Measurement

Measurement, Metric System, Conversions

Scientific Notation

- Scientific notation: a method for making very large or small numbers more compact and easier to write.

- Express # as a product of a # between 1-10 and an appropriate power of 10

Practice

- 1. Ex 93000000 becomes 9.3×10^{7}
  - (moved to the left, number got “smaller” so exponent is positive)
- 2. 0.010 become 1.0×10^{-2}
  - (moved to the right, number got “bigger” so exponent is negative)

Measurement

- Units: part of measurement that tells us what scale or standard to represent the result.

- 2 systems of measurement:
  - English System – Empirical Units (used in United States) includes: feet, inches, ounces pounds)
  - System International- Metric System (used around the world, and in science) meters, grams etc.
    - Includes derived units (density, volume)

Type of Measurement	Definition	Tool Used to Measure	Units

Metric System

- We use the metric system in science!!
- All SI standards (metric system) are *universally* accepted and understood by scientists throughout the world.
- Each type of SI measurement has a base unit
- The SI system is easy to use because it is based on multiples of *10*

Quantity Measured	Unit	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Temperature	kelvin	K
Amount of substance	mole	mol
Intensity of light	candela	cd

Standards of Measurement

- A ***Standard*** is an exact quantity that people agree to use to compare measurements
  - All scientists around the world can compare results
- For a measurement to make sense, it must include both a *number* and a *unit*

Measuring Matter

- Mass is a measurement of the *quantity* of matter in an object
- It is how much *stuff* makes up the object
- The SI unit for mass is the *kilogram (kg)*
- Mass is measured by either a *triple beam balance* or an *electric balance*

Measuring Length

- Length: the distance between two points
- Measured in meters (m)
- We use a meter stick or metric ruler to measure length.

Measuring Time

- Time is the *interval* between two events
- The SI unit for time is the *second (s)*
- Time is measured by using a clock or *stopwatch*

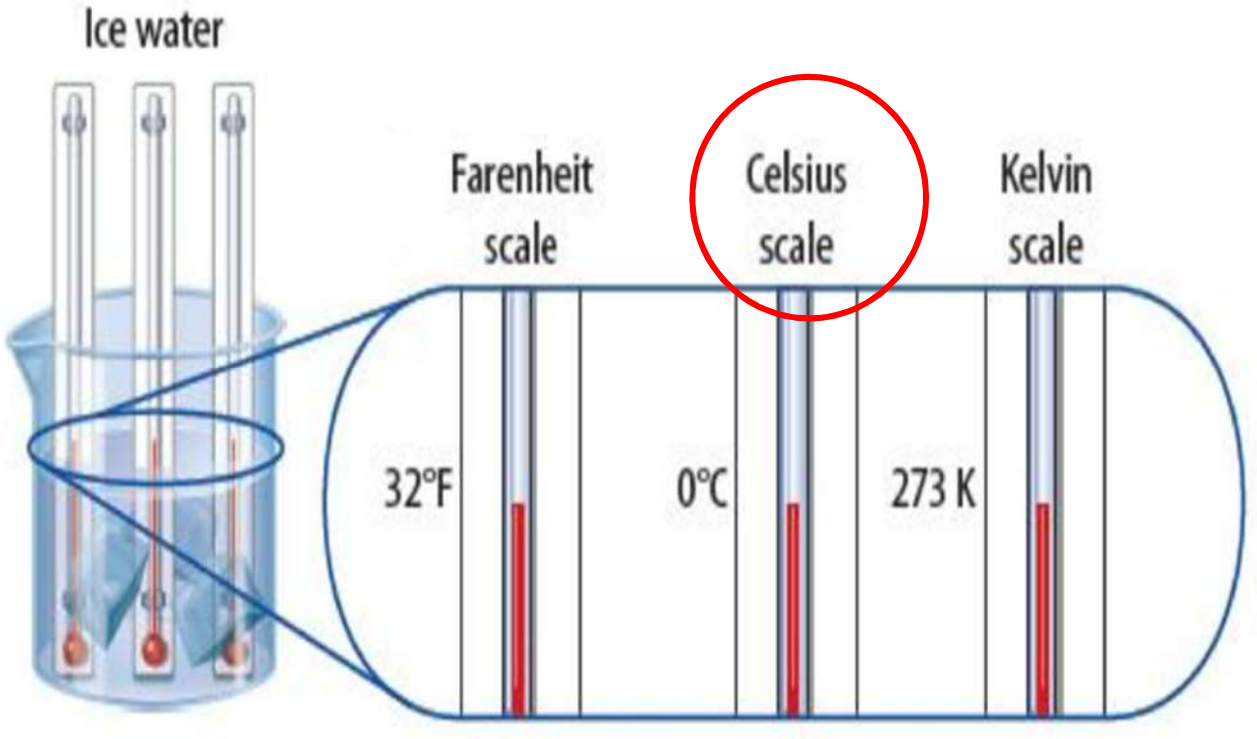
Measuring Temperature

- Temperature (for now) is a measure of how *hot* or *cold* an object is
- The SI unit for temperature is the *Kelvin (K)*
- For most scientific work, temperature is measured using *Celsius (^oC)*
- Temperature can also be measured in Fahrenheit *(^oF)* [will not use this in science!] or Kelvin

Note that Celsius and Fahrenheit both use the degree (^{o}) symbol, but that Kelvin does not!

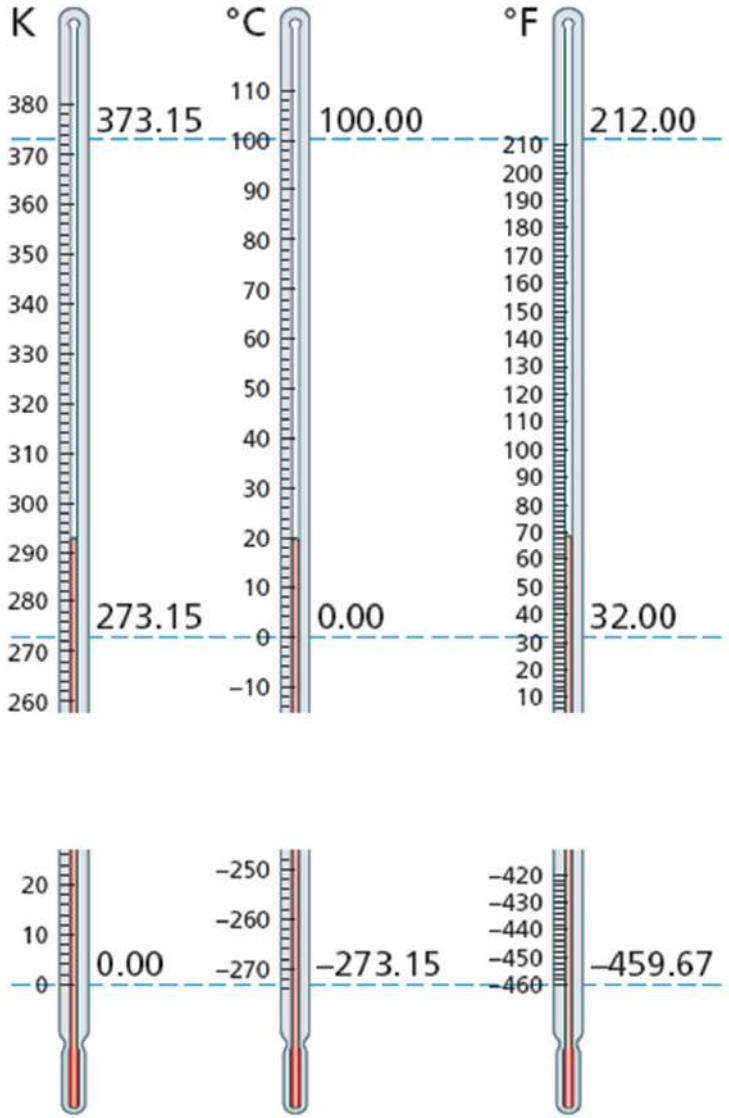
- Zero on the Kelvin scale (0 K) is the coldest possible temperature, also known as *absolute zero*

Measuring Temperature



Measuring Temperature

- These three thermometers illustrate the scales of temperature between the freezing and boiling points of water.



Converting Temperatures

- ^{o}C to Kelvin:
  - since zero Celsius corresponds to 273 K– add 273 to the Celsius temp. (subtract 273 to other way)
  - 45 ^{o} C = _____K
- ^{o}C to ^{o}F:
  - 180 ^{o}F = 100 ^{o}C (1.8 ^{o}F = 1 ^{o}C)
  - T (°F) = 1.80(T°C) + 32
- ^{o}F to ^{o}C:
  - Rearrange the equation above

Practice

- 100 °C → _____ °F
- 67 °F → _____°C
- 33 °C → _____ K

Derived Units

- A unit obtained by *combining* or *manipulating* different SI units is called a derived unit
- Examples of derived units include *volume* and *density*

Measuring Volume

- Volume is the amount of *space* occupied by an object
- To measure the volume of a solid rectangle, you measure its *length, width, and height* and multiply the three numbers together ($V = \ell \times w \times h$).
- If measured in centimeters (*cm*), the volume would then be expressed in cubic centimeters (cm^3)

Measuring Volume

- Another way to measure solid objects is by using the *water displacement method*
- This is the preferred way when the object does not have a *mathematical* equation for its volume or is an irregular shape.
- *Volume = Final volume – Initial volume*
- $V = V_f - V_i$

Measuring Liquid Volumes

- Liquid volumes indicate the capacity (*or amount*) that the container holds
- The most common units for liquid volumes are *L and mL*
- Liquid volumes are measured by *graduated cylinders*
- Sometimes liquid volumes such as doses of medicine are measured in *cubic centimeters*
- One cubic centimeter is exactly the same volume as one milliliter.
- 1 mL = 1 cm^3 = 1cc

Density

- Combining the mass and volume of an object can be used to find the density of the object
- Density cannot be measured *directly*. It must be *calculated* from the objects mass and volume.
- Density is the mass per unit volume of a substance

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}} \quad \textit{or} \quad D = \frac{M}{V}$$

Practice

- What is the density of a bowling ball if it has a mass of 17.6kg and a volume of 4.18L?
- If a block of wood has a density of 0.85g/mL and is 114mL, what is the mass of the wood?

Conversions Steps

1. Start with what's given.
2. Multiply by conversion factor w/ *wanted unit* on top (repeat until final unit is what's wanted)
3. Cancel units (double check you get correct units)
4. Multiply Straight Across
5. Divide
6. Round/Sig Figs
7. Does answer make sense?

Conversions Practice

- From Imperial to metric:

  Ex. 2.85cm = _____in

Conversion Factor:
2.54cm=1in

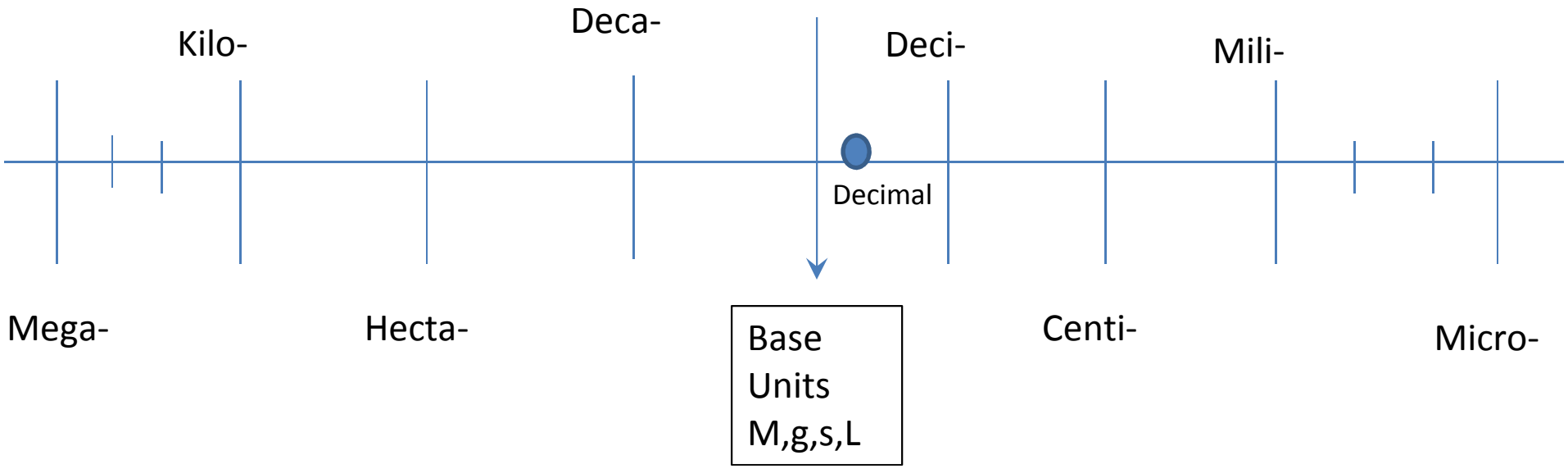
Ex. Convert 48 ounces to grams.

Conversion Factor: **1 Ounce = 28.35 Grams**

Metric Conversions

Prefix	Symbol	Meaning	Scientific notation
Mega	M	1,000,000	10^{6}
kilo	k	1000	10^{3}
deca	da	10	10^{1}
deci	D	0.1	10^{-1}
centi	C	0.01	10^{-2}
milli	M	0.001	10^{-3}
micro		0.000001	10^{36}
nano	n	0.000000001	10^{-9}

Metric Conversions

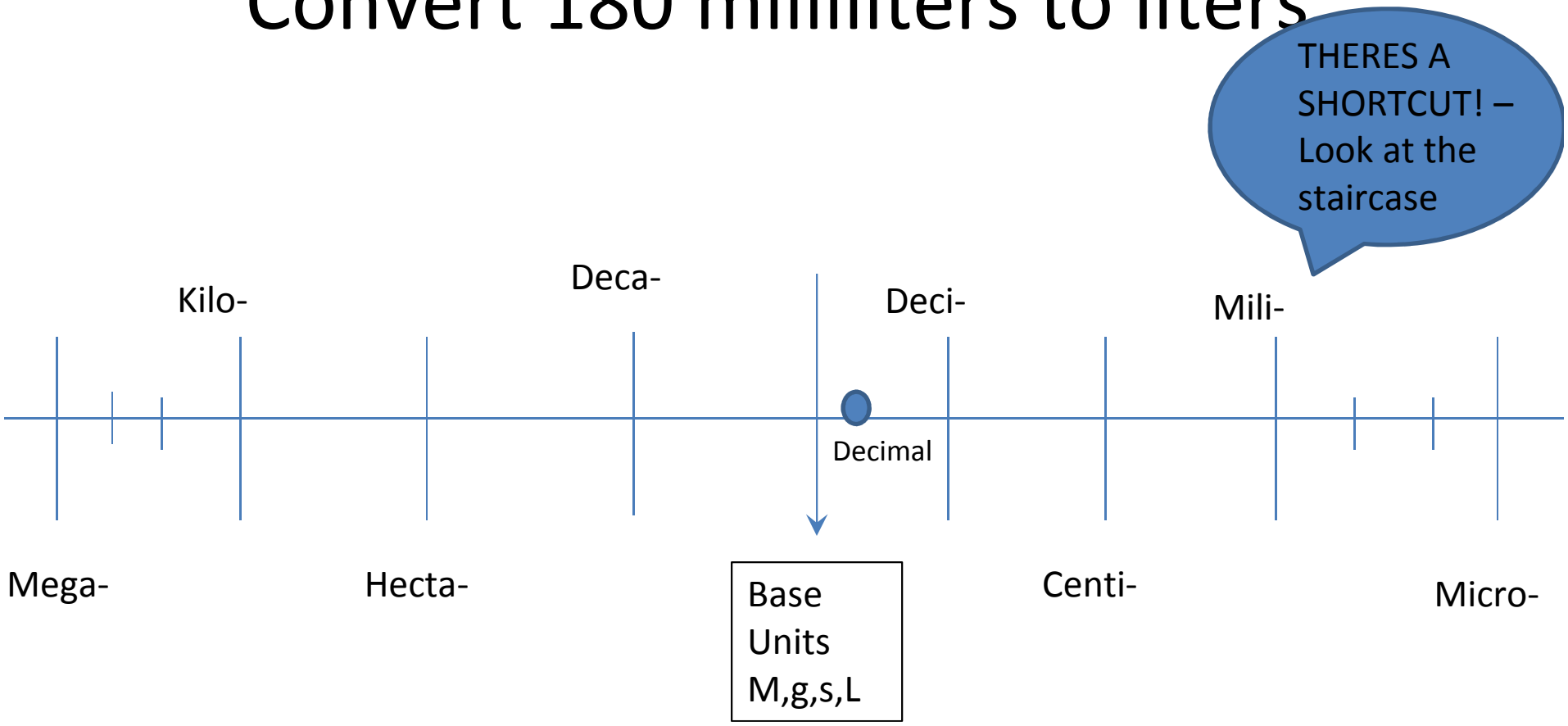


Metric Conversions

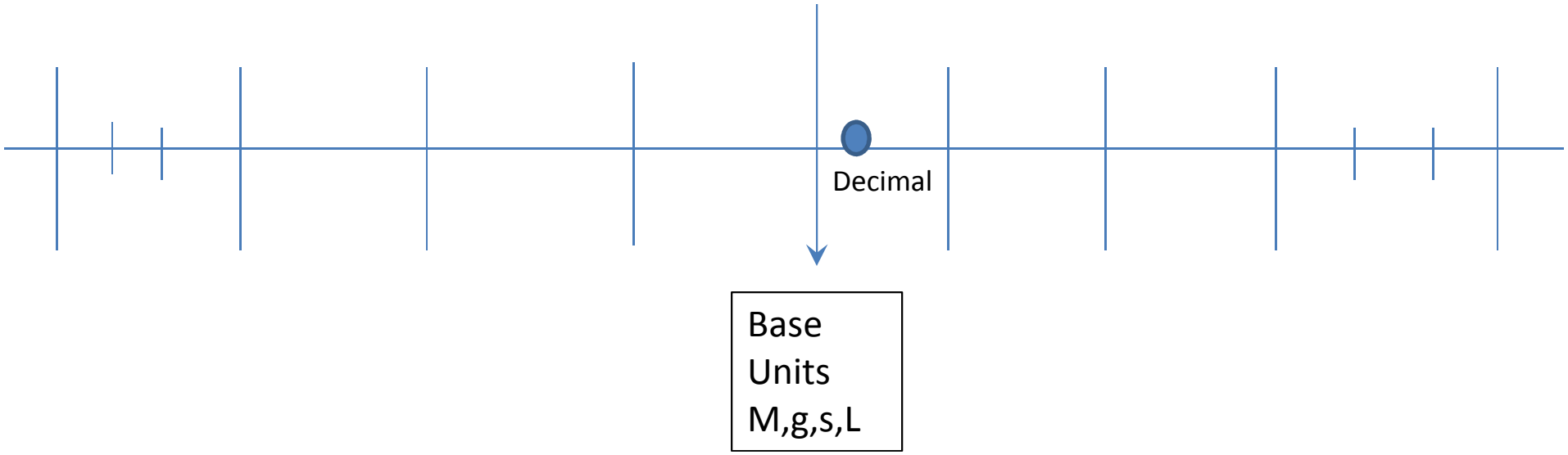
1. Meters → kilometers (1000m = 1 km)

   4.21×10^4 m = _____km

Convert 180 milliliters to liters



YAY! For the Metric System--- So much easier!


Decimal
Base
Units
M,g,s,L

Prefix	Symbol	Meaning	Scientific notation
		1,000,000	10^{6}
		1000	10^{3}
		10	10^{1}
		0.1	10^{-1}
		0.01	10^{-2}
		0.001	10^{-3}
		0.000001	10^{-6}
		0.000000001	10^{-9}