EARTH SCIENCE

KEY UNIT 1

Updated and adapted from David J. Mills 2001

UNIT 1

OBSERVATION AND MEASUREMENT OF THE ENVIRONMENT

OBSERVATION AND MEASUREMENT OF THE ENVIRONMENT

I. OBSERVATION – Interaction of our senses with our environment

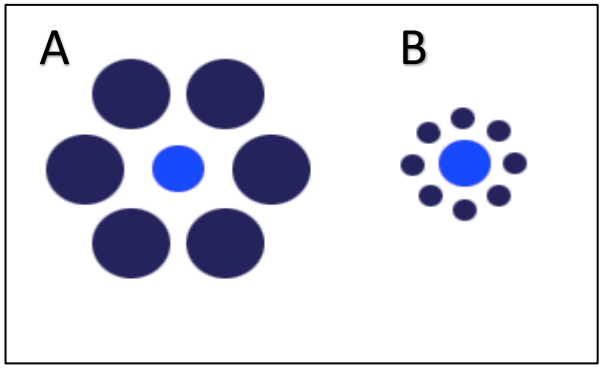
A. The five senses include:

1. Sight
2. Hearing
3. Touch / feel
4. Taste
5. Smell

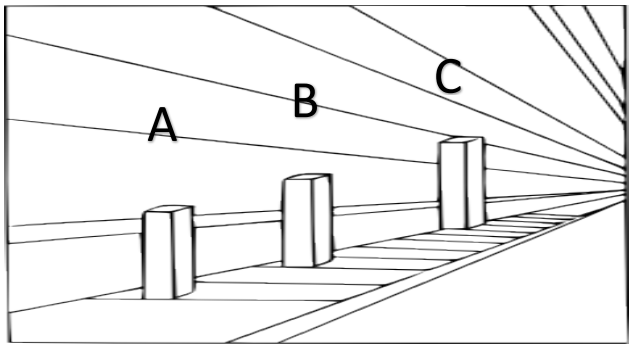
A. Testing your powers of observation:

1. Use ONLY your sense of sight to make observations to determine:

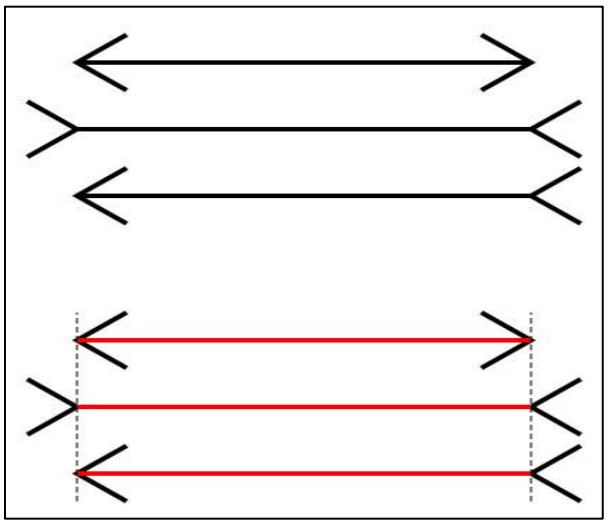
A. Which, if any, of the center circles is larger?



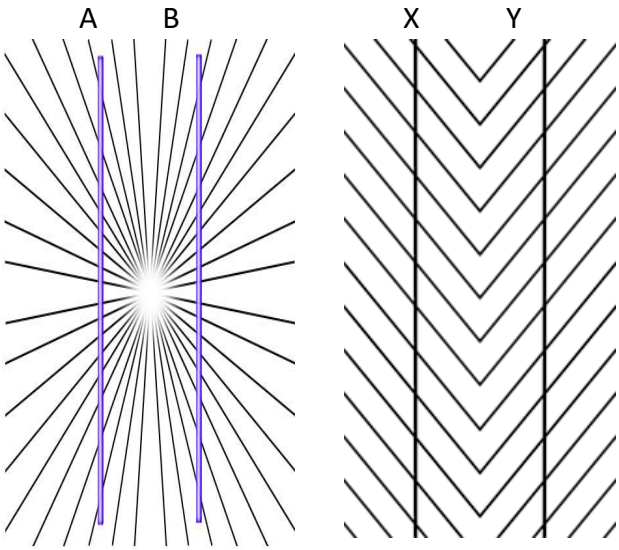
B. Which, if any, of the three blocks is the tallest?



C. Which, if any, of the lines is longest?



D. Which, if any, of the pairs of lines are parallel?



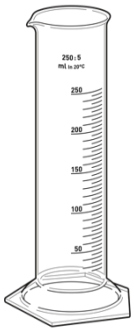
2. How can we determine if our power of observation using only sight was accurate? **Measure with a ruler**.

3. Check to determine if you were accurate. How many observations using only sight did you have correct? (1,2,3 or 4?) _____

C. **Our powers of observation are limited by our senses.**

D. **INSTRUMENTS-** Instruments are used to improve or extend our powers of observation. These devices have been invented by people to extend the human senses beyond their normal limits and enable us to make observations that would otherwise be impossible or highly inaccurate.

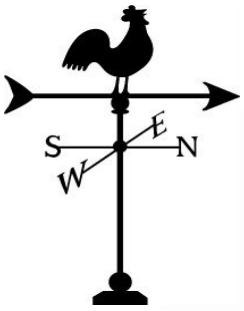
E. **EXAMPLES**:



GRADUATED CYLINDER

MICROSCOPE

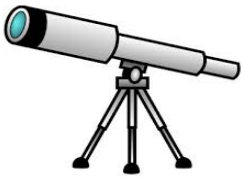
SPRING SCALE



WIND VANE

THERMOMETER

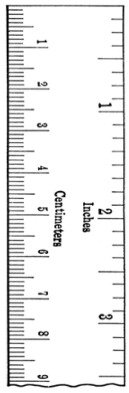
MAGNIFYING GLASS



TELESCOPE

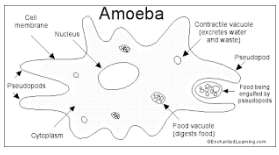
TRIPLE BEAM

COMPAS



RULER

F. Which instruments can be used to Accurately measure each of the following?



1. **MICROSCOPE**

2 **TELESCOPE**

3. **THERMOMETER**

II. **INFERENCE**: **An interpretation of an observation based on one's knowledge and / or prior experience**

A. For example, if you observed the appearance of more and more clouds that were darker and darker in color, you might infer that: **It will rain**

B. List the **OBSERVATIONS** and **INFERENCES** that you can make based on this picture:

OBSERVATION	INFERENCE

C. Review and HINTS:

- **Observations**-
  - **Information from YOUR senses only.**
  - **Instruments extend our powers of observations.**
  - ***Hint: Measurements are all observations*!**
- **Inferences** –
  - **Using prior knowledge to explain an observation.**
  - ***HINT: The past (history) and the future (forecasts / predictions) are always inferences because you were/are not there to make the observation yourself!***

D. Identify each statement as either an OBSERVATION or an INFERENCE:

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

I. III. CLASSIFICATION

A. A classification system is based on:

The properties or characteristics of an object

B. A classifications system enables an investigator to

Organize objects or data in a meaningful way

IV. MEASUREMENT

A. **A measurement is a way of expressing an observation with greater precision.**

Measurements provide a numerical value for some property of the object or event being observed.

1. All measurements consist of: (a) **A numerical value**

   (b) **A label**

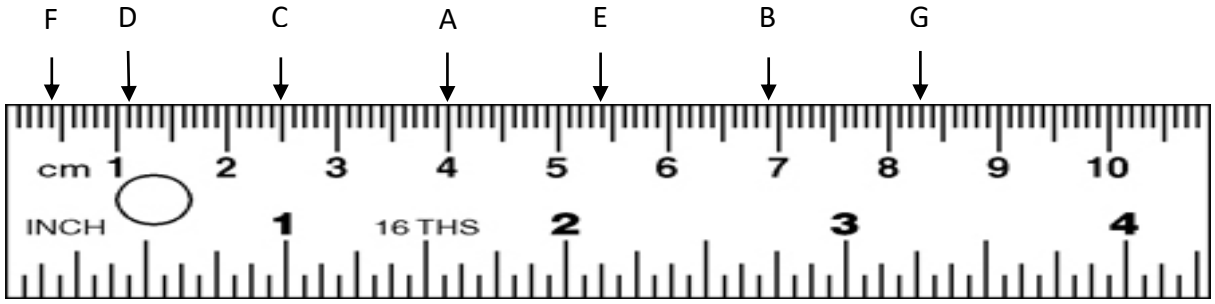
2. Some properties that can be measured include LENGTH, AREA, VOLUME, MASS, WIDTH, TEMPERATURE, DENSITY, TIME, etc.

B. Linear Measurement (or "one dimensional measurement")-

The distance between two points

1. Instrument: **RULER**
2. Unit: **METER**
   a. Centi = 1/100 meter — **100** centimeters = 1 meter
   b. Milli = 1/1000 meter — **1000** millimeters = 1 meter
   c. Kilo – 1000 meter — **1** Kilometer = 1000 meter
3. Using the model below, give the value of each dot to the nearest tenth of a centimeter and then convert to millimeters.

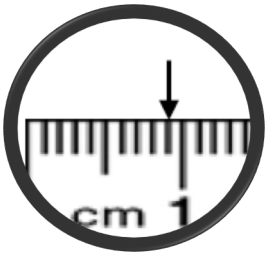
(NOT TO SCALE)



	CENTIMETERS	=	MILLIMETERS
A	**4.0**	=	**40**
B	**6.9**	=	**69**
C	**2.5**	=	**25**
D	**1.1**	=	**11**
E	**5.4**	=	**54**
F	**.4**	=	**4**
G	**8.3**	=	**83**

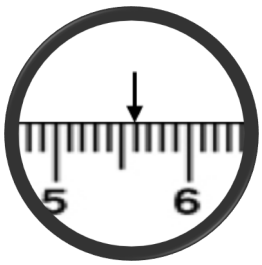
4. What is the length indicated by the arrow in each of the following pictures?

A



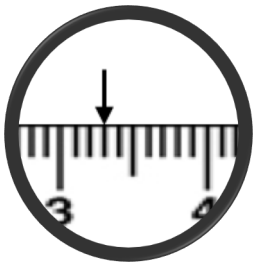
.9 cm

B



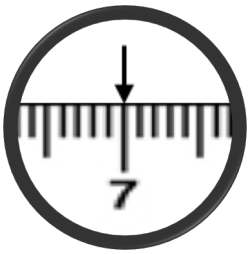
5.6 cm

C



3.3 cm

D



7.0 cm

5. Measure each line segment to the *nearest tenth of a centimeter* and then convert to millimeters:

(a)

(b)

(c)

(d)

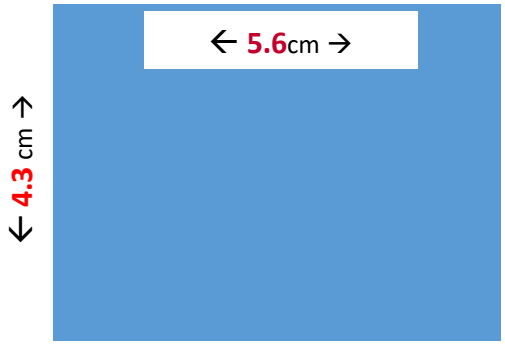
(e)

	cm	mm
(a)	**7.4**	**74**
(b)	**9.7**	**97**
(c)	**6.2**	**62**
(d)	**11.3**	**113**
(e)	**2.0**	**20**

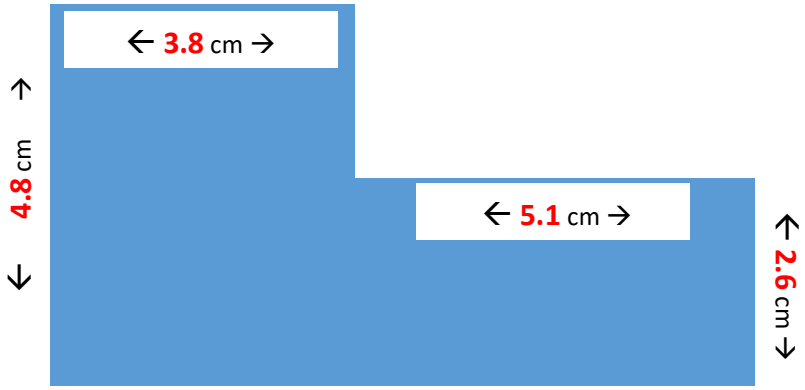
C. **AREA** (or "two dimensional measurements") – **The amount of surface space**

1. Instrument: **RULER**
2. Formula: **Area = Length X Width (A=LW)**
3. Units: **"Square Units"**
   - **a.** Square centimeter or **cm^2**
   - b. Square meter or **m^2**
   - c. Square kilometer or **km^2**

4. Determine the area of each figure below:



A = 4.3 * 5.6 = 24.08 = 24.1 c^2

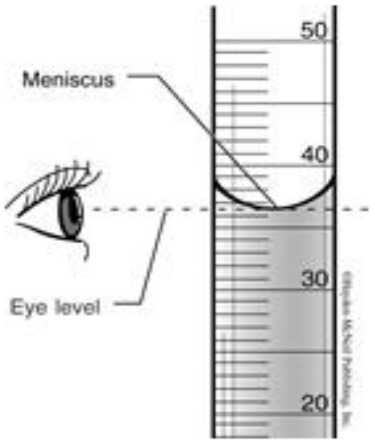


A = (4.8*3.8) + (5.1*2.6) = 31.5 = 31.5 cm^2

D. Volume (or "three dimensional measurements") sometimes referred to as the "size" of an object

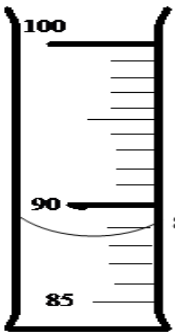
The amount of space an object occupies

1. Volume of liquids
    a. Instrument – **Graduated Cylinder**
    b. Units – **milliliters**
    c. Reading measurements on a graduated cylinder:



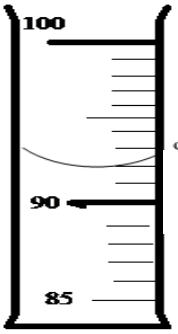
Measurement = 36.5 ml

    d. What is the volume of the liquid in the graduated cylinders illustrated below?



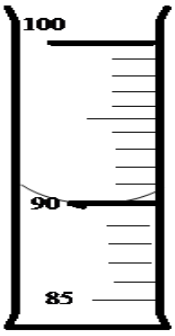
88.5 ml

1



92.0 ml

2



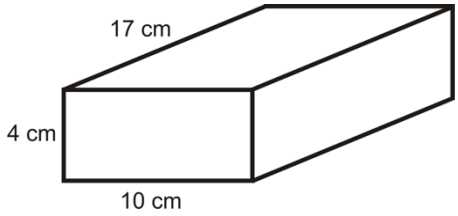
90.0 ml

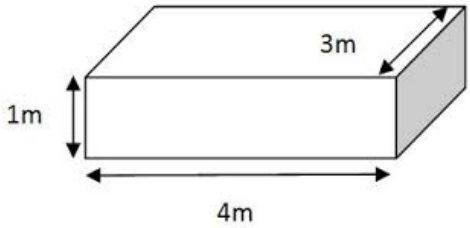
3

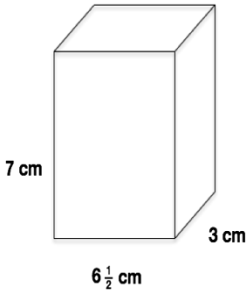
2. Volume of rectangular solids

    a. Instrument – **Ruler**
    b. Formula – **Volume = Length x width x height (V=LWH)**
    c. Units: **"Cubic" units**
        1. Cubic centimeters or **cc** or **cm^3**
        2. Cubic meters or **m^3**
    d. **1** cubic centimeter = **1** milliliter

e. Determine the volume of the objects in each illustration







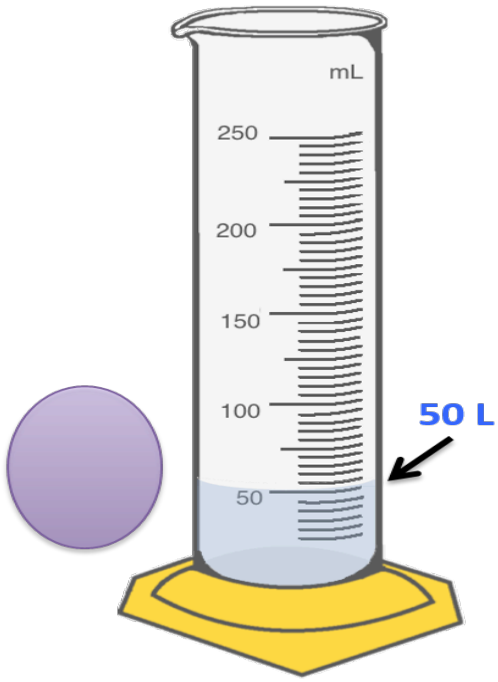
V= 17cm x 4cm x 10cm
V = 680 cc or cm^3

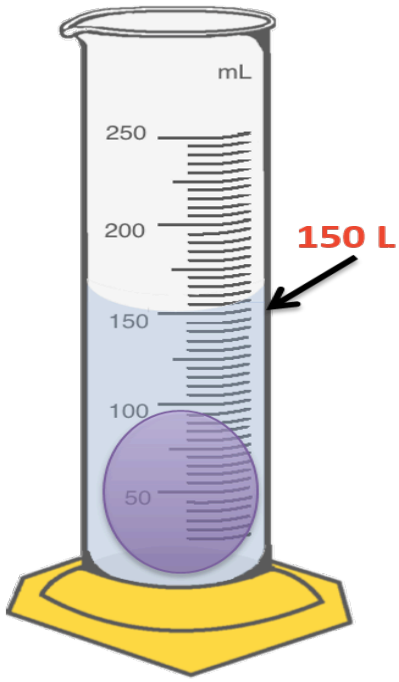
V= 1m x 4m x 3m
V = 12 m^3

V= 7cm x 6.5cm x 3cm
V = 136.5 cc or cm^3

3. Volume by displacement

Finding Volume:



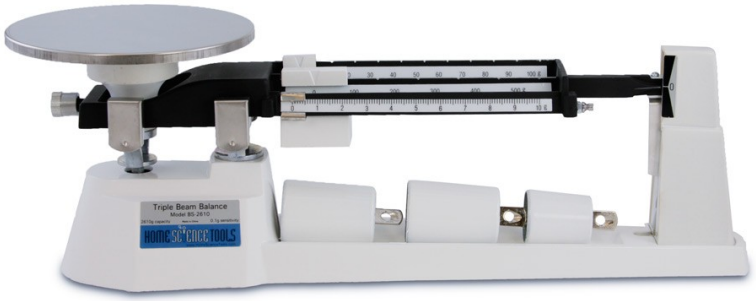


Volume of water	-	Volume of water + object	=	Volume of object
50 ml		**150 ml**		**100 ml**

E. Mass: The amount of matter an object possesses.

1. Instrument –

Digital Scale



Triple Beam Balance

2. Units:

(a) Grams (g)

(b) Kilograms (k)

F. Reading a triple beam balance:

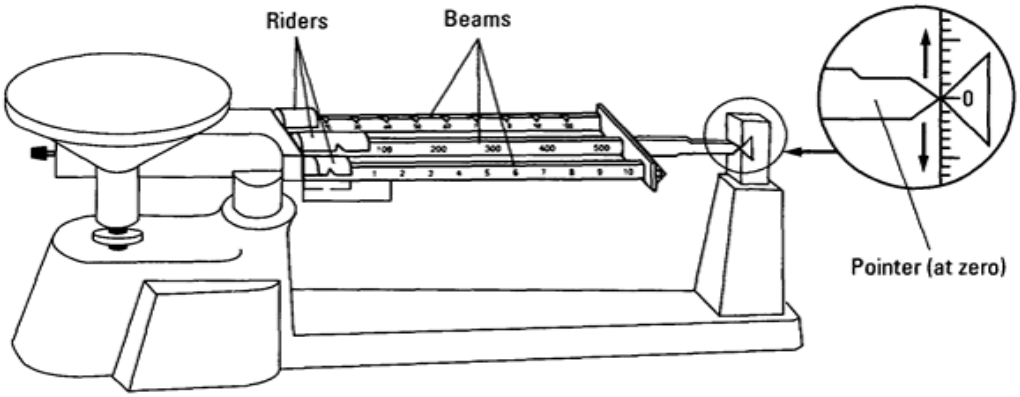
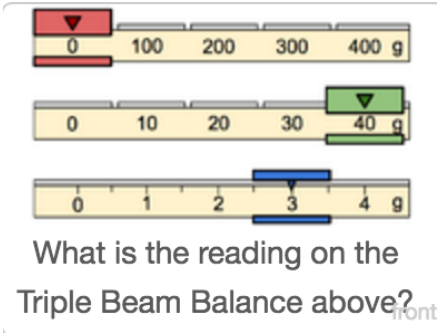
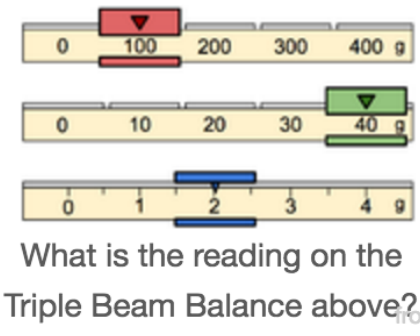


Figure 2



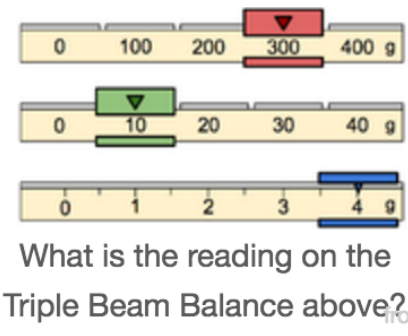
What is the reading on the Triple Beam Balance above?

43 g



What is the reading on the Triple Beam Balance above?

142g

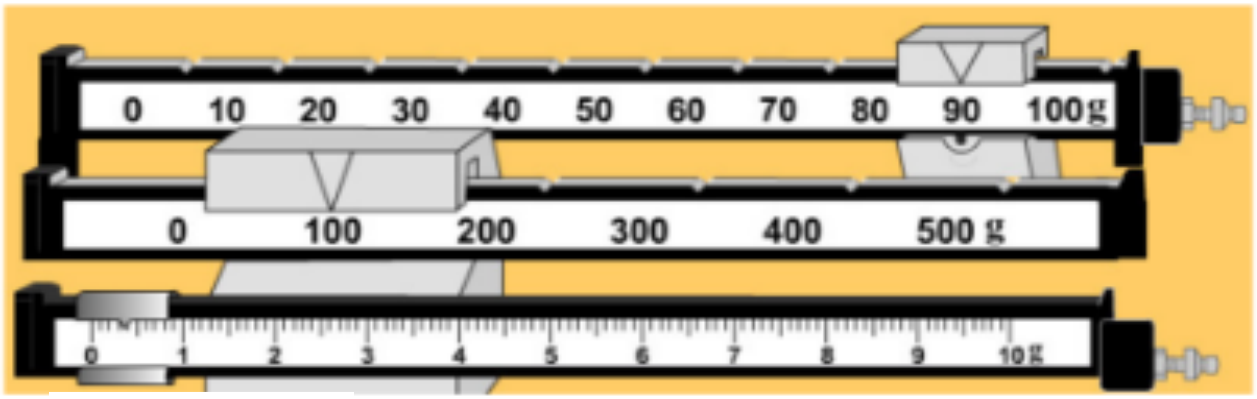


What is the reading on the Triple Beam Balance above?

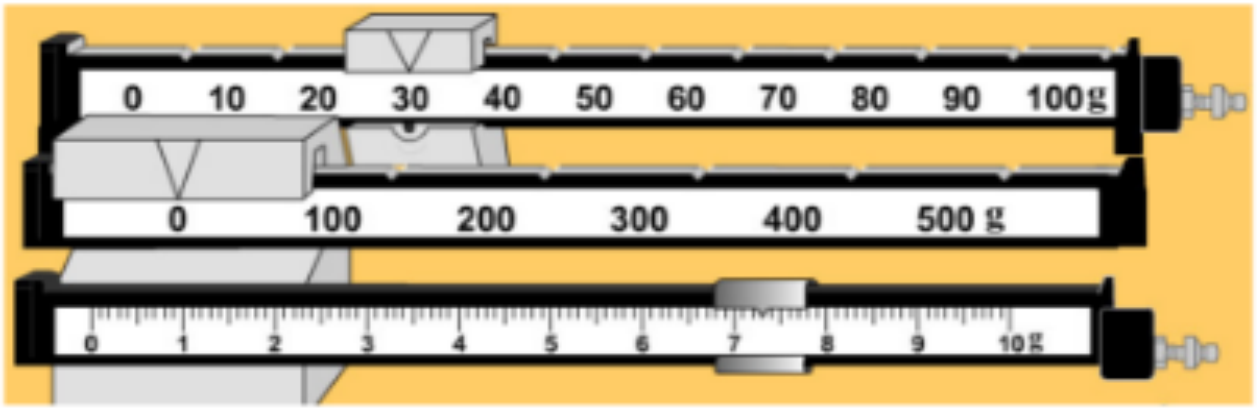
314g

Triple Beam Balance Practice

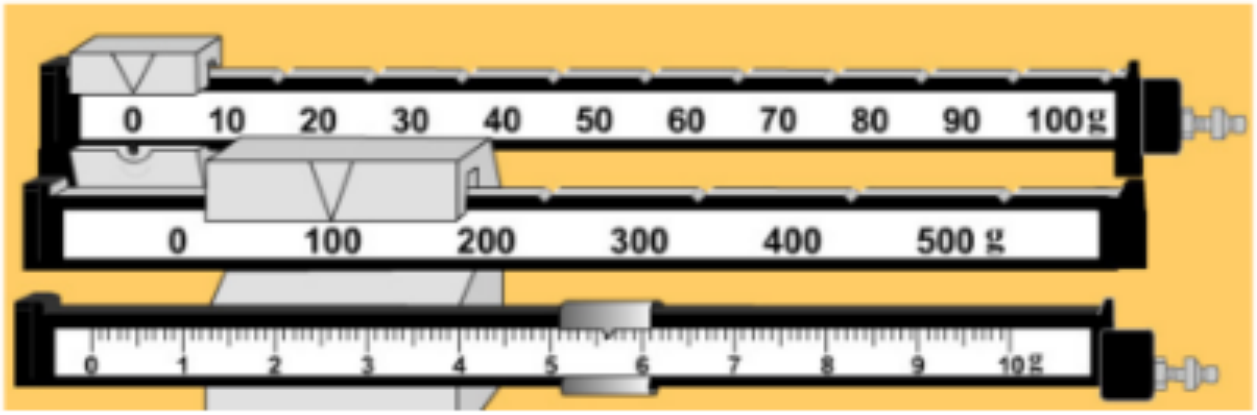
Record the mass show on each balance. Remember to include both the value on the beams and the unit of measurement.



1. **190.4 g**



2. **37.3 g**



3. **105.7 g**

E. **WEIGHT – THE MEASURE OF THE PULL OF GRAVITY ON AN OBJECT**

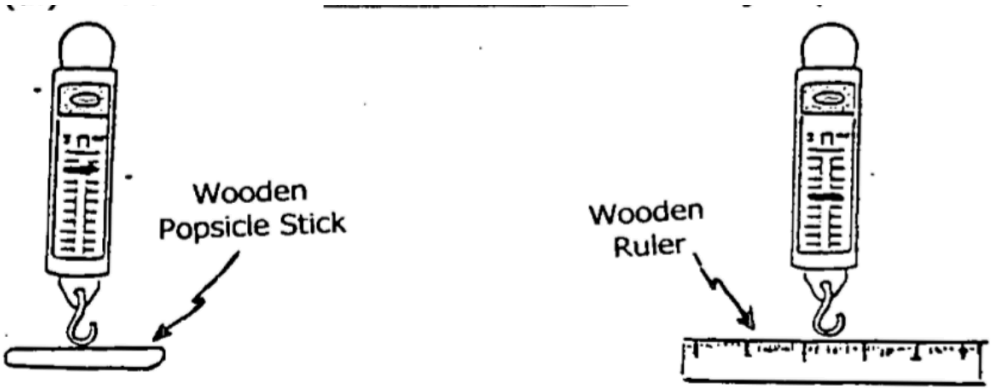
1. **INSTRUMENT: RULER**

2. **UNITS: (a) Metric – GRAMS**

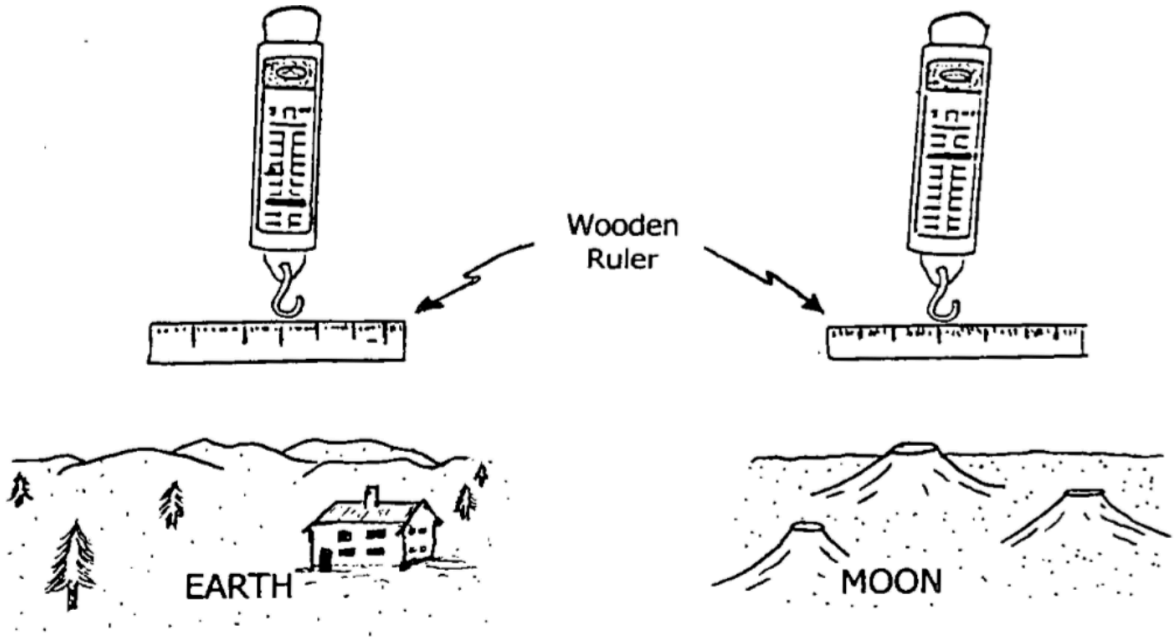
   (b) English - POUNDS

3. **Factors that cause weight or effect weight:**

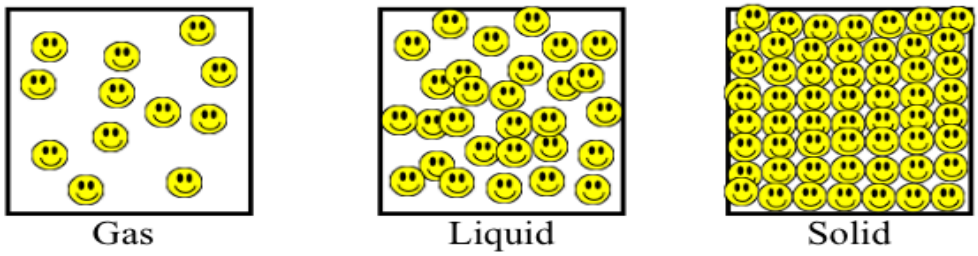
   a. **The amount of MASS the object possesses.**



   b. **The amount of GRAVITY acting on the object.**



G. Density: **The concentration of matter in an object - the ratio of mass per unit of volume**



Less dense → **More dense**

1. Formula: **ESRT: Page 1**

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}} \qquad D = \frac{m}{V}$$

ESRT Page 1 ☺

2. Instruments:

(A) Density of a liquid:

Graduated Cylinder & Scale

(B) Density of a solid

Ruler & Scale

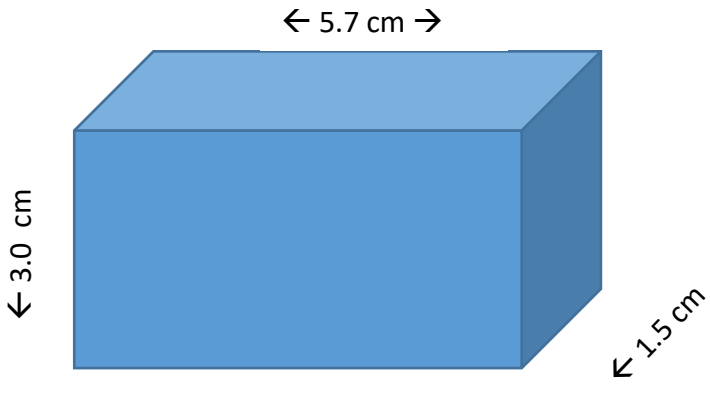
3. Units:

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}} = \frac{g}{cm^3} = \frac{g}{mL}$$

solids liquids

4. Solve the density problems below:

(a) The dimensions of a rectangular solid object is given as illustrated below. Given that This object has a mass of 150 grams; determine the density of the object:



1. State the Formula

D = M / V

2. Substitute your data into the equation

D = 150g / 3.0 cm x 1.5 cm x 5.7 cm

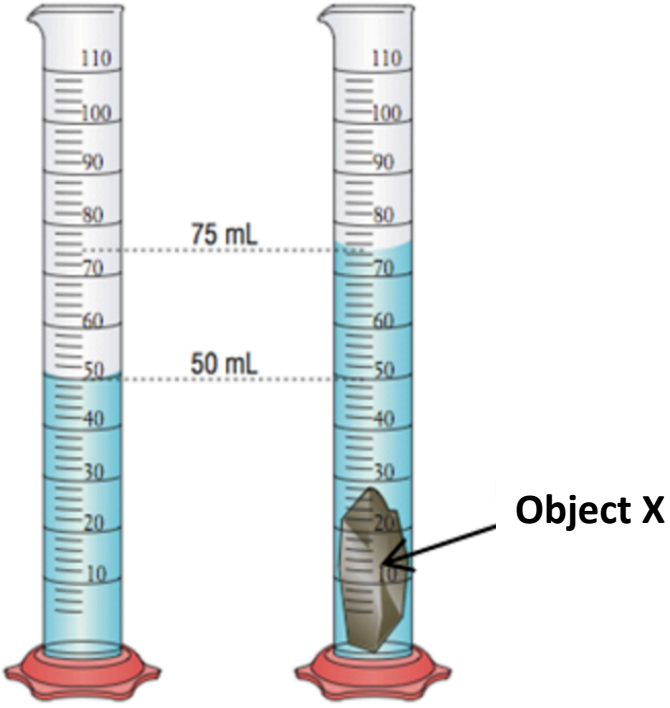
3. Solve the equation

D = 150 g / 25.65cm³

4. Round to the nearest tenth and use proper units.

D = 5.8479 = 5.8 g /cm³

(b) In the illustration to the right, the **mass of object X is 80 grams**. The volume of can be determined by the change in fluid level.



What is the density of object X?

Mass (given) = ***80g***

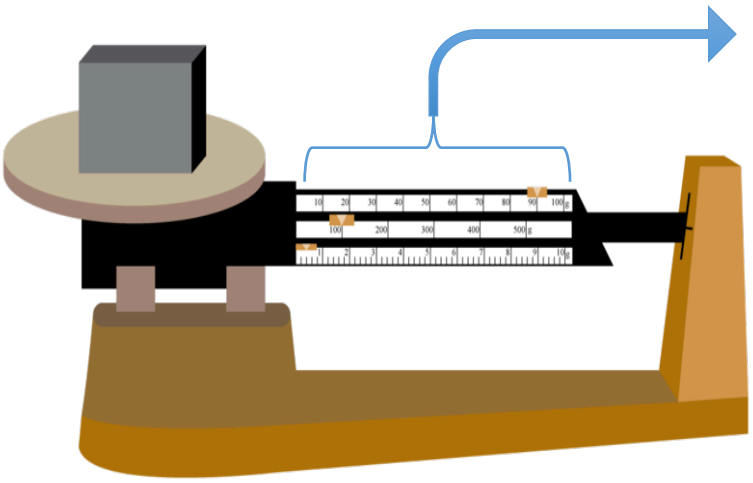
Volume (Difference in water level) = ***25ml***

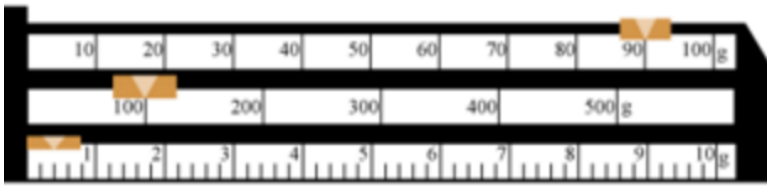
D = M/V

D = 80.0 g / 25.0 ml

D = 3.2 g/ml

(c) **Object Y is a perfect cube**. The **density of object Y is 23.8 g/cm^3**.





(1.) What is the **mass** of object Y as shown by the position of the balance riders?

190.4 g

(2) Calculate the volume of object Y.

8.0 cm^3.

D= M/V

23.8 g/cm^3 = 190.4 g / V

23.8 g/cm^3 = 190.4 g / 8.0 cc

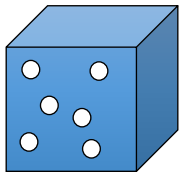
(3.) Since object Y is a perfect cube, determine the length of each side of that cube.

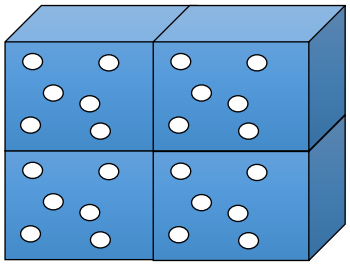
2.0 cm

H. **Density Relationships**

1. Density in relation to size

(a) **Model Problem**





KEY:

 = $1cm^3$

○ = 1 gram particles of matter of the SAME substance

D= M/V

Total mass = **6 g**

Total Volume = **1 cm^3**

Density = **6.0 g/cm^3**

D= M/V

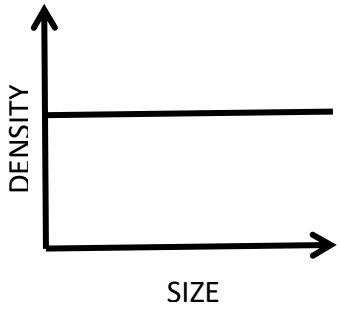
Total mass = **24.0 g**

Total Volume = **4 cm^3**

Density = **6.0 g/cm^3**

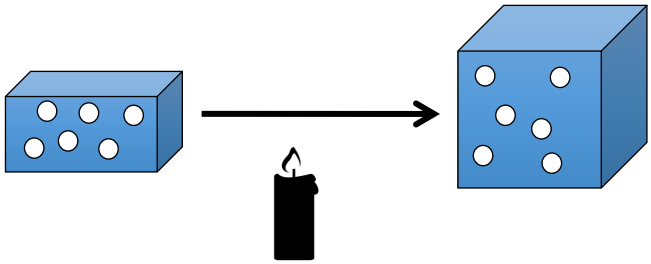
(b) **Relationship**: **The size of an object does not determine / effect it's density. Density is the SAME for any size object of the same, uniform substance.**

(c)



2. Density in relation to temperature

(a) Model Problem



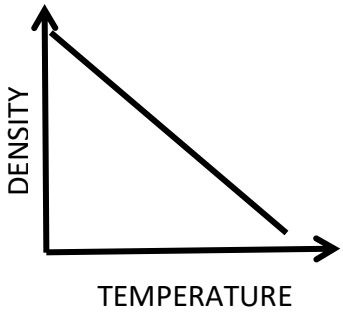
KEY:

○= 1 gram particle of matter

(1.) **Volume** = **INCREASES (EXPANDS)**
(2.) **Mass** = **REMAINS THE SAME**
(3) **Density** = **DECREASES**

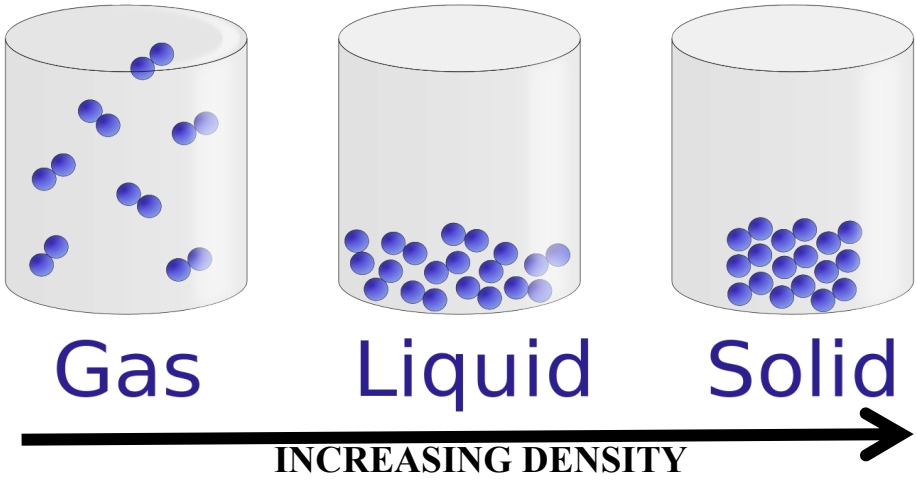
(b) Relationship: **As temperature increases, density decreases**.

(c)



3. Density in relation to state of matter

(a.) Model Problem



(b.) **INCREASING DENSITY**

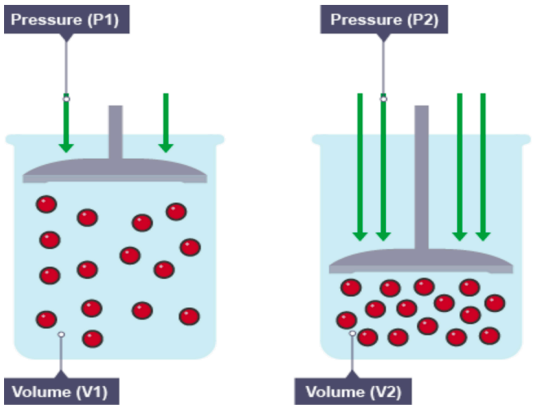
(c.) Most earth materials are most dense in their solid form

(d.) EXCEPTION!!! Water: has maximum density at 3.98^{0} C as a liquid!!!!

4. Density in relation to pressure (on a gas)

(a.) Model Problem

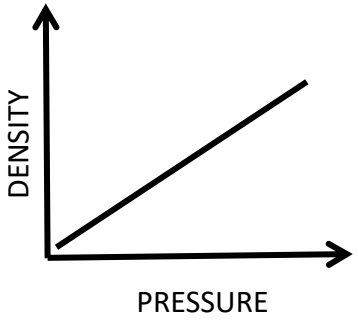
KEY:
● = Particle of matter



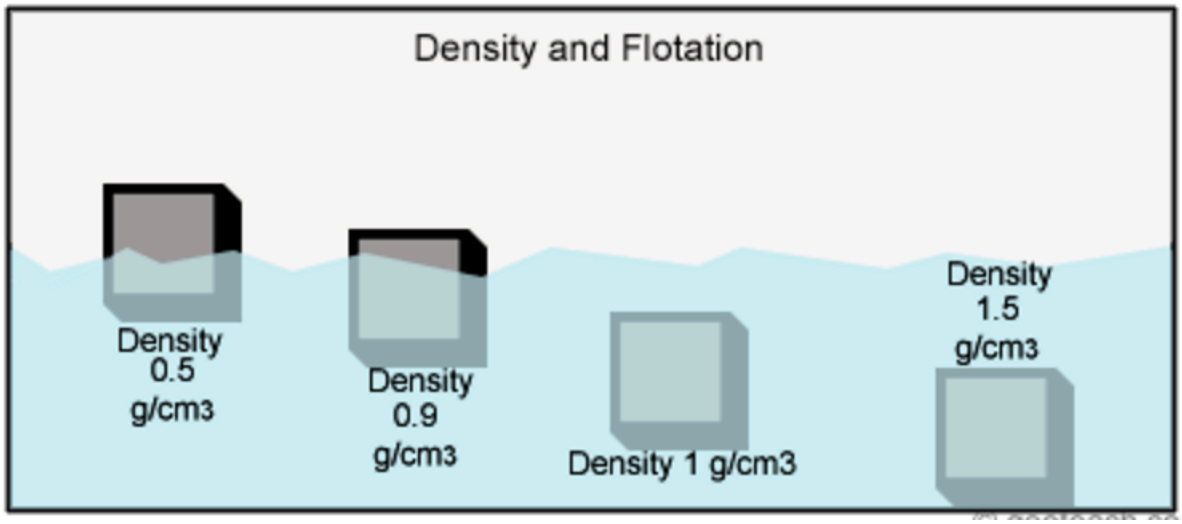
(1.) **Volume** = **DECREASES**
(2.) **Mass** = **REMAINS THE SAME**
(3) **Density** = **INCREASES**

(b.) **Relationship**: **As pressure increases, density increases**

(c.)



5. Density and floatation



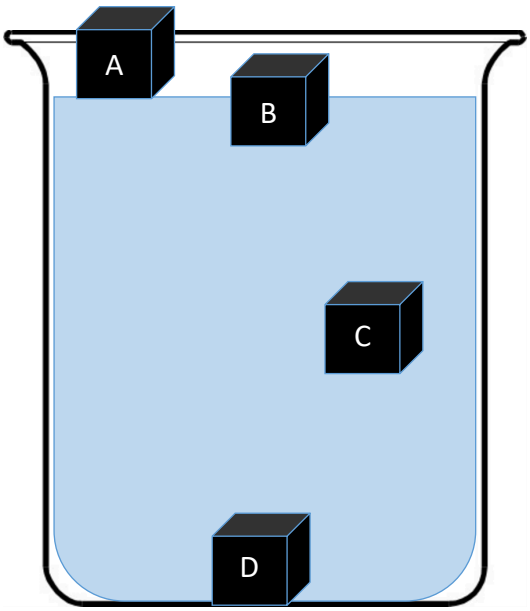
(1.) Liquid Water = 1.0 g/ml

(2.) Objects with density GREATER than 1.0 will SINK in water

(3.) Objects with density LESS than 1.0 will FLOAT in water

(4.) Objects with the SAME density of water (1.0) will suspend in

(a.) Sample Problem:



1. Which Object most likely has a density of:

a. 2.7 g/ml? D

b. 0.2 g/ml? A

c. 1.0 g/ml? C

d. Same as solid water (ice)? B

UNIT 1 VOCABULARY

1. **Observation:**

2. **Inference:**

3. **Classification:**

4. **Direct Relationship:**

5. **Inverse (or indirect) relationship:**

6. **Constant (or static) relationship:**

7. **Cyclic relationship:**

8. **Extrapolate:**

9. **Independent Variable:**

10. **Dependent Variable:**

11. **Density:**

12. **Mass**

13. **Volume**

Unit Topics for Review and Study:

1. Area
2. Classification
3. Density
    a. Relative
    b. vs. volume
    c. vs. Phase
    d. vs. Size
    e. vs. Temperature
    f. of Fluids
    g. Solve for: D, M, or V
4. Graph Relationships
    a. Cyclic
    b. Constant
    c. Direct
    d. Indirect / Inverse
5. Graphs:
    a. Pie
    b. Line
6. Inference
7. Measurement
8. Observation
9. Rate of Change
10. Safety
11. Scientific Notation
12. Volume

UNIT 1 HINTS & FACTS

(Here are some facts to help you study. You can also use this page to fill in your own)

1. ***Equilibrium = balance (equal)***

2. ***Dynamic Equilibrium = Balance between moving things***

3. ***The SAME materials have the SAME density NO MATTER WHAT SIZE!***

4. ***Properties of water can be found on PAGE 1 of the ESRT***

5. ***Measurements are ALWAYS observations***

6. ***Events in the past are ALWAYS inferences (you weren't there to see it happen)***

7. ***Predictions and forecasts are ALWAYS inferences (they haven't happened yet)***

8. ***Classification: Look for associated words: <u>Group</u> or <u>Organize</u>***

UNIT 1 SAMPLE QUESTIONS

1. Which action can be performed most accurately using only the human senses?

   A) tearing a sheet of paper into squares whose sides measure 1 centimeter
   B) adding 10 grams of salt to a cup of water
   C) measuring the air pressure of a room
   D) counting 28 shells from a beach

2. In the classroom during a visual inspection of a rock, a student recorded four statements about the rock. Which statement about the rock is an observation?

   A) The rock formed deep in the Earth's interior.
   B) The rock cooled very rapidly.
   C) The rock dates from the Precambrian Era.
   D) The rock is black and shiny.

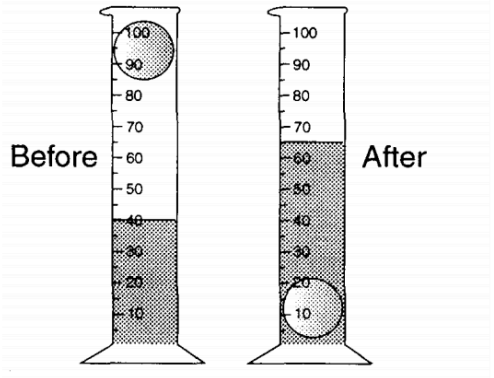
3. Which statement about a major hurricane is an inference?

   A) The windspeed is measured at 200 km/hr.
   B) The central air pressure is recorded at 946.0 mb.
   C) A rain gauge records three inches of rain in less than one hour.
   D) Damage from the storm is expected to be extensive.

4. A student is asked to classify several rocks. For best results, the classification should be based on

   A) inferences B) interpretations
   C) hypotheses D) observations

5. The sphere was dropped into water in a graduated cylinder as shown below.



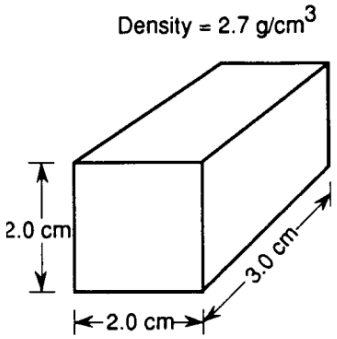
   What is the volume of the sphere?

   A) 15 mL B) 25 mL
   C) 40 mL D) 65 mL

6. As air on the surface of Earth warms, the density of the air

   A) decreases B) increases
   C) remains the same

7. Base your answer to the following question on the diagram below, which represents a solid material of uniform composition.



   When this material is placed in a container of water, it sinks to the bottom of the container. Compared to the density of water, the density of this material is

   A) less B) greater
   C) the same

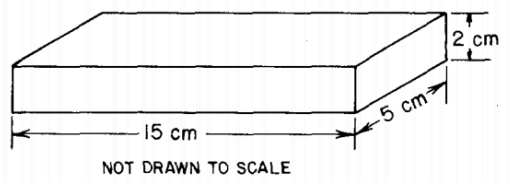
8. Compared to the density of liquid water, the density of an ice cube is

   A) always less
   B) always greater
   C) always the same
   D) sometimes less and sometimes greater

9. Water has its greatest density at a temperature of

   A) –6° C B) 10° C C) 32° C D) 4° C

10. The diagram below represents a rectangular object with a mass of 450 grams. What is the density of the object?



    A) 1 gram per cubic centimeter
    B) 2 grams per cubic centimeter
    C) 3 grams per cubic centimeter
    D) 4 grams per cubic centimeter