Measurement

Chemistry Chapter 2

Scientific Notations, Measurement, Metric System

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

1-10 ______ $\times 10^{\_\_}$

Practice

- 1. Ex 93000000 becomes 9.3 x 10^{7}
  - (moved to the left, number got "smaller" so exponent is positive)
- 2. 0.010 become 1.0 x10^{-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)

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 measure-ment 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*

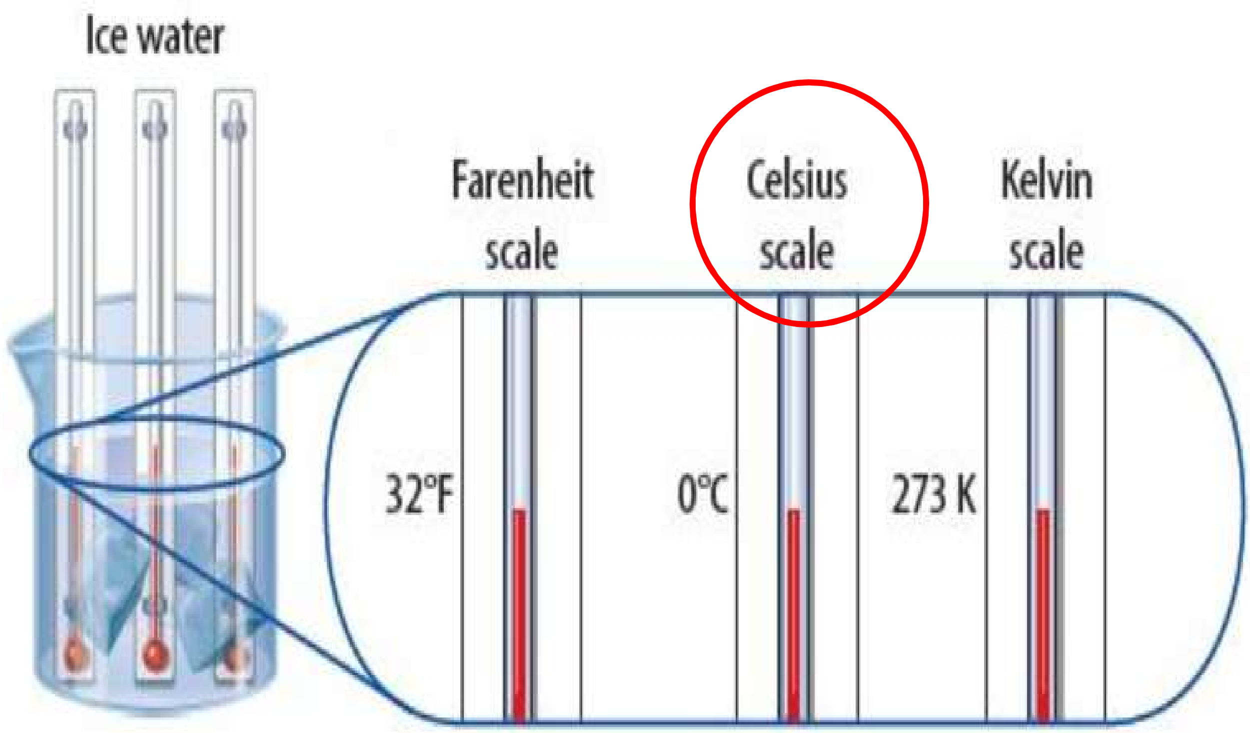
Measuring Temperature

- 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 (^{o}C)*
- Temperature can also be measured in Fahrenheit *(^{o}F)* [will not use this in science!] or Kelvin

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

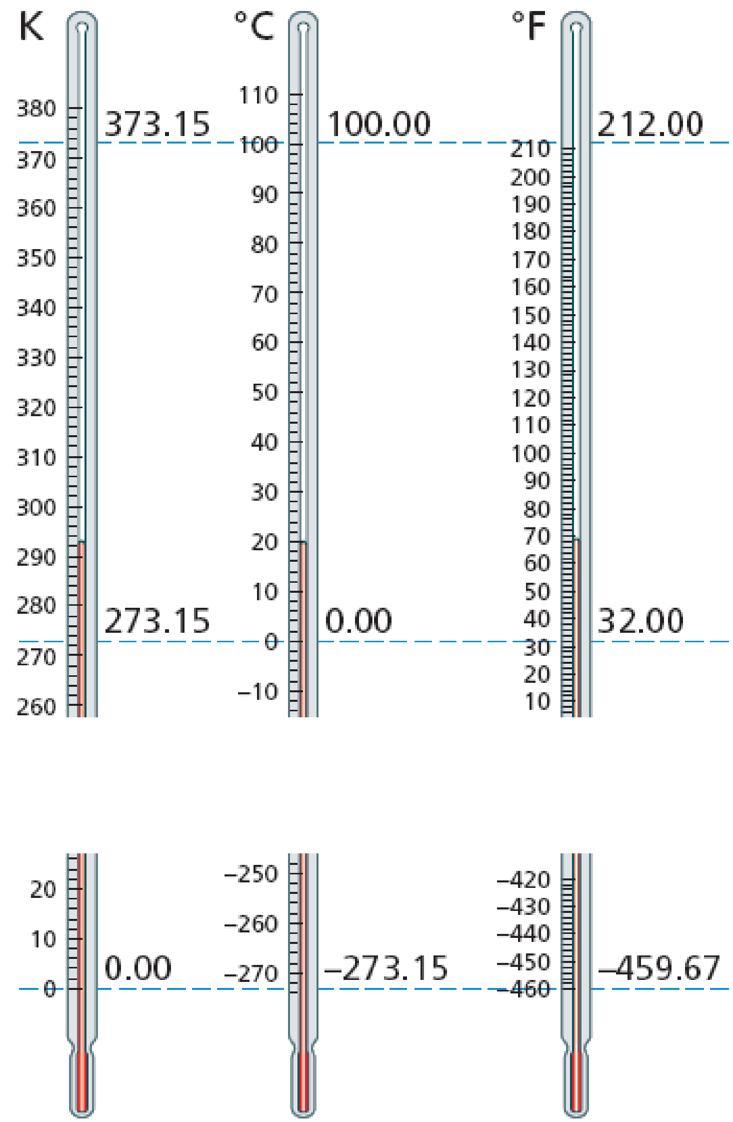
- Zero on the Kelvin scale (0 K) is the coldest possible temperature, also known as *absolute zero*

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 ^oC → ______ ^oF
- 67 ^oF → ______^oC
- 33 ^oC → ______ 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?

Uncertainty in Measurement

- Must rely on visual measurements often or equipment with measurement limits so some measurements could be recorded slightly different by another.
- Certain numbers: numbers the same regardless of who measures (shown on tool)
- Uncertain number: estimated, can vary
- Record certain numbers and first uncertain number!

Significant Figures

- All measurement has some degree of uncertainty.
- chemistry requires math so we must know the uncertainty of the result.

Rules for Significant Figures

1. Nonzero Integers always count!
   - (ex. 1457 = 4 sig figs)
2. Zeros:
   A. Leading zero: (precedes all nonzero digits) NEVER count. Ex. 0.0025 = 2 sig figs
   B. Captive zero: (fall between nonzeros) ALWAYS count. Ex. 1.008 = 4 sig figs
   C. Trailing zeros: (right at end of #) signi9cant if with decimal Ex. 100 =1 sig fig ; 100. = 3 sig figs
3. Exact numbers: (arise from definitions) unlimited significant figures

Rules apply to scientific notation also 100. -> 1.0 $x10^2$ = 3 sig figs

Rules for Rounding

If digit to be removed is…:

1. less than 5 = preceding digit stays same (1.33 →1.3)
2. equal to increased/greater than 5 = preceding digit (ex. 1.36→ 1.4)

In series of calculation: carry extra digits to final, then round

Significant Figures in Calculations

1. Multiplication/Division: keep the same significant numbers as that in the measurement with the **least # of sig figs**.

Ex. 4.56 x 1.4= 6.384

→6.4

8.315/298 = 0.0279027

→2.79×10^{-2}

Sig Figs in Calculations

- 2. Addition/Subtraction: limiting term is one with **<u>least # of decimal places.</u>**

Ex 12.11

18.00

+ 1.013

31. 123

→31.1

Ex. 0.6875

- 0.1

0.5875

→ 0.6

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}

Conversions Steps

1. Start with what's given.
2. Multiply by conversion factor w/ ***wanted unit*** <u>on top </u>(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 Empirical to metric:

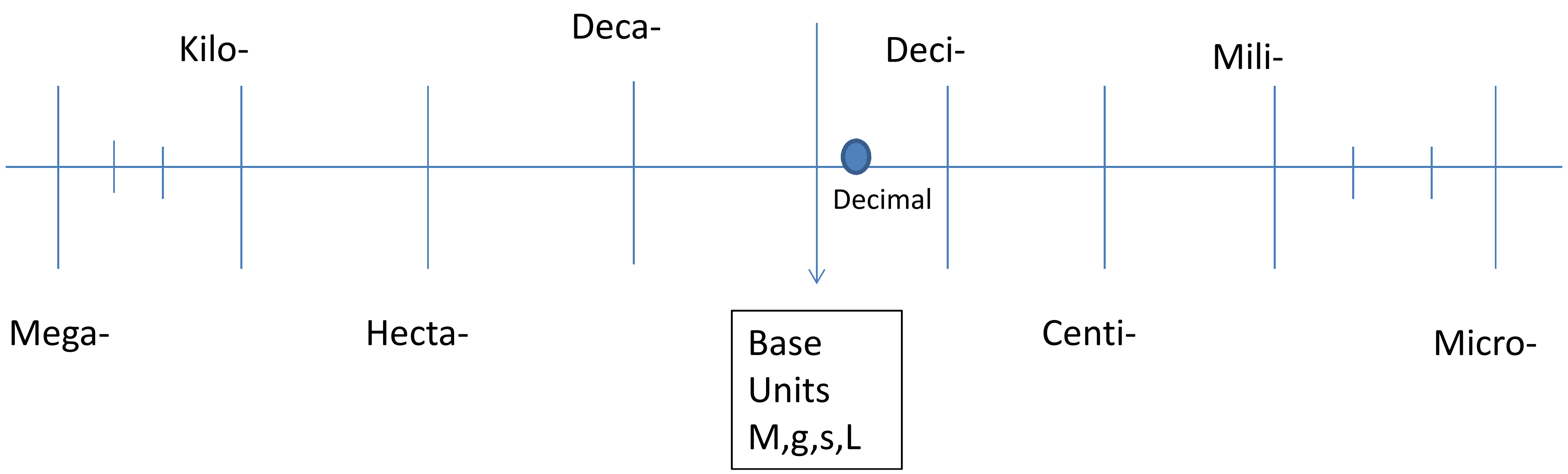
  Ex. 2.85cm = _______in

Conversion Factor:
2.54cm=1in

Ex. Covert 48 ounces to grams.

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

Metric Conversions



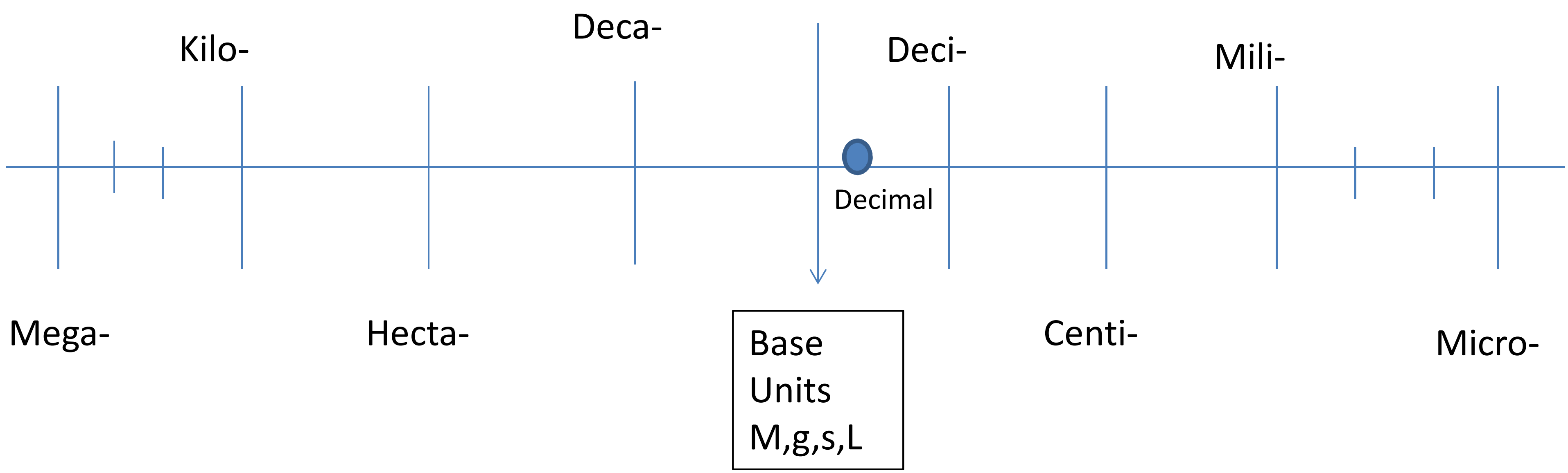
Metric Conversions

1. Meters → kilometers (1000m = 1 km)

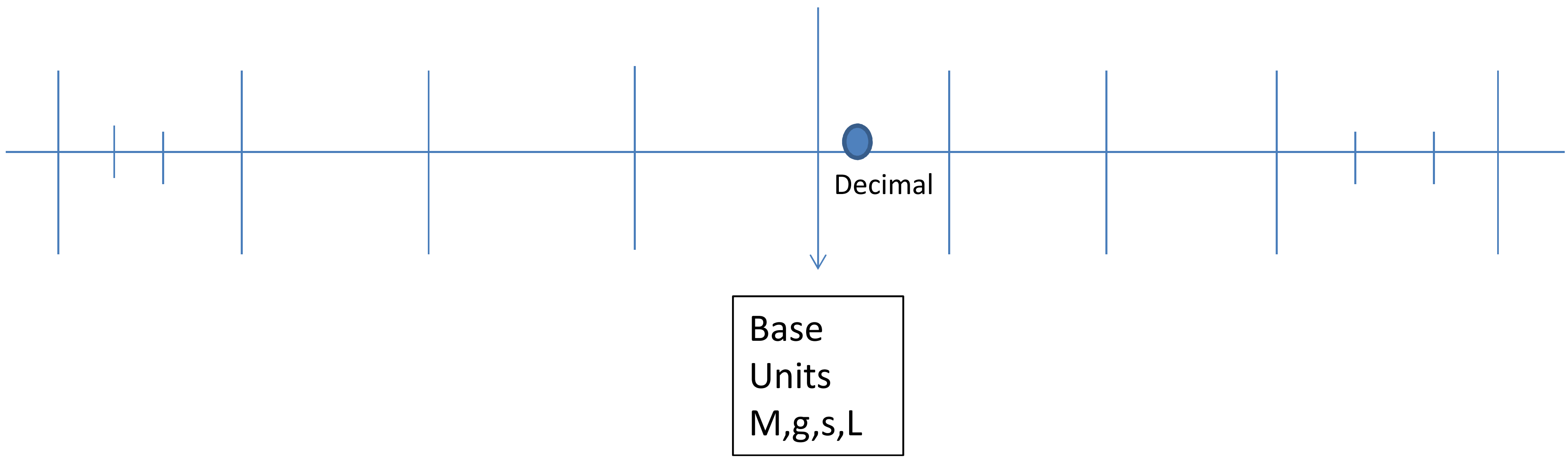
   4.21×10^4 m = ___________km

THERES A SHORTCUT! – Look at the staircase

Convert 180 milliliters to liters



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


Decimal
Base
Units
M,g,s,L