Units of Measurement
Warm Up

- Name 3 tools used for measurement.
- What is a unit?
- Give an example of a unit.
- Why are units important?
SI MEASUREMENT

- Developed in the late 1700s
- Based on the powers of ten
- Abbreviated SI, which is French for Systeme International
- International standard of measurement
- Defined in terms of standards of measurement

To ensure that results have the same units and scientists can easily compare results and data.

Why is important to have measurement standards though?
## SI Base Units

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Symbol</th>
<th>Base Unit</th>
<th>Abbrev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>length</td>
<td>$l$</td>
<td>meter</td>
<td>m</td>
</tr>
<tr>
<td>mass</td>
<td>$m$</td>
<td>kilogram</td>
<td>kg</td>
</tr>
<tr>
<td>time</td>
<td>$t$</td>
<td>second</td>
<td>s</td>
</tr>
<tr>
<td>temperature</td>
<td>$T$</td>
<td>Kelvin</td>
<td>K</td>
</tr>
</tbody>
</table>
Prefixes are added to the names of SI base units to represent quantities that are larger or smaller than the base units.

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Scientific notation</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>mega (M)</td>
<td>$10^6$</td>
<td>1 000 000</td>
</tr>
<tr>
<td>kilo (k)</td>
<td>$10^3$</td>
<td>1 000</td>
</tr>
<tr>
<td>hecto (h)</td>
<td>$10^2$</td>
<td>100</td>
</tr>
<tr>
<td>deka (da)</td>
<td>$10^1$</td>
<td>10</td>
</tr>
<tr>
<td><strong>Base Unit</strong></td>
<td><strong>$10^0$</strong></td>
<td>1</td>
</tr>
<tr>
<td>deci (d)</td>
<td>$10^{-1}$</td>
<td>0.1</td>
</tr>
<tr>
<td>centi (c)</td>
<td>$10^{-2}$</td>
<td>0.01</td>
</tr>
<tr>
<td>milli (m)</td>
<td>$10^{-3}$</td>
<td>0.001</td>
</tr>
<tr>
<td>micro (µ)</td>
<td>$10^{-6}$</td>
<td>0.000 001</td>
</tr>
<tr>
<td>nano (n)</td>
<td>$10^{-9}$</td>
<td>0.000 000 001</td>
</tr>
</tbody>
</table>
Standard Units of Measurement

- **Length**: the distance between two points
  - SI base unit = meter

- **Mass**: the measure of the amount of matter that makes up an object
  - SI unit = kilogram
DERIVED UNITS

- Combinations of SI base units
- Produced by multiplying or dividing standard units

**Ex:**
- **Area** \((m^2)\)
  - length \(\times\) width
- **Volume** \((m^3\) or \(cm^3)\)
  - length \(\times\) length \(\times\) length
- **Density** \((kg/m^3\) or \(g/cm^3)\)
  - mass per volume
Volume

- **Volume**: the amount of space occupied by an object
- SI unit = cm$^3$

Volumes of liquids and gases are often measured by a non-SI unit called the liter (L)
- 1 L = 1000 cm$^3$

- mL is used for smaller volumes
  - 1000 mL = 1 L
- 1000 mL = 1L = 1000 cm$^3$ → 1 mL = 1 cm$^3$
Density

- **Density**: the ratio of mass to volume or mass divided by volume
  - Density = mass/volume or $D = \frac{m}{V}$
- A characteristic property of a substance
  - Can be used as one property to help identify a substance

- SI unit = kg/m$^3$
- Units often used = g/cm$^3$ or g/mL

How tightly packed matter is. The amount of mass in a given space.

Less dense  More dense
Examples of…
- Units of mass?
  - g, kg, mg
- Units of volume?
  - L, mL, cm³, m³
Comparing Densities

- If something was less dense would it float or sink?
  - Float

- If something was more dense would it float or sink?
  - Sink

- So, imagine you have two liquids. Liquid A has a density of 2.45 g/mL and Liquid B has a density of 1.89 g/mL. Which liquid would sink? Which liquid would float?
  - Liquid A = sink ; Liquid B = float
DENSITY: SAMPLE PROBLEM #1

- A sample of aluminum has a mass of 8.4 g. The volume of the sample is 3.1 cm$^3$. Calculate the density of the aluminum.

- **Given:**
  - $m = 8.4$ g
  - $V = 3.1$ cm$^3$

- **Unknown:**
  - $D =$ ?

- **Solve:**
  - $D = \frac{m}{V}$
  - $D = \frac{8.4 \text{ g}}{3.1 \text{ cm}^3} = 2.7 \text{ g/cm}^3$
DENSITY: SAMPLE PROBLEM #2

- An object has a volume of 825 cm\(^3\) and has a density of 13.6 g/cm\(^3\). Find its mass.

- **Given:**
  - \(V = 825\) cm\(^3\)
  - \(D = 13.6\) g/cm\(^3\)

- **Unknown:**
  - \(m = ?\)

- **Solve:**
  - \(D = \frac{m}{V}\)
  - \(m = (13.6\text{ g/cm}^3)(825\text{ cm}^3) = 11,220\text{ g or }1.12 \times 10^4\text{ g}\)
YOU TRY!

- What is the density of a block of marble that occupies 310 cm$^3$ and has a mass of 853 g?
  - 2.75 g/cm$^3$

- Diamond has a density of 3.26 g/cm$^3$. What is the mass of a diamond that has a volume of 0.350 cm$^3$?
  - 1.14 g

- What is the volume of a sample of liquid mercury that has a mass of 76.2 g, given that the density of mercury is 13.6 g/mL?
  - 5.60 mL
1. The mass of a sample of aluminum is 4.82 g. The same sample of aluminum occupies a volume of 3.08 mL. Determine the density of the aluminum sample.

2. A small gold nugget has a volume of 0.87 cm$^3$. What is its mass if the density of gold is 19.3 g/cm$^3$?

3. What volume is occupied by 35.2 g of carbon tetrachloride if its density is 1.60 g/mL?

4. A cork occupying a volume of 5.23 mL is measured to have a mass of 14.7 g. What is the density of the cork?

5. A wooden block has a mass of 18 g and has a known density of 0.72 g/mL. How much volume does the block occupy?

6. A girl wanted to check if the ring her boyfriend got her was really gold. She tested the ring and found it to have a mass of 65 g and has a volume of 21 cm$^3$. Gold is known to have a density of 19.3 g/cm$^3$. Is the ring gold?