

SCIENTIFIC MEASUREMENT

WHY DO SCIENTISTS USE A STANDARD MEASUREMENT SYSTEM?

- To share information or repeat experiments done by other scientists.
- Modern scientists use a version of the metric system called the International System of Units (SI)



THE METRIC SYSTEM

- The metric system is a standard measurement system based on the number 10.
- Mass, length, and volume are measured using SI units.
- All SI units use the same prefixes.

SI UNITS OF MEASURE

- Length • meter
- Mass • gram
- Volume • Liter
- Time • second
- Temperature • Kelvin (we use Celsius in lab)

Kilo -
1000
units

Hecto -
100
units

Deka -
10
units

**Basic
Unit**

Deci -
0.1
units

Centi -
0.01
units

Milli -
0.001
units

To convert to a smaller unit, move decimal point to the right or multiply

To convert to a larger unit, move decimal point to the left or divide



LENGTH

- The distance from one point to another.
- Basic SI unit is the meter (m)
- Take measurements with a metric ruler

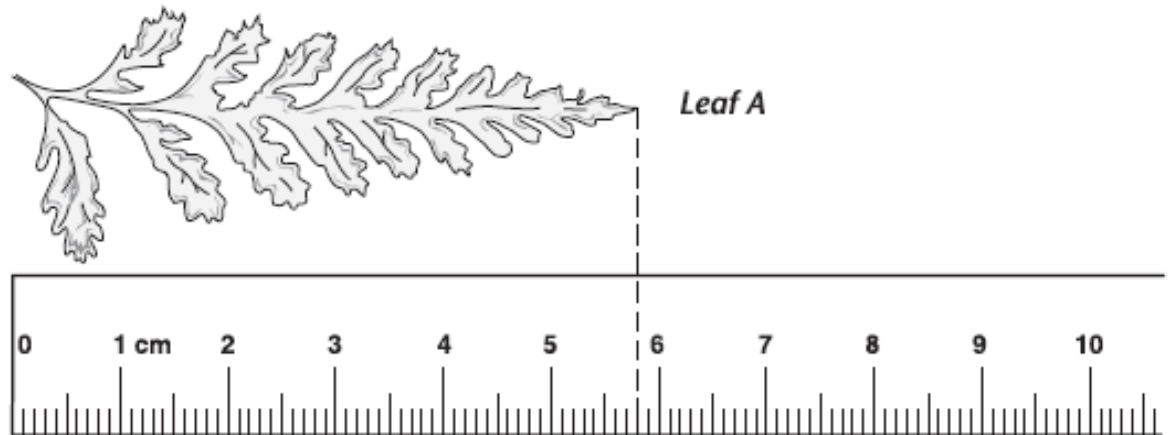
Conversions for Length

$$1 \text{ km} = 1,000 \text{ m}$$

$$1 \text{ m} = 100 \text{ cm}$$

$$1 \text{ m} = 1,000 \text{ mm}$$

$$1 \text{ cm} = 10 \text{ mm}$$



MASS

- Mass is the measure of the amount of matter in an object.
- Basic SI unit is the kilogram (kg).
- Take measurements with a triple beam balance

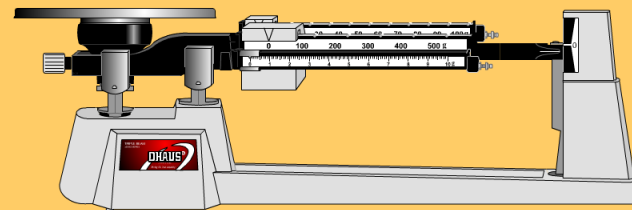
Conversions for Mass

$$1 \text{ kg} = 1,000 \text{ g}$$

$$1 \text{ g} = 1,000 \text{ mg}$$

Triple Beam Balance

Scale Reading Exercise



[Back to Entrance](#)

[NEXT](#)

<http://www.ohaus.com/input/tutorials/tbb/TBBread.html>

VOLUME

- The amount of space taken up by an object or substance.
- The basic SI unit for volume is cubic meter (m³), but liter (L) and cubic centimeter (cm³), are also commonly used.
 - Liter – liquid
 - Cubic centimeter – solid

Conversions for Volume

$$1 \text{ m}^3 = 1,000,000 \text{ cm}^3$$

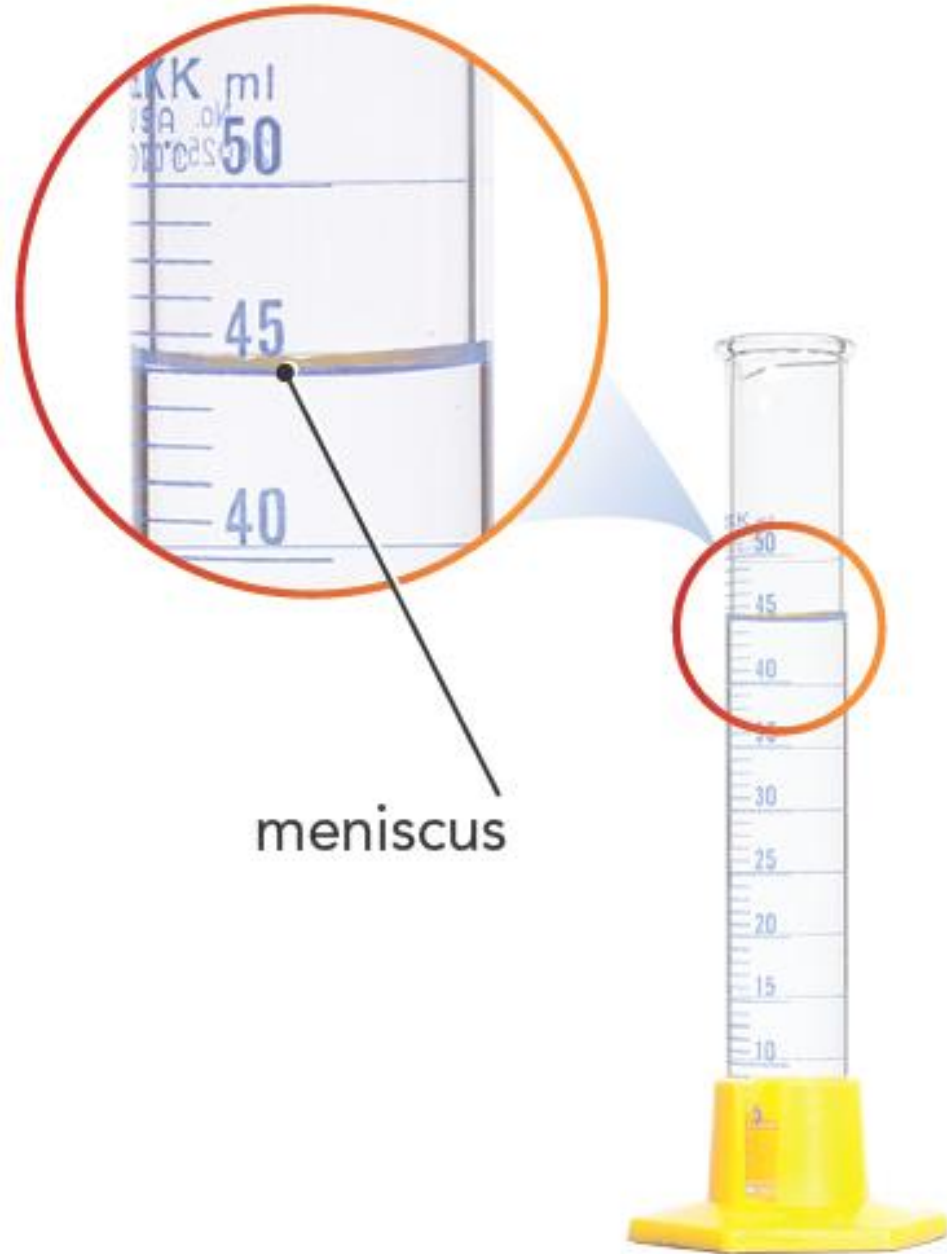
$$1 \text{ cm}^3 = 1 \text{ mL}$$

$$1 \text{ L} = 1,000 \text{ mL}$$

$$1 \text{ L} = 1,000 \text{ cm}^3$$

VOLUME

- Take measurements for liquid volume using a graduated cylinder
- Read the meniscus (curved line) at the bottom



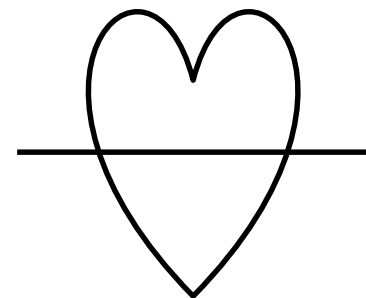
DENSITY



- The measure of how much mass is contained in a given volume.
- The SI unit for density is kilograms per cubic meter (kg/m³), but scientists commonly use:
 - grams per milliliter (g/mL)
 - grams per cubic centimeter (g/cm³)

- The formula for density:
- Density = LOVE

$$D = \frac{M}{V}$$



TIME

- The SI unit for time is the second (s).
- Can be divided into smaller units
 - Ex: milliseconds (ms)
- Take measurements for time using a clock or stopwatch



JESSICA SWIMS THE LAST RACE IN 22.56 SECONDS. BY HOW MUCH TIME DID SHE LOSE THE RACE?

$$22.56\text{S} - 22.40\text{S} = 0.16\text{S}$$

TEMPERATURE

- The measure of the energy of motion of the particles in a substance.
- When particles move fast = HOT
- When particles move slow = COLD
- Take measurements using thermometers.
- SI Unit is the Kelvin (K) but scientists commonly use Celsius (°C)

Conversions for Temperature

$$0^{\circ}\text{C} = 273\text{K}$$

$$100^{\circ}\text{C} = 373\text{K}$$

SCIENTIFIC NOTATION

Scientific notation is used when numbers are very large or very small.

Written in the following format: $a \times 10^n$

a is the coefficient and always between 1 and 10

n is the exponent



SCIENTIFIC NOTATION

- The exponent tells us how many spaces to move the decimal.
- Positive exponents move to the right.
- $3.14 \times 10^5 = \underline{314000}$ in standard notation.
- Negative exponents move to the left.
- $3.14 \times 10^{-5} = \underline{0.0000314}$ in standard notation.



DIMENSIONAL ANALYSIS

- A structured process for converting one set of units to another set of units.
- Dimensional analysis works when a conversion factor, or a fraction equal to one, is used until you reach the desired unit.



EXAMPLE

- How many centimeters are in 2 feet?
- Starting: 2 ft
- Ending: centimeters

$$\frac{2 \cancel{\text{ft}}}{1 \cancel{\text{ft}}} \times \frac{12 \cancel{\text{in}}}{1 \cancel{\text{in}}} \times \frac{2.54 \text{ cm}}{1 \cancel{\text{in}}} = 60.96 \text{ cm}$$

