Observation and Measurement of the Environment

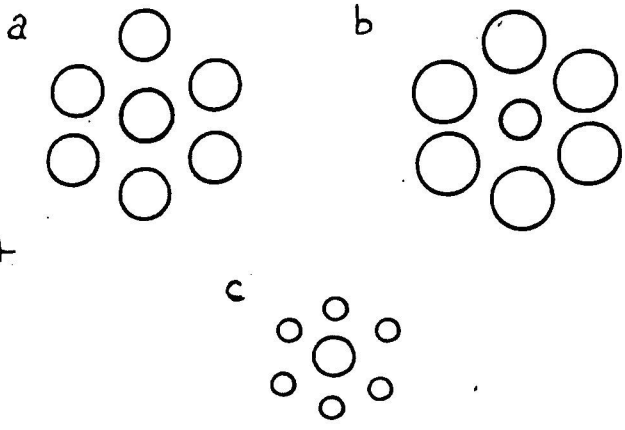
I. OBSERVATION - interaction of our senses with our environment

A. The five senses include: (1) sight
(2) hearing
(3) touch / feel
(4) taste
(5) smell

B. Testing your powers of observation:

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

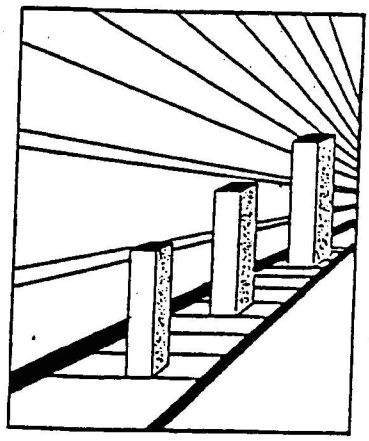
(a.) Which, if any, of the three center circles is largest or smallest (a, b or c)?



Largest
a

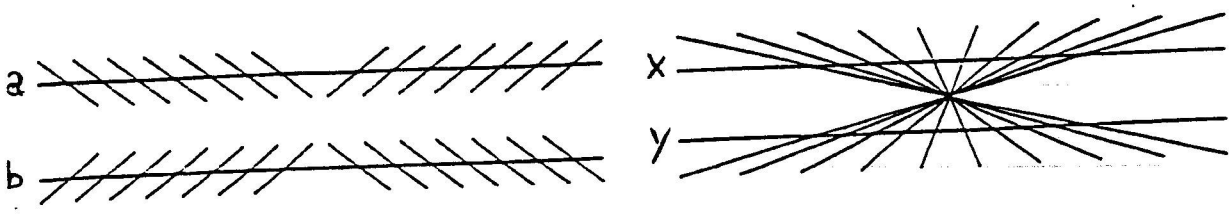
b = c

(b.) Which if any of the three blocks is the tallest (front, middle, or back)?



all equal

(c.) Which if any of the labeled pairs of lines are parallel (ab or xy)?



both parallel

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

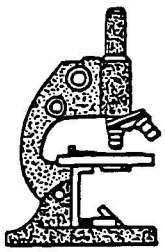
3. Check to determine if you were accurate. How many observations using only sight did you have correct(1,2,or 3)?___

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

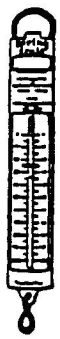
D. Instruments - can be used to improve or extend our powers of observation. These devices have been invented by people to extend the human senses beyond their normal limits, and thus enable us to make observations that would otherwise be impossible or highly inaccurate.

E. Examples:

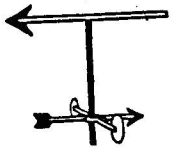
1. graduated cylinder



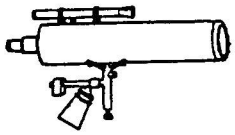
2. microscope



3. spring scale

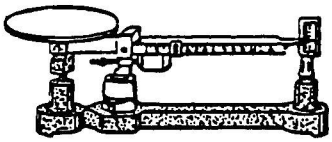


4. wind vane



7. telescope

8. thermometer



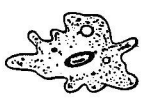
6. triple beam balance

5. Compass

9. Magnifying glass

10. ruler

F. Which instruments can be used to accurately measure each of these?



1. microscope

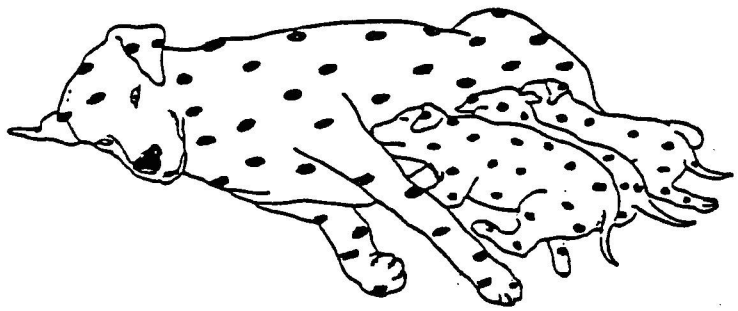
2. telescope

graduated cylinder
3. thermometer
triple beam balance

II. INFERENCE - an interpretation of an observation based on one's knowledge and or 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:



1. observations: 4 dogs, 1 large and 3 small puppies feedings

2. inferences: Large dog is mother puppies are hungry

C. Identify each statement as either an observation or an inference:

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

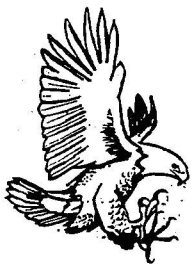
III. Classification

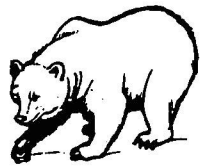
A. A classification system is based on properties or characteristics of an object

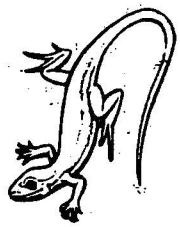
B. A classification system enables an investigator to organize data / objects in a meaningful way.

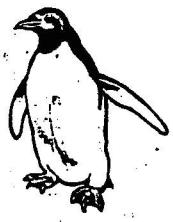
C. Classify the following animals using the classification system on the next page. Places the names of the animals in the diagram.

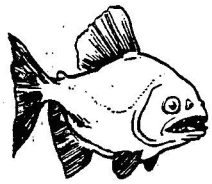
HINT: Begin by comparing and contrasting characteristics.

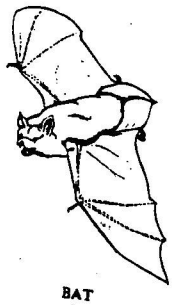
1. 
EAGLE

2. 
GRIZZLY BEAR

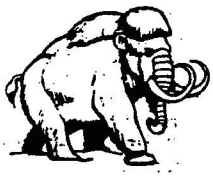
3. 
LIZARD

4. 
PENGUIN

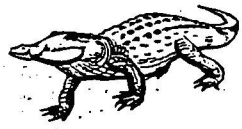
5. 
PIRANHA

6. 
BAT

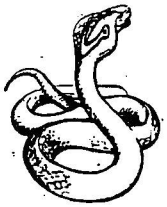
7. 
SEA HORSE

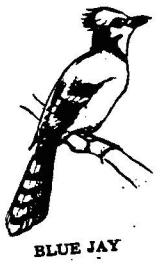
8. 
HAIRY MAMMOTH

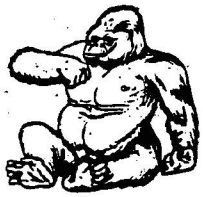
9. 
KILLER WHALE

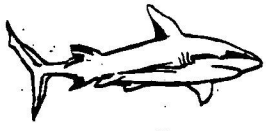
10. 
CROCODILE

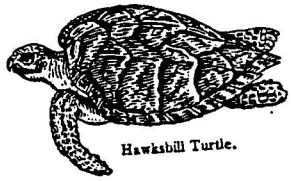
11. 
OSTRICH

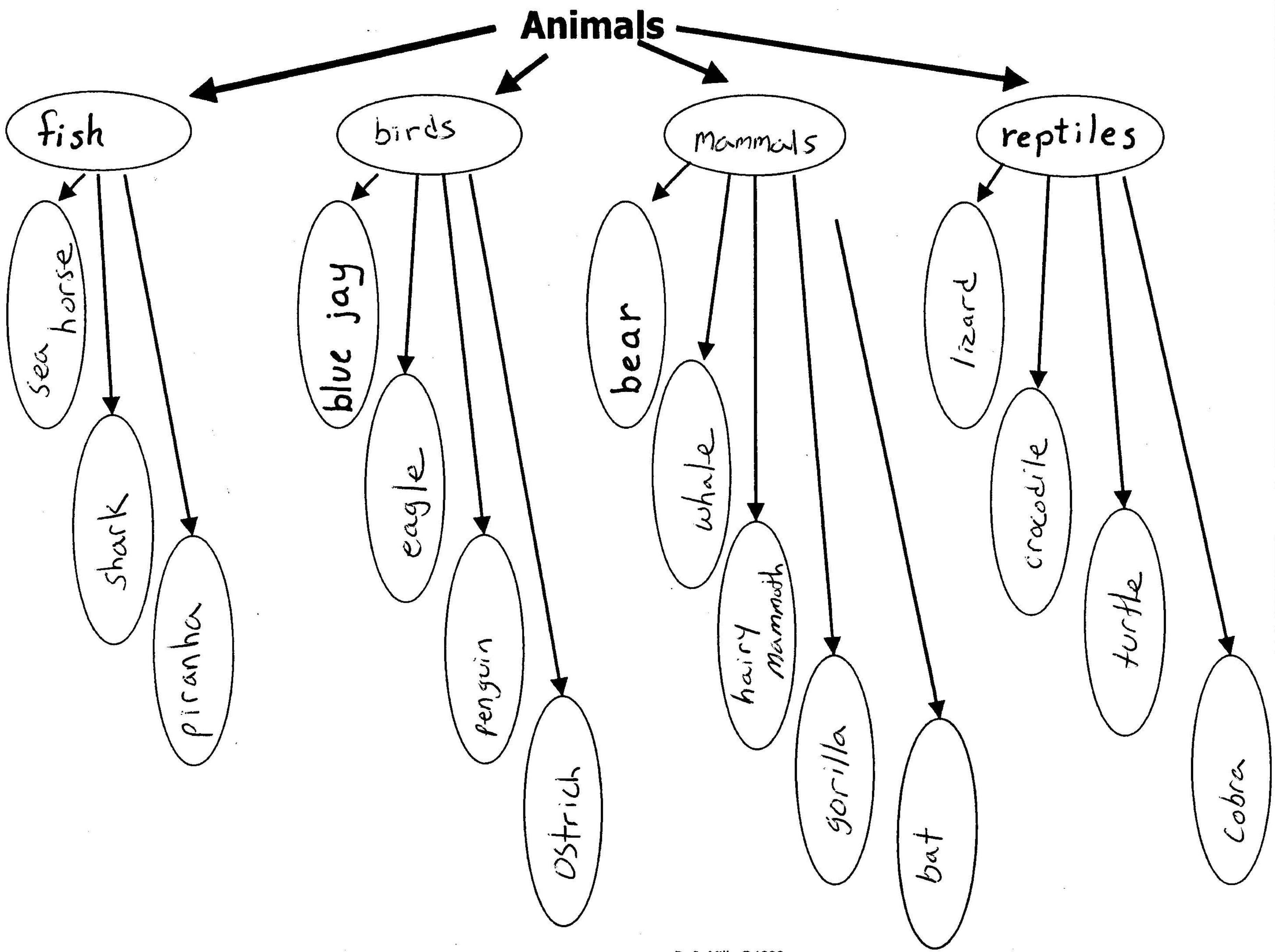
12. 
INDIAN COBRA

13. 
BLUE JAY

14. 
GORILLA

15. 
SHARK

16. 
Hawksbill Turtle.



IV. MEASUREMENT

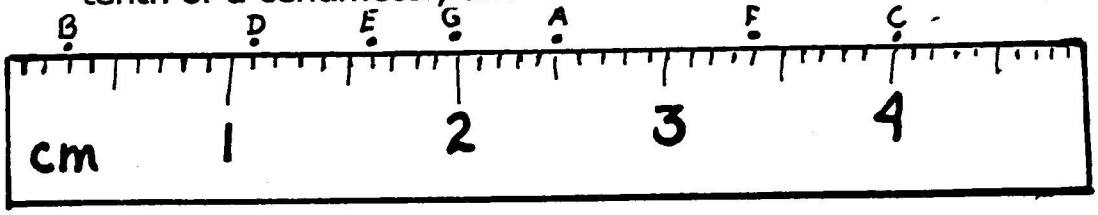
A. A measurement is a way of expressing an observation with greater precision. It provides a numerical value for some property of the object or the event being observed.

1. All measurements consist of: (a.) Numerical value
   (b.) label
2. Properties that can be measured include length, area, volume, mass, weight, temperature, density, time, etc.

B. Linear Measurement (or "one dimensional measurement") - 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 meters — 1 kilometer = 1000 meters
3. Using the model below, give the value of each dot to the nearest tenth of a centimeter, and then convert to millimeters.

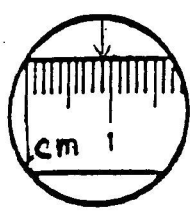
NOT TO SCALE



(a.) A 2.5 centimeters, or 25 millimeters
(b.) B .3 centimeters, or 3 millimeters
(c.) C 4.0 centimeters, or 40 millimeters
(d.) D 1.1 centimeters, or 11 millimeters
(e.) E 1.6 centimeters, or 16 millimeters
(f.) F 3.4 centimeters, or 34 millimeters
(g.) G 2.0 centimeters, or 20 millimeters

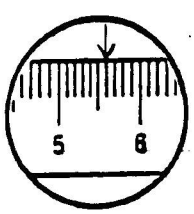
4. What is the length indicated by the arrow in each of the following pictures?

(a.)



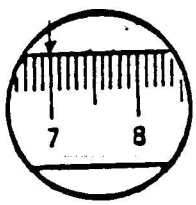
.9

(b.)



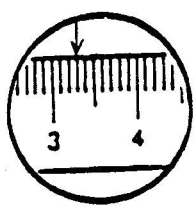
5.6

(c.)



7.0

(d.)



3.3

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

4.1 (a.) ——— 4.0-4.2 cm, or 40-42 mm

5.6 (b.) ——— 5.5-5.7 cm, or 55-57 mm

3.9 (c.) ——— 3.8-4.0 cm, or 38-40 mm

6.4 (d.) ——— 6.3-6.5 cm, or 63-65 mm

1.0 (e.) — .9-1.1 cm, or 9-11 mm

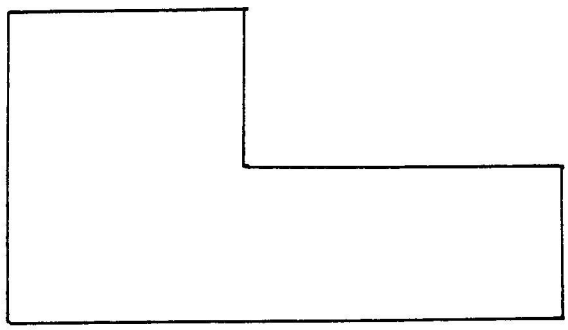
C. Area (or "two-dimensional measurement") - amount of surface space

1. Instrument - ruler
2. Formula: $A = l \times w$
3. Units – "square" units
   - (a.) sq. cm or cm^2
   - (b.) sq. m or m^2
   - (c.) sq. km or km^2
4. Determine the area of each figure below. (They have been drawn scale.)

(a.)

$8 cm^2$

(b)



$20 cm^2$

D. Volume (or "three-dimensional measurement" sometimes referred to as the "size" of an object) - amount of space an object occupies

1. Volume of Liquids

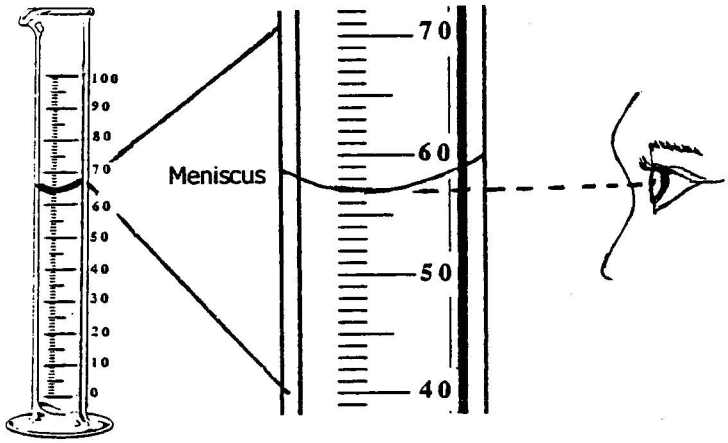
(a.) Instrument - graduated cylinder

(b.) Units - milliliters

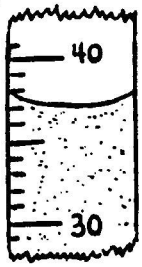
(c.)

Measurement:

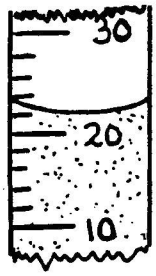
57 ml



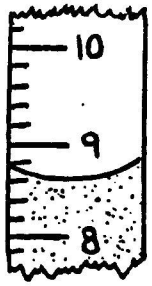
(d.) What is the volume of the liquid in the graduated cylinders illustrated below?



37 ml



22 ml



8.6 ml

2. Volume of Rectangular Solids

(a.) Instrument: ruler

(b.) Formula: $V = l \times w \times h$

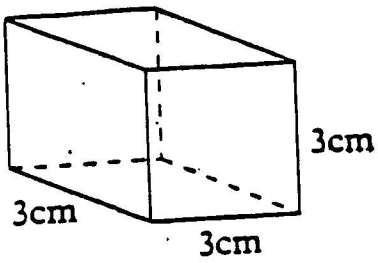
(c.) Units – "cubic" units

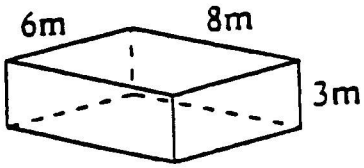
(1.) cu. cm or cc or cm^3

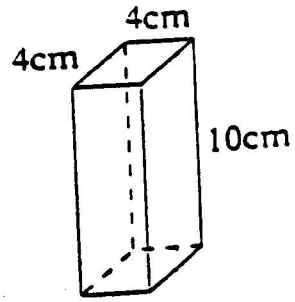
(2.) cu. m or m^3 or _____

(d.) 1 cubic centimeter = 1 milliliter

(e.)Determine the volume of the objects in each illustration:

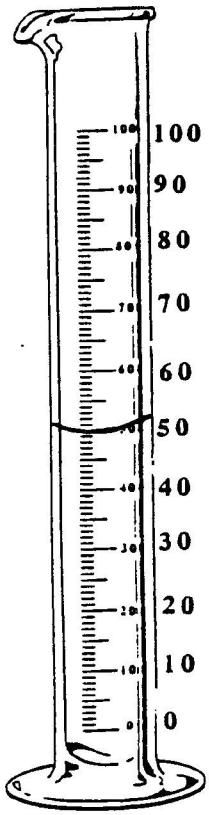






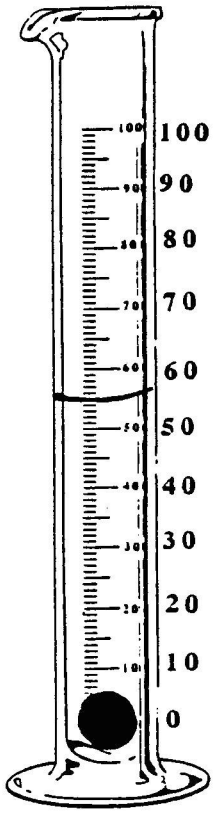
27 cm^3 144 cm^3 160 cm^3

3. Volume by Displacement



Volume of Water

50ml



Volume of Water and Marble

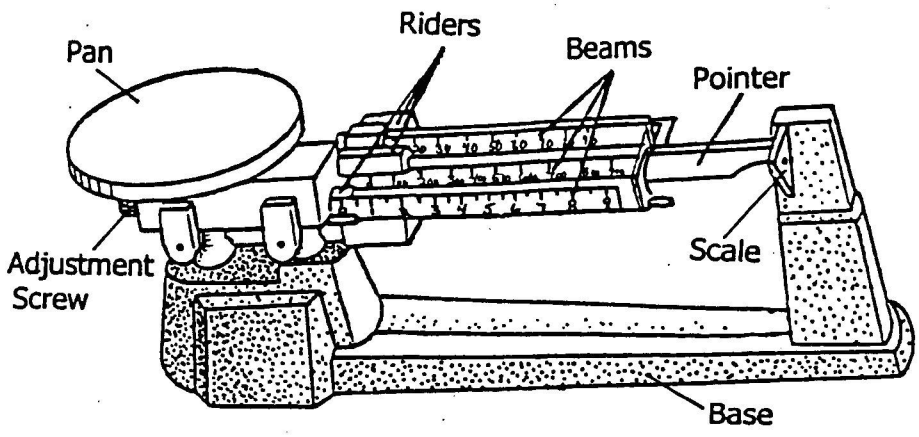
55ml

Volume of Marble

5ml

E. Mass - the amount of matter an object possesses

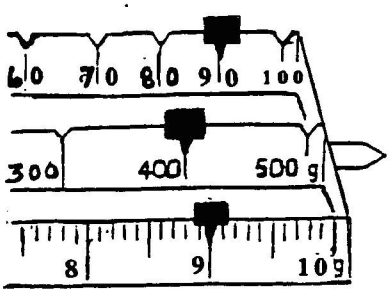
1. Instrument - triple beam balance

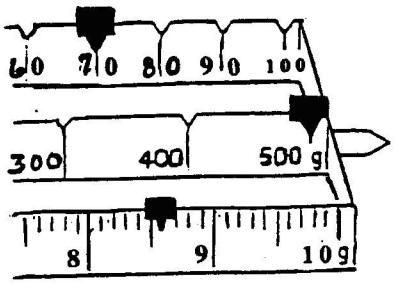


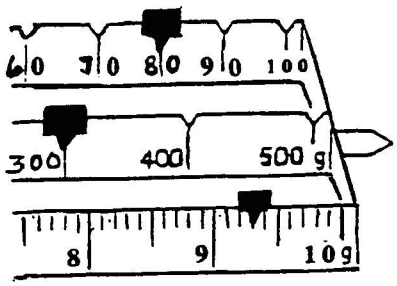
2. Units: (a.) grams

(b.) kilograms

3. Determine the mass by reading the scales of the beams in the illustrations below:



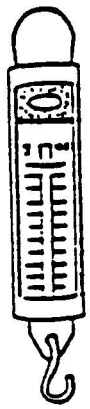




(a.) 499.0g (b.) 578.6g (c.) 389.3g

F. Weight - the amount of gravity acting on an object

1. Instrument - spring Scale



2. Units: (a.) Metric - _____

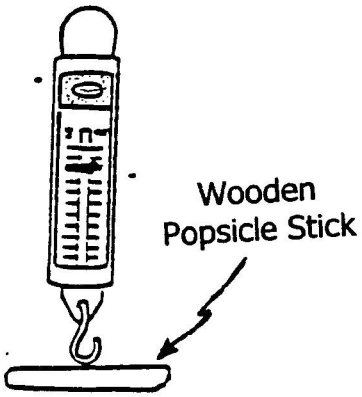
_____

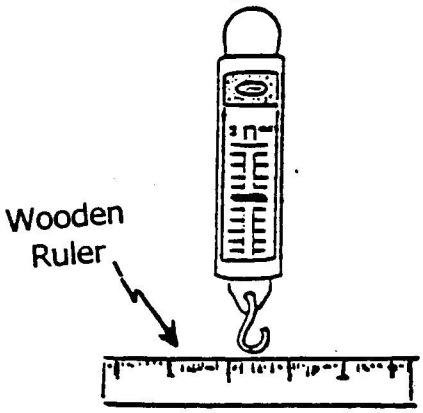
(b.) English - ounces

pounds

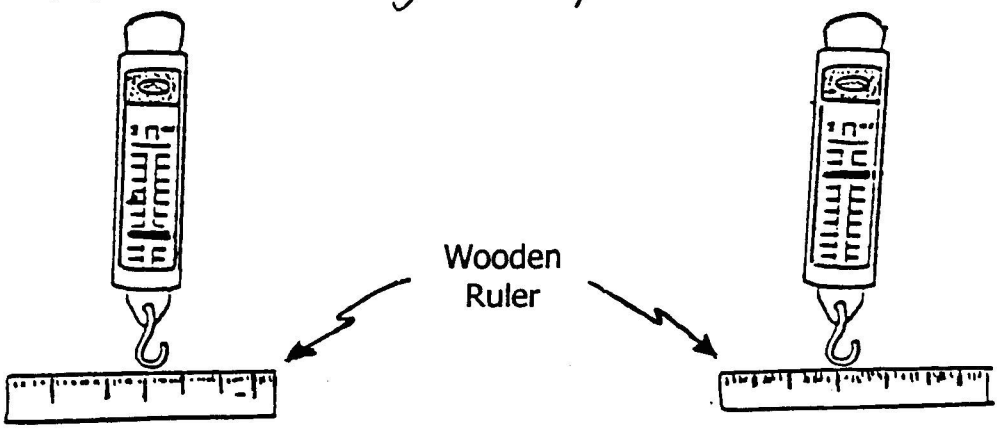
3. Factors that cause weight or effect weight:

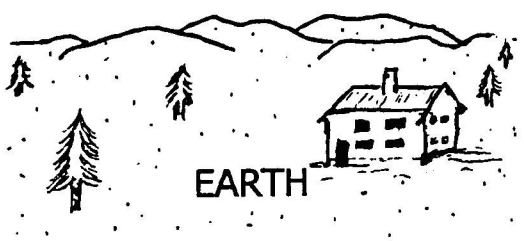
(a.) The amount of mass the object possesses.

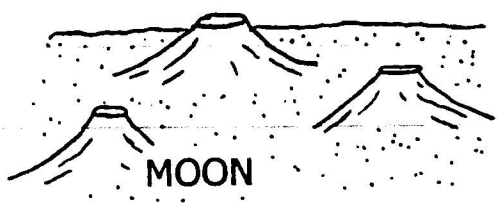




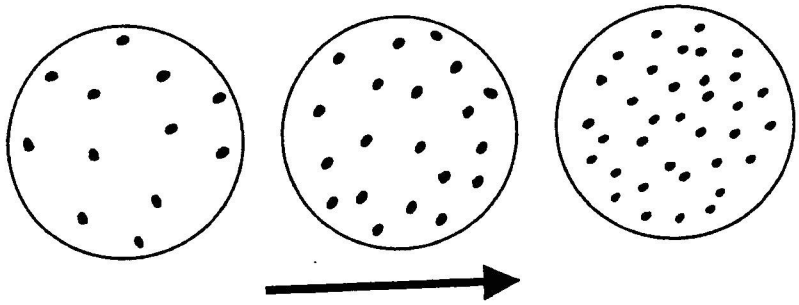
(b.) The amount of gravity acting on the object.







G. Density - Concentration of matter in an object; ratio of mass per unit volume



1. Formula:

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

page 10 in the Earth Science Reference Tables

2. Instruments:

(a.) Density of a liquid

graduated cylinder

(b.) Density of a solid

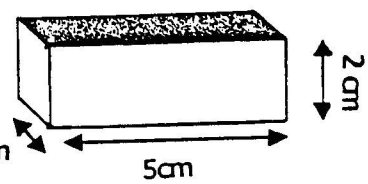
ruler + triple beam balance

3. Units: (a.) g/ml

(b.) g/cm³

4. Solve the density problems below:

(a.) The dimensions of a rectangular solid object is given as illustrated to the right. Given that this object has a mass of 150 grams, determine the density of the object.



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

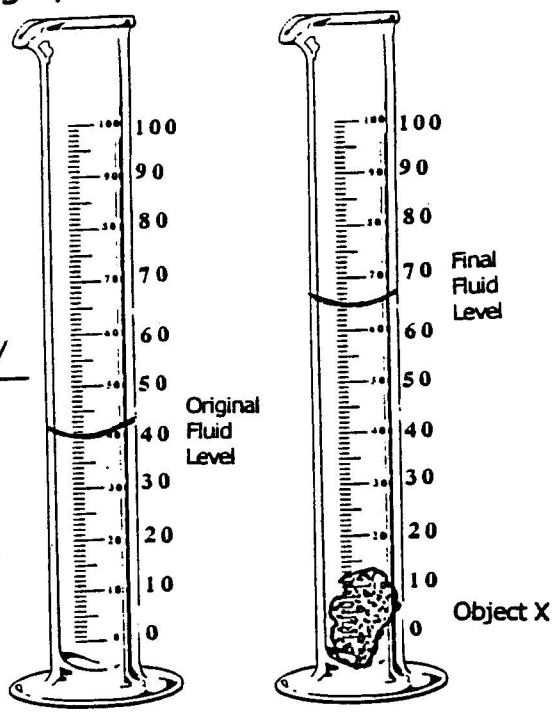
$D = \frac{150\,g}{10\,cm^3}$

$D = 15\,g/cm^3$

15 g/cm³

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

What is the density of Object X? 3.2 g/ml

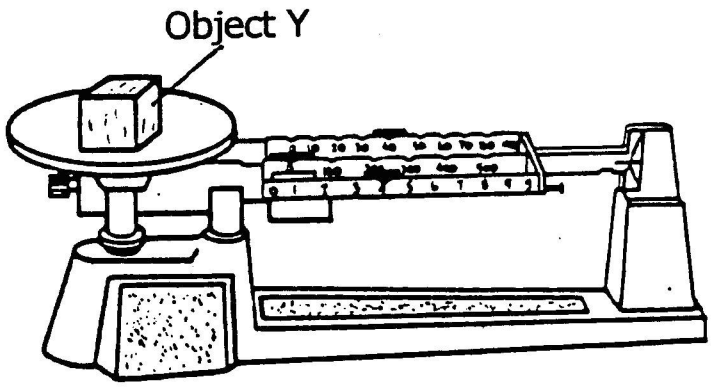


$D = m/V$

$D = \frac{80}{25ml}$

$D = 3.2\ g/ml$

(c.) Object Y is a perfect cube. The density of object Y is 5.5 g/cm3



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

$5.5 = \frac{44}{V}$

(1.) What is the mass of object Y as shown by the position of the balance riders? 44

(2.) Calculate the volume of object Y. $8cm^3$

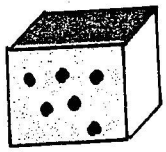
(3.) Since object Y is a perfect cube, determine the length of each side of that cube. 2cm

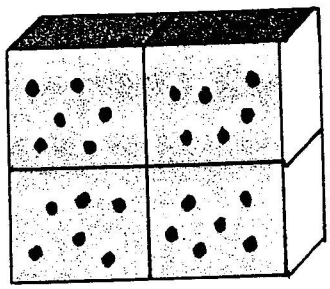
H. Density Relationships

1. Density is Relation to Size

(a.) Model Problem

Key
= 1 cm^3
● = 1 gram particles of matter of the **same** substance





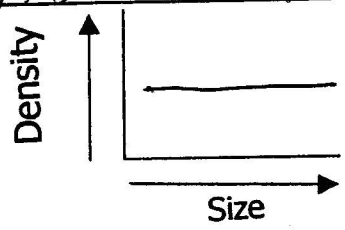
$D = \frac{M}{V}$

total mass = 6g
total volume = 1 cm^3
density = 6 g/cm^3

total mass = 24g
total volume = 4 cm^3
density = 6 g/cm^3

(b.) Relationship: the size of an object does not determine/affect its density

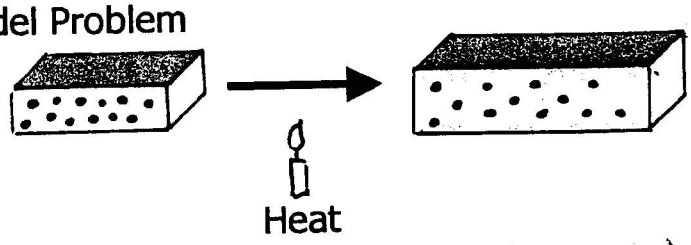
(c.)



2. Density in Relation to Temperature

(a.) Model Problem

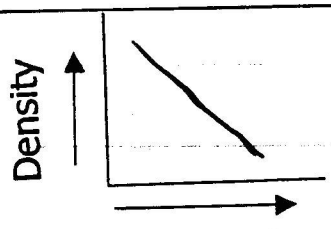
Key
● = particle of matter/1 gram



(1.) volume - increases (expands)
(2.) mass - remains the same
(3.) density - decreases

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

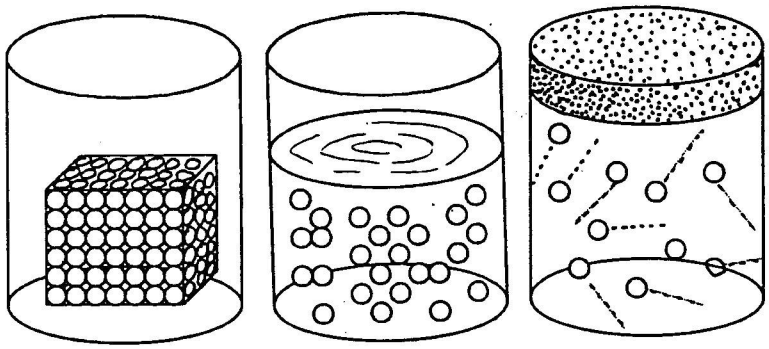
(c.)



3. Density in Relation to State of Matter

(a.) Model Problem

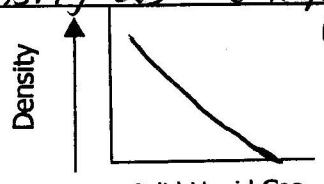
Solid Liquid Gas



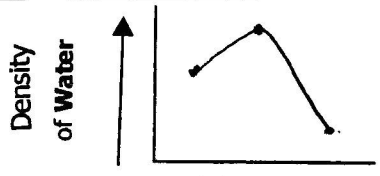
(b.) decreasing density →

(c.) Water has a maximum density as a liquid

(d.) (1)



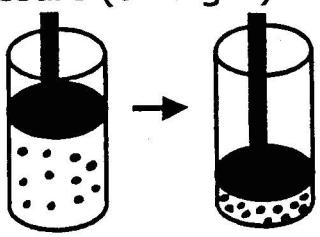
(2)



4. Density in Relation to Pressure (on a gas)

(a.) Model Problem

Key
• = particle of matter



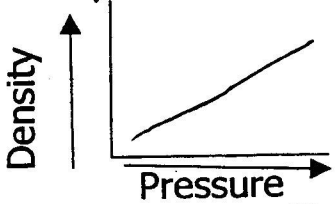
(1.) volume - decreases

(2.) mass - remains the same

(3.) density - increases

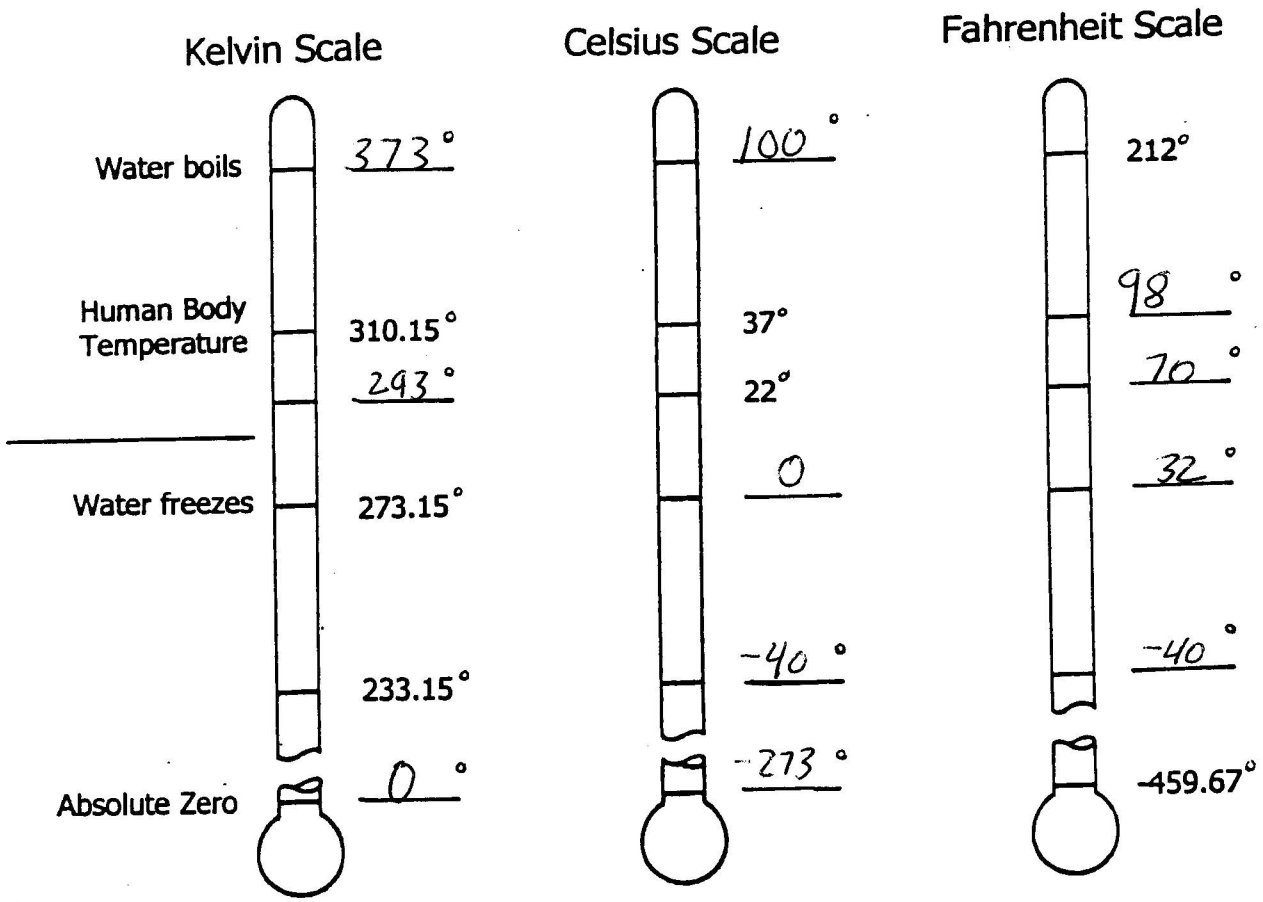
(b.) Relationship: As pressure increases, density increases

(c.)



I. Temperature - Average kinetic energy of a material

1. Instrument - thermometer
2. Units – degrees: (a.) Fahrenheit
   (b.) Celsius
   (c.) Kelvin
3. Complete the diagram below by to page 13 of the Earth Science Reference Tables.



4. Temperature Conversion Formulas:

$$^{o}K = {}^{o}C + 273.15$$

$$^{o}C = \frac{^{o}F - 32}{1.8}$$

$$^{o}F = 1.8\,(^{o}C) + 32$$