\text{gal}}} = \frac{\$6.78}{1\,\text{gal}}$$

"The deal" was actually **$6.78/gal**!

Conversion of Temperature

When converting temperature between different scales, we need to pay attention to the fact that they all have <u>different "0" points</u>, therefore not only a *multiplication factor* is needed but also a *shift*.

Kelvin

$$K = {}^\circ C + 273.15$$

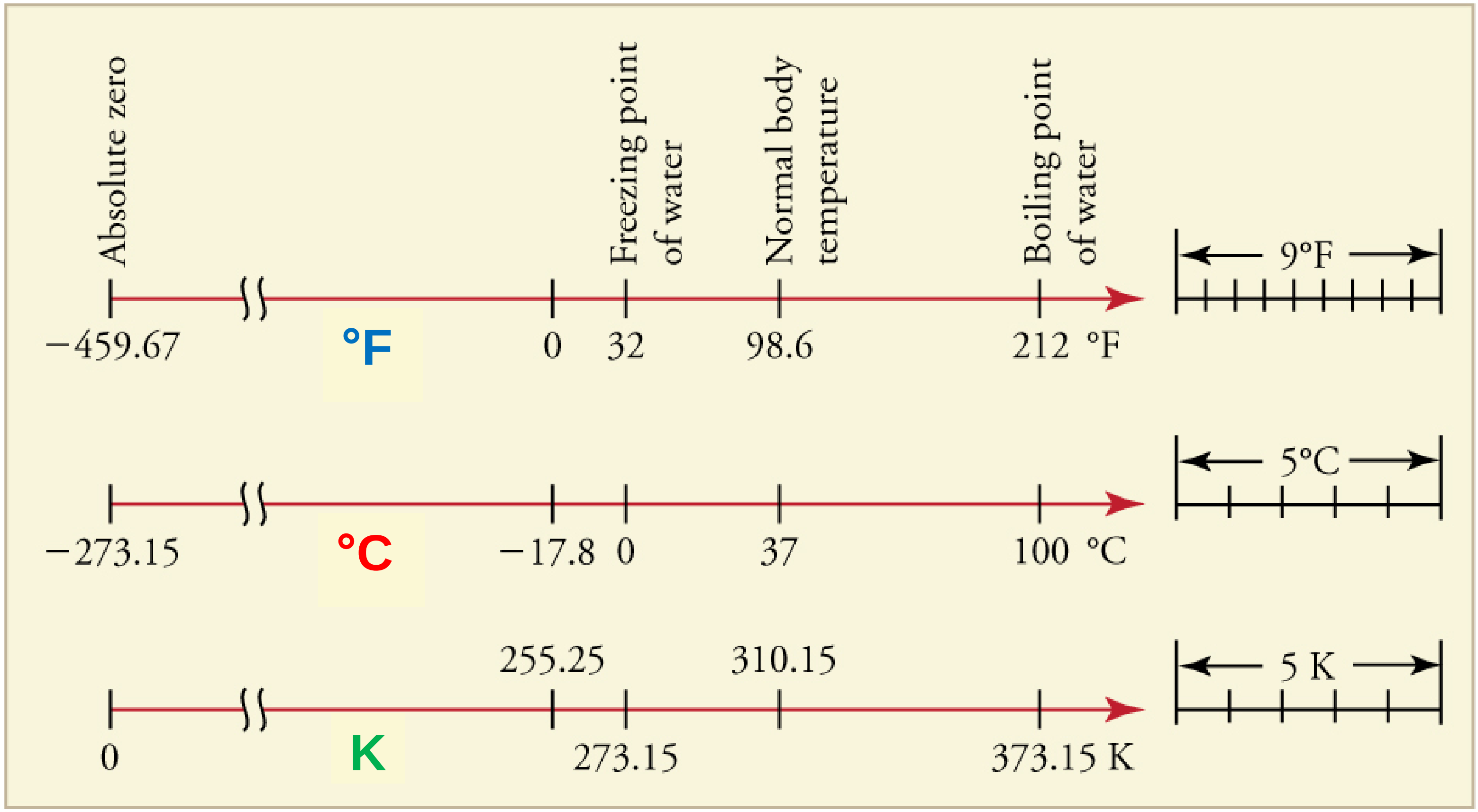
Fahrenheit

$$^\circ F = {}^\circ C \cdot 1.8 + 32 = {}^\circ C \cdot \frac{9}{5} + 32$$

Celsius

$$^\circ C = \left({}^\circ F - 32\right)/1.8 = \left({}^\circ F - 32\right) \cdot \frac{5}{9}$$

Temperature Scales



Note: according to the latest research, <u>normal human body temperature</u> is 36.8 °C ±0.7 °C, or 98.2 °F ±1.3 °F.