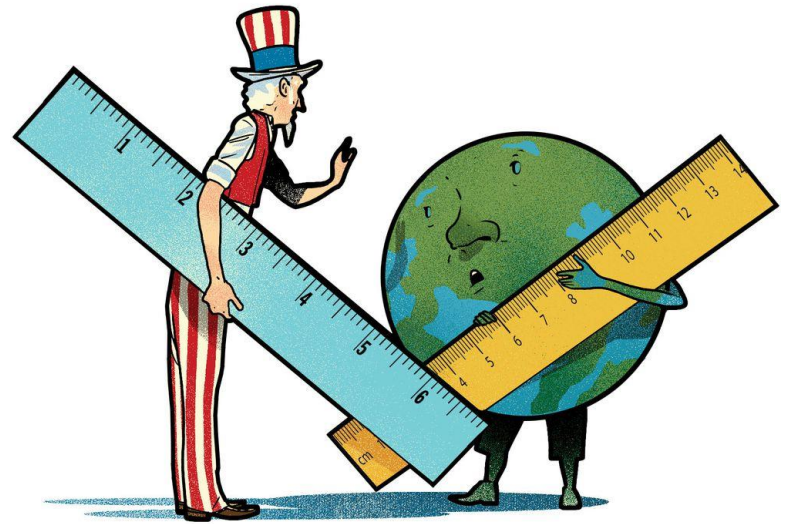# Conversion
# of Units

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>	<u>Units of Weight</u>	<u>Units of Capacity</u>
➢ **1 in = 2.54 cm**	➢ **1 oz = 28.35 g**	➢**1.06 qt = 1 L**
➢ **3.28 ft = 1 m**	➢ **1 lb = 454 g**	➢**1 gal = 3.79 L**
➢ **1 mi = 1.61 km**	➢ **2.2 lb = 1 kg**	

- **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

- **Dimensional Analysis** (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 multiplied by one** *(Magic One)* **without changing its value**.

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

Equivalence Statement(s)

Magic One(s)

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

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

Example: Convert 130 lbs to kg

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

$$130 \text{ lbs} / 1$$

➢ **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*):**

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

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

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

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

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

Exercise: As a practical joke, on the show Candid Camera, a <u>gas station listed their price</u> 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:
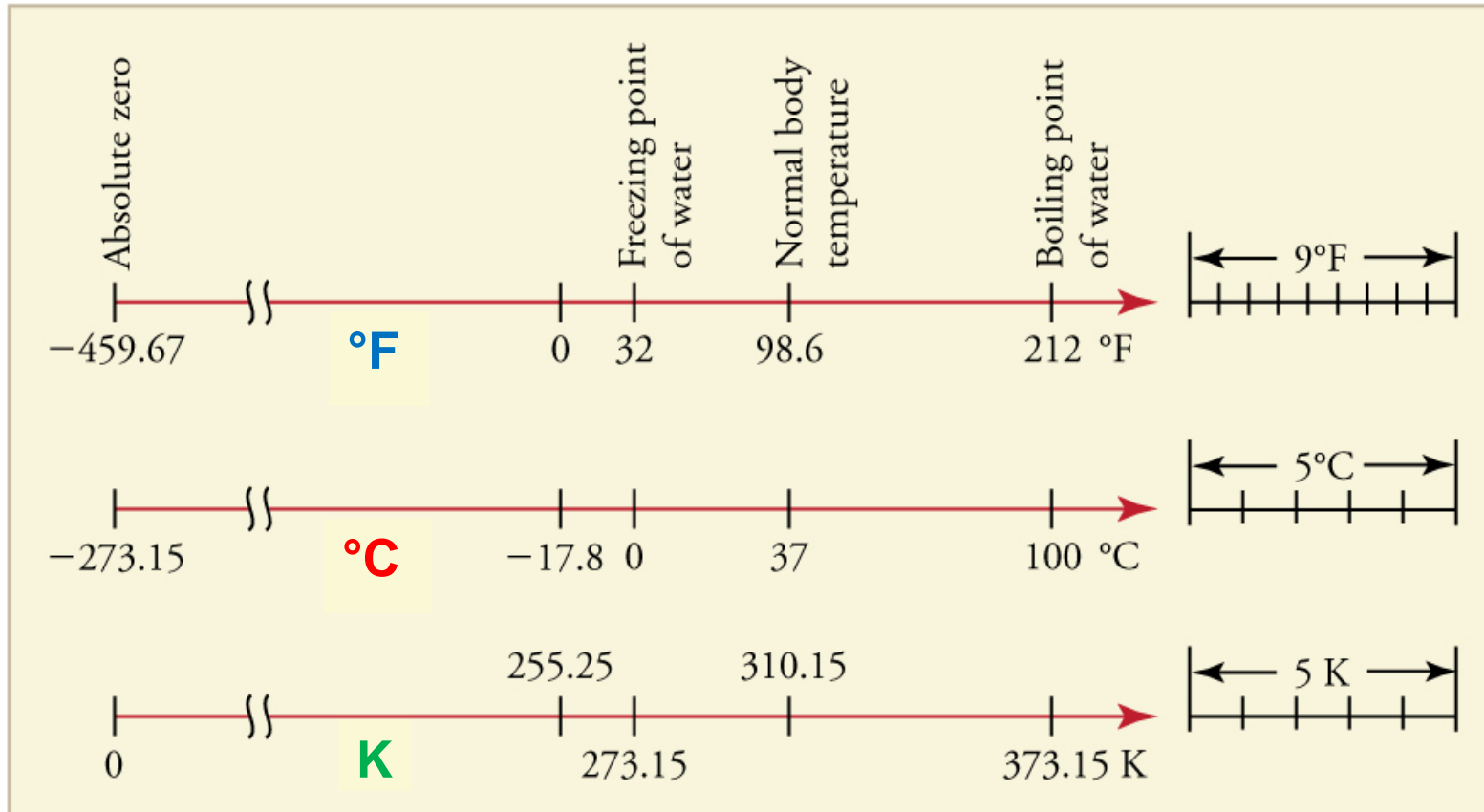## "Listed their price as $1.79/L"

Equivalency: 1 gal = 3.79 L

$$\frac{\$1.79}{1 \, \text{L}} \cdot \boxed{\frac{3.79 \, \text{L}}{1 \, \text{gal}}} = \frac{\$6.78}{1 \, \text{gal}}$$

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

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.

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***.**

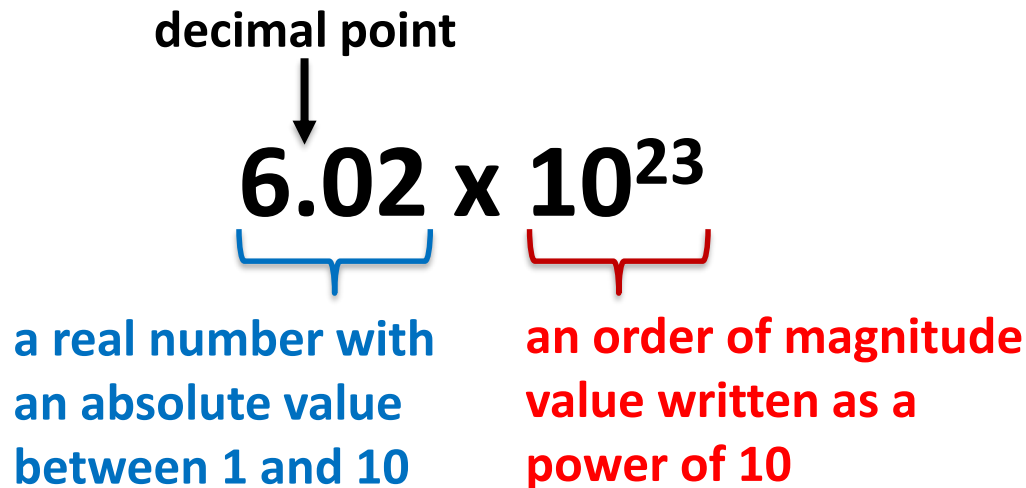**Kelvin**

$$K = °C + 273.15$$

Fahrenheit

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

Celsius

$$°C = (°F - 32)/1.8 = (°F - 32) \cdot \frac{5}{9}$$
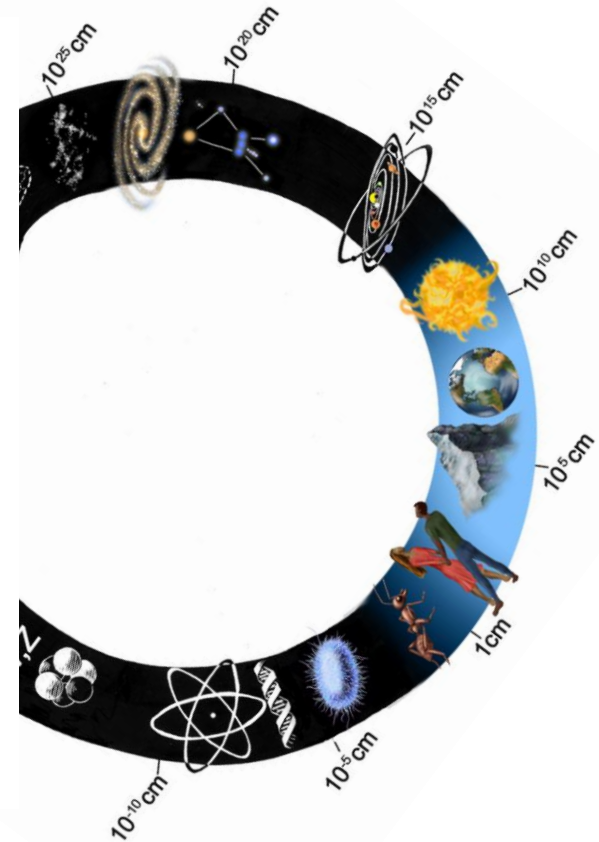
Scientific Notation

Scientific notation (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**

Orders of Magnitude

- **<u>Orders of magnitude</u>** are numbers on a scale where each number is rounded to the *nearest power of ten*.

- **Examples:**

  - ➤ **Distance to Andromeda Galaxy** is about **10^{19} miles**

  - ➤ **Influenza virus** is about **10^{-7} meters in diameter**

Orders of magnitude are generally used to make **very approximate comparisons** of measurements, and reflect **very large differences**.

Powers of Ten video

https://www.youtube.com/watch?v=bhofN1xX6u0

https://www.youtube.com/watch?v=EMLPJqeW78Q