Observation - interaction of our senses with the environment
- sight, touch, taste, smell
- senses give limited or vague information

Measurements – using a standard unit to describe a sense
- meters, seconds, grams, liters, degrees Celsius
  • more accurate, precise and consistent
  • allows more detailed observations

Instrument - used to improve or extend our powers of observation
  • examples:

Inference - an interpretation of an observation based on one’s knowledge and experience
  • an educated guess or prediction
  • example: weather forecasts

Identify each statement as either an observation or an inference:

1. (a.) The dog is growling. ______________
   (b.) The dog is angry. ______________
2. (a.) The pebble is smooth and rounded. ______________
   (b.) The pebble was carried by a stream. ______________
   (c.) The pebble is light brown in color. ______________
3. (a.) By tomorrow, the stream will overflow its banks. ______________
   (b.) The river is high, muddy and flowing swiftly. ______________
   (c.) The rainfall has been continuous and is very heavy. ______________
4. (a.) The tire has a leak. ______________
   (b.) The tire is flat. ______________
5. (a.) There is a track on this trail. ______________
   (b.) The track was made by a large deer. ______________
6. (a.) The leaves on the trees are moving. ______________
   (b.) The leaves on the trees are moving, so the wind must be blowing. ______________
Classification

**Classification** - to organize objects, ideas, or information to make it more meaningful/useful.

- based on the properties or characteristics of an object

ANIMALS

- fish
- birds
- mammals
- reptiles

- shark
- piranha
- eagle
- falcon
- gorilla
- bear
- snake
- lizard

Measurement

- measurements are made to express an observation with greater precision
- consist of:
  1. **numerical value**
  2. **label**

- examples:
  1. 3 meters
  2. 100 km./hr.
  3. 26 grams

**Distance** - ruler/meter stick

- unit = meter (m)
- conversions:
  1. 1 meter = 100 centimeters
  2. 1000 millimeters
  3. 1 kilometer = 1000 meters

**Temperature** – average kinetic energy of a material

- instrument - thermometer
- unit = degrees

- examples:
  1. Kelvin (°K)
  2. Celsius (°C)
  3. Fahrenheit (°F)

Reference Tables p. 13
Measurement

**Volume** – amount of space an object occupies
- regularly shaped objects:
  - formula: \( V = l \times w \times h \)
  - unit = cubic centimeters (\( \text{cm}^3 \))
- liquids/irregularly shaped objects: **water displacement**
  - instrument - graduated cylinder
  - unit = milliliters (\( \text{ml} \))
    \[ 1 \text{ ml.} = 1 \text{ cm}^3 \]

**Weight** - measure of the amount of gravity acting on an object
- instrument - scale
- units = pounds, ounces

Earth

180 lbs.

Moon

30 lbs.

Gravity = 1/6 Earth's

* his mass has not changed!!

**Mass** – the amount of matter an object has
- instrument - balance
- units = grams (\( g \))
  \[ 1000g = 1 \text{ kg.} \]

**Density** – concentration of matter in an object
- ratio of mass per unit volume
- formula:
  \[ \text{density} = \frac{\text{mass}}{\text{volume}} \]
  \[ D = \frac{m}{v} \]
- unit = g/cm\(^3\) or g/ml.

**Equations**

- Eccentricity = \( \frac{\text{distance between foci}}{\text{length of major axis}} \)
- Gradient = \( \frac{\text{change in field value}}{\text{distance}} \)
- Rate of change = \( \frac{\text{change in value}}{\text{time}} \)
- Density = \( \frac{\text{mass}}{\text{volume}} \)

Reference Tables p. 1
# Metric Measurements

- in Science, we usually use metric or international units (except in weather)

**Standard Units** - (a unit is a given amount of something that is the same everywhere)

<table>
<thead>
<tr>
<th>Property</th>
<th>Unit</th>
<th>Instrument</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance</td>
<td>meter (m)</td>
<td>ruler</td>
<td>length, width, height</td>
</tr>
<tr>
<td>Mass</td>
<td>gram (g)</td>
<td>balance</td>
<td>amount of matter (molecules)</td>
</tr>
<tr>
<td>Weight</td>
<td>newton (N)</td>
<td>scale</td>
<td>pull of gravity on matter</td>
</tr>
<tr>
<td>Volume</td>
<td>liter (L)</td>
<td>graduated cylinder</td>
<td>amount of space occupied</td>
</tr>
<tr>
<td>Temperature</td>
<td>degree Celsius (°C)</td>
<td>thermometer</td>
<td>average kinetic energy of molecules</td>
</tr>
<tr>
<td>Time</td>
<td>second (s)</td>
<td>watch</td>
<td>how long lasting</td>
</tr>
<tr>
<td>Density</td>
<td>grams/ meter (g/m)</td>
<td></td>
<td>how close molecules are packed in a space</td>
</tr>
</tbody>
</table>

## Unit Prefixes
- (a prefix multiplies the unit to make it bigger or smaller)

<table>
<thead>
<tr>
<th>Prefix Name</th>
<th>Value</th>
<th>Power of Ten</th>
</tr>
</thead>
<tbody>
<tr>
<td>milli</td>
<td>.001</td>
<td>$10^{-3}$</td>
</tr>
<tr>
<td>centi</td>
<td>.01</td>
<td>$10^{-2}$</td>
</tr>
<tr>
<td>deci</td>
<td>.1</td>
<td>$10^{-1}$</td>
</tr>
<tr>
<td>deka</td>
<td>10</td>
<td>$10^{1}$</td>
</tr>
<tr>
<td>nano</td>
<td>1000</td>
<td>$10^{3}$</td>
</tr>
</tbody>
</table>
Scientific Notation

Scientific Notation is an abbreviation for writing very large or very small numbers

- ex.: 65,000,000 = 0.00065 =
- to use scientific notation, you move the decimal places at the beginning or end of a number and replace them with a power of ten ($10^{\text{power}}$)
- only zeros are removed at the beginning or end of a number (never within a number)
- numbers greater than one have a positive exponent while numbers less than one have a negative exponent

- Examples:

  145,000 = $1.45 \times 10^5$
  8,076 = $8.067 \times 10^3$
  405,000,000 = $4.05 \times 10^8$
  .000145 = $1.45 \times 10^{-4}$
  .8076 = $8.076 \times 10^{-1}$
  .000000405 = $4.05 \times 10^{-7}$
Density

• things that are less dense will float in more dense materials:
  1. a cork floats in water. A cork is less dense than water. Cork’s density is less than 1.0g/ml.
  2. a rubber “cork” will sink in water. It’s density is greater than 1.0g/ml.

• which substances are more dense than water?
• which substances are less dense?
• which have the same density as water?
• which one floats like ice?
Density Relationships

Density and Size
• the size of an object does not effect its density

\[ d = \frac{m}{V} \]

Density and Temperature
• as temperature increases, density decreases

Density and State of Matter
• water has a maximum density as a liquid at 4°C

Density and Pressure
• as pressure increases, density increases
Regents Earth Science – Unit 2: Changes and Graphing

Changes

Change (Event) - occurs when the properties of a system or matter are altered

- some occur fast (meteorite impact)
- most occur slow (mountain building, continental drift, expansion of the universe)

All changes have the following characteristics:

1. flow of energy from high potential (source) to low potential (sink)
2. occur at the interface (boundary) between two different materials or systems
3. observed from a fixed reference point based on time and space/distance

Reference point - place where you begin your measurement (location, time)

- space - property by which you are measuring the change

Dynamic Equilibrium - two opposite changes occur at the same time and at the same rate

- does not appear to be any change
- dynamic means changing
- equilibrium means equal

Static Equilibrium - no change occurring

- static means not changing

Earth is in constant change with most changes occurring in cycles

- some cycles are short (day and night, seasons)
- some cycle are long (ice ages, precession of axis) and are therefore difficult to observe
Rate of Change - how fast a change occurs

\[ R = \frac{\Delta FV}{T} \]

Ex.: The temperature changes from 56°F to 45°F in 3 hours. What is the rate of change?

\[ R = \frac{\Delta FV}{T} = \frac{56°F - 45°F}{3 \text{ hrs.}} = 3.7°F/\text{hr.} \]

Graphing

Graph - picture of our data

- **Bar Graphs** - show amounts of variables
- **Pie Graphs** - show percentages of a whole
- **Line Graphs** - show relationships of changing variables

Parts of a Graphs:

- **Independent Variable** - determined before the experiment begins
  - always on the horizontal axis
  - measured at preset, regular intervals

- **Dependent Variable** - measurement that is taken and recorded during the experiment
  - always on the vertical axis

**Ex.**: graph the temperature of the room throughout the day

**Time of Day (hours)** (known)

**Temp. (°C)** (unknown)
Graphing

How to determine the scale:
1. Find the range between the highest and lowest values for the variable
2. Divide the range by the number of spaces on the axis
3. Round off the answer from the division to the next whole number that is easy to work with on a graph scale

A line graph shows 4 properties of change:
1. speed of change (rate)
2. consistency of change
3. relationships between variables
4. extrapolation and interpolation

**Speed of Change** - shown by the slope of the line
- the steeper the slope, the faster the change is taking place

**Consistency of Change** - a straight line is constant speed, curving (bending) lines are a change in speed (rate)

There are 4 basic types of graph relationships:
1. Direct - as 1 variable increases, the other increases (change the same)
2. Inverse - as 1 variable increases, the other decreases (change opposite)
3. No Relationship - as one variable increases, the other stays the same
4. Cyclic - repeating pattern
Graphing

- **Extrapolation** - to predict data by extending the graph pattern from the data plotted

- **Interpolation** - to predict data between plotted points based on the graphed line
  - read between connected plotted points

\[
X = \frac{8 \text{ m}}{10 \text{ sec.}}
\]

\[
X = 0.8 \text{ m/sec.}
\]