Your Name ______________________ Score __________

Group Members ______________________ ______________________ Minutes __________

Standard 1

Key idea 1

Scientific Inquiry

- The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.

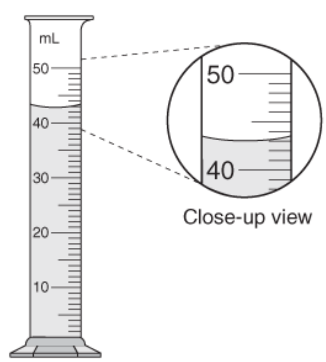
Key idea 2

Mathematical Analysis

- Abstraction and symbolic representation are used to communicate mathematically.
- Deductive and inductive reasoning are used to reach mathematical conclusions.

Major Understandings:

- Distinguish between observation, inference and prediction and give examples
- Make observations, collect data, generate inferences
- Become proficient in measuring length, volume and mass
- Determine density using different measurements and/or graphs



Graduated cylinder

Mini Lesson 1: Scientific Method

In order to be successful in science you need to refine certain skills that you already have. There are things going on around you that you do not even realize. While doing this activity you will be collecting data about your surroundings and working towards fine tuning your observational skills. Once accomplished, you will be analyzing and making inferences from your data, based on what you observed.

Scientists are a vital part of our world because they attempt to answer questions about the unknown. To do so, they use the scientific method. They ask questions, make observations, put together a hypothesis (an educated guess), collect and analyze data, and formulate a conclusion. The scientific method enables scientists to be consistent and repeat experiments to check and recheck their work. It also allows other scientists to prove or disprove the results, which is a vital part of the process.

Need to know:

1. State the five steps involved in the scientific method

   (a) ________________________________

   (b) ________________________________

   (c) ________________________________

   (d) ________________________________

   (e) ________________________________

2. Which of the five steps in the scientific method do you feel is the most important? Support your response with a well thought out explanation.

3. Explain why it is so important that other scientists are able to repeat the experiments?

4. Explain what happens when a scientist's results do not support the hypothesis?

Laboratory Activity 1.1 **Observations** [40]

Introduction:

Throughout history people have been looking at and studying their surroundings. They make observations, classify them, and then make inferences in order to try to make sense out of how things work.

Materials
- ✓ 4 misc. objects
- ✓ 4 texture bags
- ✓ Variety of candy

Objective:

- To determine what we need to use in order to make observations
- Determine how accurate inferences are

Procedure:

1. As the teacher instructs you, close your eyes and make environmental observations. Once time is up, write down everything you heard.

2. Write down what you smell.

3. Pick up the box labeled textures. Describe the texture of each item in the box. Write down what you feel (be specific).

Bag 1 ______________________________

____

Bag 2 ______________________________

____

Bag 3 ______________________________

____

Bag 4 ______________________________

____

4. Describe the 4 objects in your kit that you see.

Object 1: ______________________________

____

Object 2: ______________________________

____

Object 3: ______________________________

____

Object 4: ______________________________

____

5. Take one brown bag from your instructor. Take one piece of candy at a time without looking at it. Describe the taste. What do you think it is?

First piece ______________________________

____

Second piece ______________________________

____

Third piece ______________________________

____

✓ **Check Point**

(1) An observation is an interaction between you and the environment. Using the information in steps 1 – 5 above, what do you need to use when making observations? ______________

(2) An inference is a guess. When scientists make inferences what do they base their guesses on? ____________________

(3) Classification is the grouping of objects with similar characteristics. What must scientists use in order to classify objects? ____________________

(4) Make some inferences about the following situations.

a. It is late at night. Everyone in the house is asleep. All of a sudden you smell smoke. What do you think is happening?

____

____

b. You rode your bike to the mall. You locked it in the bike rack. You come out of the mall and your bike is missing. What happened?

____

____

c. You are sitting in the house and hear a loud crash coming from outside. All of the power in your house immediately goes out. What happened?

____

____

(5) Give an example of an alternative to each of the inferences you listed above.

a. ____________________

____

b. ____________________

____

c. ____________________

____

Think

(6) Is an inference always correct? __________

Mini Lesson 2: Predictions

Scientists believe the processes at work on Earth's surface and below are the same as those that occurred in the past. This is known as the Law of Uniformitarianism, "*the present is the key to the past*". Many inferences have been made about past events such as the extinction of the dinosaurs, formation of rocks and the interior of Earth. These inferences are supported by data gathered today. Another type of inference is a prediction. A prediction is an inference about the future. When an event occurs in a pattern, over and over again, it is said to be cyclic. This is the easiest type of prediction to make. Predictions that do not occur in a pattern are called non-cyclic and are not as reliable.

Need to know:

1. Explain what the statement "*the present is the key to the past*" means. ________________________

____

____

____

____

2. Explain why a cyclic prediction is easier to predict than a non-cyclic prediction. ________________

____

____

____

____

____

3. Determine if each of the following are examples of cyclic or non-cyclic predictions by circling your choice. Briefly explain your reasoning.

   a) Sunrise and sunset (cyclic or non-cyclic)
      Explanation: ____

   b) Phases of the moon (cyclic or non-cyclic)
      Explanation: ____

   c) Seasons of the year (cyclic or non-cyclic)
      Explanation: ____

   d) Global Warming (cyclic or non-cyclic)
      Explanation: ____

Introduction:

As scientists continue to make observations and study the phenomena around us, they begin to take note of certain patterns. When something occurs over and over again scientists feel more confident in making predictions. If there is a change, however, in any part of their experiment, predictions may not be accurate.

Materials
- ✓ Tall cylinder
- ✓ Short cylinder
- ✓ Plastic container
- ✓ Scoop
- ✓ Rice
- ✓ Popcorn
- ✓ Beans
- ✓ Bird seed

Objective:

- To make predictions and record observations
- To determine what happens to predictions if one variable is changed

Procedure: Part 1

1. For this activity you will need the scoop, the plastic container and three different materials to measure (rice, popcorn kernels, beans, bird seed, etc).
2. Choose one material to use at a time. Place the name of the first material on the data chart below. Predict how many scoops it will take to fill the container. Record this in the data chart in the "Prediction" column.
3. Fill the scoop completely and level it off. Pour the scoop into the plastic container. Repeat until the container is filled level to the top. Count how many scoops it actually takes to fill the container. You may use $\frac{3}{4}$, $\frac{1}{2}$ or $\frac{1}{4}$ estimations if the entire final scoop does not fit. Record this number in the chart in the "Actual" column.
4. In the last column, describe how close you feel your prediction was and give a brief explanation on what you based your prediction on.
5. Put the first material back into the container.

Chart A

Material	How many scoops?		Was your prediction correct? Explain why or why not.
	Prediction	Actual	

6. Using the remaining two materials, repeat steps 2– 5
7. Did you feel your predictions improved (answer honestly)? ______________________
8. The predictions you made should have improved. Explain why. ______________________________

____

____

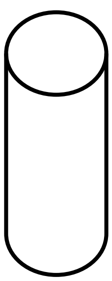
9. If you had any other material to fill the container, how many scoops should it take?

Explain your reasoning. ____

____

Procedure – Part 2

1. For this activity you will need the scoop, the tall cylinder, the short cylinder and only one of the materials to measure (rice, popcorn kernels, beans, bird seed, etc). NOTE: Both cylinders are made from the exact size transparency. The only difference is that the tall one has been constructed with the long edge being taped and the short one has the short ends of the transparency taped.



2. Take the tall transparency cylinder. Predict how many scoops it will take to fill the cylinder. __________

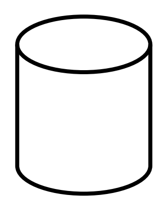
3. Explain what you based your prediction on. ______________________________

____

____

4. Using the scoop, carefully fill the tall cylinder with the material you chose. How many scoops did it actually take to fill the tall cylinder? __________

5. **DO NOT EMPTY THE CYLINDER**.

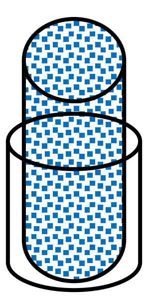


6. Take the short transparency cylinder. Predict how many scoops it will take to fill the cylinder. __________

7. Explain what you based your prediction on. ____________________________________

____

____



8. Place the wider, shorter cylinder around the taller one that is already filled.
9. Slowly and gently lift the tall cylinder until it is empty.
10. What did you observe? ______________________________

____

____

11. Continue to fill the shorter container with the scoop.
12. How many scoops did it take to fill the shorter, wider container? __________

✓ **Check Point**

(1) Which container held more material? (tall cylinder / short cylinder)

(2) The same size transparency was used for both cylinders (in part I and part II). What change caused a difference in the amount that each could hold? ______________________________

____

____

(3) Whenever possible, mathematics can be used to verify certain scientific findings. In this case, determine the volume of both the tall and short cylinders using the formula

$$V = \pi r^2 h$$

(Use 3.14 for π)

SHOW ALL WORK

a. The radius of the tall container is 3.4 cm, its height (h) is 27.9 cm. Determine the volume of the tall cylinder.

Formula:

Substitute numbers with units

Solution with units:

b. The radius of the tall container is 4.5 cm, its height (h) is 21.6 cm. Determine the volume of the short cylinder.

Formula:

Substitute numbers with units

Solution with units:

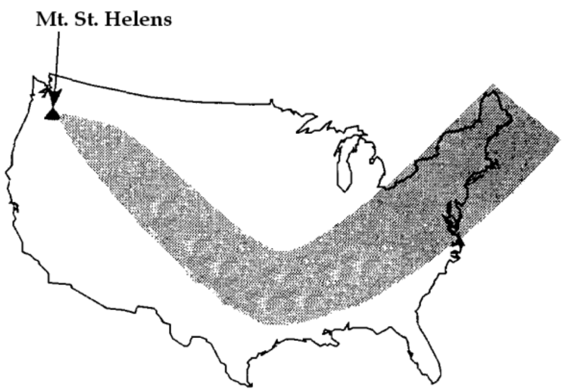
Regents Questions:

____1. Using a ruler to measure the length of a stick is an example of
(1) Extending the sense of sight by using an instrument
(2) Calculating the percent error by using a proportion
(3) Measuring the rate of change of the stick by making inferences
(4) Predicting the length of the stick by guessing

____2. The grouping of objects or events based on similar characteristics is called
(1) an observation
(2) an interpretation
(3) a measurement
(4) a classification

_____3. Which action can be performed most accurately using *only* the human senses?
(1) Tearing a sheet of paper into squares whose sides measure 1 centimeter
(2) Adding 10 grams of salt to a cup of water
(3) Measuring the air pressure of a room
(4) Counting 28 shells from a beach

_____4. The map below shows the path of an ash cloud that resulted from the Mount St. Helens volcanic eruption. The map was developed from satellite photographs.



The path of the ash cloud was most probably determined by

(1) hypothesis
(2) inference
(3) observation
(4) theory

_____5. An interpretation based upon an observation is called
(1) fact (2) an inference (3) a classification (4) a measurement

_____6. While on a field trip to a large lake in New York State, an observer recorded four statements about this lake. Which of these statements is most likely an inference?
(1) The lake was formed by glacial action
(2) The water is clear enough to see the bottom of the lake.
(3) A log is floating in the lake.
(4) The surface temperature of the lake is 18.5°C.

_____7. A student classifies several objects. The classification system should be based on
(1) hypotheses (3) observations
(2) inferences (4) interpretations

_____8. Which factor can be predicted most accurately from day to day?
(1) chance of precipitation (3) direction of the wind
(2) time of an earthquake occurring (4) altitude of the Sun at noon

_____9. A prediction of next winter's weather is an example of
(1) an observation (2) an inference (3) classification (4) a measurement

_____10. A student is asked to classify several rocks. For best results, the classification should be based on
(1) inferences (2) interpretations (3) hypotheses (4) observations

____11. Scientists often use classification systems in order to
(1) extend their powers of observation
(2) organize their observations in a meaningful way
(3) make direct comparisons with standard units of measurement
(4) make more accurate interpretations

____12. A student examined a patch of mud and recorded several statements about footprints in the mud. Which statement is most likely an inference?
(1) There are five footprints in the mud.
(2) The footprints were made by a dog.
(3) The depth of the deepest footprint is 3 centimeters
(4) The footprints are orientated in an east-west direction.

____13. Which statement about a mineral sample found in a field is most likely an inference? The sample
(1) was transported by a glacier.
(2) is white in color.
(3) is rectangular, with sharp, angular corners.
(4) is 8 cm long, 5 cm wide, and 3 cm high.

____14. Which statement about a rock sample is most likely an inference?
(1) The rock has flat sides and sharp corners.
(2) The rock is made of small, dark-colored crystals.
(3) The rock has thin, distinct layers.
(4) The rock has changed color due to weathering.

____15. A student observed a freshly dug hole in the ground and recorded statements about the sediments at the bottom of the hole. Which statement is an inference?
(1) The hole is 2 meters deep.
(2) Some of the particles are rounded.
(3) The sediments were deposited by a stream.
(4) Over 50% of the sediments are the size of sand grains or smaller.

Mini Lesson 3: Density

Density plays an important role in almost every area of Earth Science. It is the driving force for plate tectonics, the main transfer of energy in Earth's atmosphere and even affects our oceans. Before we discuss how density influences these and other aspects of Earth we must first investigate what density is. Density is defined as the amount of matter per unit of volume. It is a physical property of a material that can help in identification. Even if you break the object apart, the density of each piece remains the same as the original. The tighter the molecules are packed in a given volume, the more dense a material is. Density can be determined mathematically using the following formula:

$$Density = \frac{mass}{volume}$$

Need to know:

1. List the three things mentioned in the information box that density has a part in.

   (a) ______________________________

   (b) ______________________________

   (c) ______________________________

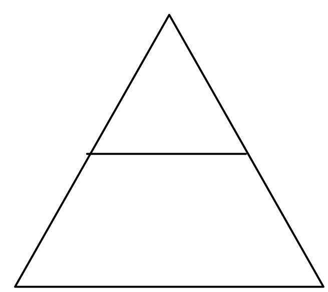
2. Why doesn't the density of an object change even when you break into pieces?

   ____

   ____

3. Find the formula for density on the front on the Earth Science Reference Tables. Using a yellow highlighter, highlight the formula.

4. Fill in the "solving triangle" using the density formula
   Hint: (d = m over v) Which letter goes in the top section of the triangle?



5. Determine the density of a mineral that has a mass of 50 g and a volume of 10 cm^3. Show all work.

   Formula:

   Substitute numbers:

   Solution :
   Don't forget units

Materials
- ✓ Modeling clay
- ✓ Balance
- ✓ Butter knife
- ✓ Calculator

Introduction:

When a material is broken into pieces both the volume and the mass of that material changes, however if it is simply broken the density does not change.

Objective:

- To determine the density of different pieces of the same piece of clay

Procedure:

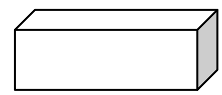
1. Determine the volume of the block. Using a ruler measure the following to the nearest *tenth of the centimeter*:

   length of the block (l) __________ cm

   width of the block (w) __________ cm

   height of the block (h) __________ cm

   Volume = (l) x (w) x (h) __________ cm^3



2. Determine the mass of the play dough by placing it on the balance. Record its mass to the nearest tenth. Mass = _________ grams

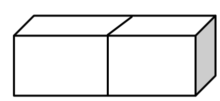
3. Determine the density of the block of play dough.

   a. Write the formula: ___________________________

   b. Substitute with numbers: ___________________________

   c. Solve for density: ___________________________ g/cm^3

4. Using the butter knife, carefully cut the block in half. Be as accurate as possible.



5. Determine the volume of one of the halves. Using a ruler measure the following to the nearest *tenth of the centimeter*:

   length of the block (l) __________ cm

   width of the block (w) __________ cm

   height of the block (h) __________ cm

   Volume = (l) x (w) x (h) __________ cm^3

6. Determine the mass of the play dough by placing it on the balance. Record its mass to the nearest tenth. Mass = _________ grams

7. Determine the density of the block of play dough.
   a. Write the formula: ______________________
   b. Substitute with numbers: ______________________
   c. Solve for density: ______________________ g/cm^3

8. Determine the volume of the other half block. Using a ruler measure the following to the <u>nearest</u> <u>*tenth*</u> *of the centimeter*:

   length of the block (l) _________ cm
   width of the block (w) _________ cm
   height of the block (h) _________ cm
   Volume = (l) x (w) x (h) _________ cm^3

9. Determine the mass of the play dough by placing it on the balance.
   Record its mass to the <u>nearest</u> <u>tenth</u> Mass = ________ grams.

10. Determine the density of the block of play dough.
   a. Write the formula: ______________________
   b. Substitute with numbers: ______________________
   c. Solve for density: ______________________ g/cm^3

✓ **Check Point**

1. Compare the mass of each half of clay with the mass of the original. ______________________
____

2. Compare the volume of each half of clay with the volume of the original. ____________________
____

3. Compare the density of each half of clay with the density of the original. __________________
____

4. If a material is cut in half, what happens to the density? _______________________________

Materials

- ✓ Water
- ✓ Alcohol
- ✓ Balance
- ✓ Calculator
- ✓ Graduated cylinder

Introduction:

The density of water can be determined the same as the density of any other material. The mass and volume, however need to be done very carefully.

Objective:

- To determine the density of water and rubbing alcohol
- To compare the density of water, rubbing alcohol and ice

Procedure:

1. Determine the mass of an empty graduated cylinder. Place that value in <u>every</u> space of the column labeled "Mass of empty graduated cylinder", in the data table below. *Round to the nearest 10^{th}*.

2. Place 20 mL of water in the graduated cylinder. Determine the mass of the graduated cylinder with the water in it. Place it in the column for "Mass of water and graduated cylinder", in the data table below. *Round to the nearest 10^{th}*.

3. Subtract the mass of the empty graduated cylinder from the mass of the graduated cylinder with water. This is the actual mass of the water. Place this value in the column labeled "Mass of the water", located in the data table below. *Round to the nearest 10^{th}*.

4. Determine the density of the water by using the same formula found on the Earth Science Reference Tables. Write down the formula in the box.

5. When doing an experiment, the more trials you do, the more accurate your data will be. Repeat steps 2 through 4 for the volumes listed in the data table. *Round to the <u>nearest</u> <u>tenth</u>*.

Mass of water and graduated cylinder	Mass of empty graduated cylinder	Mass of the water	Volume of the water	Density of Water
g	g	g	20 mL	g/mL
g	g	g	40 mL	g/mL
g	g	g	60 mL	g/mL
g	g	g	80 mL	g/mL

6. Finally, take each of the determined values for the density of water, add them together then divide by 4. This will give you the average density of water.

What is the density of water? _________ g/mL

7. Locate the box labeled "Properties of Water" on the front page of the Earth Science Reference Tables. Highlight the information that states the density of water at 3.98°C.

   What is the density of water at this temperature? __________ g/mL

8. Determine the density of rubbing alcohol by using the formula found on the Earth Science Reference Tables and following procedures 2 through 5.

9. When doing an experiment, the more trials you do, the more accurate your data will be. Repeat steps 2 through 4 for the volumes listed in the data table. *Round to the nearest 10th.*

Mass of rubbing alcohol and graduated cylinder	Mass of empty graduated cylinder	Mass of the rubbing alcohol	Volume of the rubbing alcohol	Density of rubbing alcohol
g	g	g	20 mL	g/mL
g	g	g	40 mL	g/mL
g	g	g	60 mL	g/mL
g	g	g	80 mL	g/mL

10. Finally, take each of the determined values for the density of the rubbing alcohol, add them together then divide by 4. This will give you the average density of rubbing alcohol.

    What is the density of rubbing alcohol? ____________ g/mL

11. Pour 200 mL of water into the beaker. Take a piece of ice and place it in the water.

    What happens to the ice when it is placed in the water? ________________________________

12. Pour 200 mL of rubbing alcohol into the beaker. Take a piece of ice and place it in the alcohol. What happens to the ice when it is placed in the rubbing alcohol? ____________________

✓ **Check Point**

(1) Referring to step 11, is the density of ice (more / less) than the density of water?
Using a complete sentence, explain your reasoning. ________________________________

____

(2) Referring to step 12, is the density of ice (more / less) than the density of rubbing Alcohol? Using a complete sentence, explain your reasoning. ________________________

____

(3) Keeping the answers to numbers 3 and 4 above, compare the density of water with the density of rubbing alcohol. ____

____

Mini Lesson 4: Density / Temperature / Pressure

Although breaking a material into smaller pieces does not change its density there are two factors that will, temperature and pressure. As temperature increases, molecules begin to move a part (expand), which means the volume increases.

Referring to the formula, density = mass / volume, if volume increases *and mass stays the same,* the density will decrease. When pressure is added to a material, it causes the material to become smaller (compress) and its volume decreases. If the volume decreases *and mass stays the same,* its density increases.

Need to know:

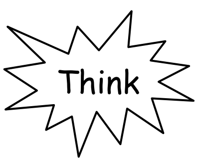
1. What happens to density as temperature increases? ______________________

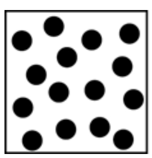
   Using a complete sentence, support your answer. ______________________

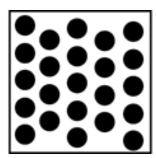
   ____

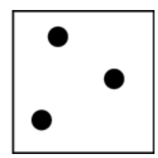
   ____

You may recall that density is the amount of material in a certain amount of space. Below are diagrams of a material in three different phases. Label each diagram with the phase that it represents (solid, liquid or gas)









______________ ______________ ______________

The questions below apply to MOST materials.

2. Which phase of material (solid, liquid or gas) would be the most dense? ______________
3. Which phase of material (solid, liquid or gas) would be the least dense? ______________
4. What happens to water when it freezes? ______________________
5. Using a complete sentence, explain why ice floats in water even though it is water in a solid form. Hint: mention volume in your response. ______________________

   ____

6. What happens to density as pressure increases? ______________________

Introduction:

As mentioned in Mini Lesson 4, pressure and temperature affect the density of a material. In this activity you will see how each really do affect it.

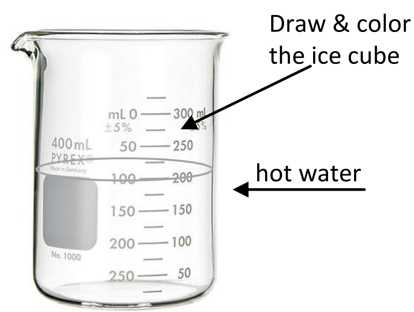
Materials
- ✓ Balance
- ✓ Water
- ✓ Ice
- ✓ 2-400 mL beakers
- ✓ Hot water
- ✓ Blue colored ice
- ✓ Eye dropper
- ✓ Bread

Objective:

- To determine how temperature and pressure affect density.

Procedure: Part 1 - Temperature

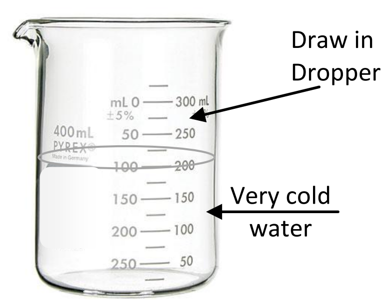
1. Only one per class: Prepare one beaker with 100 mL of red colored hot water. Pour 100 mL of hot tap water into a beaker and place ten drops of red food coloring in the water. Place it on the hot plate and heat it for about 5 minutes, stirring constantly.
2. Fill one beaker with 200 mL of cold tap water. Place regular ice in the cup. Set it aside to allow it time to get very cold.
3. Fill the ***second*** beaker with 200 mL of hot tap water. Place the colored ice cube in the water.
   - Draw the ice cube in the beaker to the right. Remember to color it.
   - Observe what happens as the ice cube melts.
   - Draw your observations on the diagram to the right.
   - Describe your observations below



____

____

4. Pour the water into the sink.
5. Take the beaker that you set aside (in step 2) with the regular ice in it. If there is any ice left in the beaker, stir it until it melts in the water.
6. Very carefully place the water dropper into the hot water and fill i
7. Keeping the dropper vertical, slowly release the red hot water on top of the water already in the beaker.
   - Draw the dropper in the beaker to the right. Remember to color it.
   - Observe what happens to the red hot water when placed in the clear cold water.
   - Draw your observations in the diagram to the right.
   - Describe your observations below



____

____

✓ **Check Point**

(1) When you placed the colored ice cube in the warm water in step 2, what happened to the cold water from the ice cube?

- Which is more dense, the *warm water* or the *cold water* from the ice cube? State and explain your answer using a complete sentence.

____

____

____

(2) When you placed the warm water in the cold water in step 8, what happened to the warm water?

- Which is more dense, the *warm water* or the *cold water*? State and explain your answer using a complete sentence.

____

____

____

(3) What happens to the density of an object as it is heated? [increases / decreases]

(4) Warm water stays on top because it is [more dense / less dense]

(5) Warm air rises because it is [more / less] dense.

(6) Explain why a hot air balloon rises as a fire burns directly under the balloon.

____

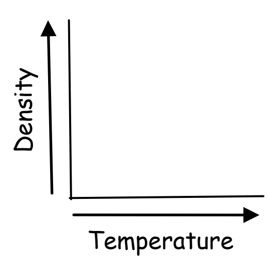
____

____

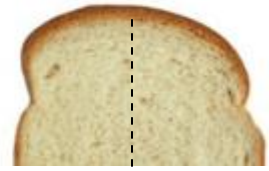
(7) Complete the following statement:

As temperature increases, density ____________________

Draw the relationship on the graph to the right.



Procedure - Part 2: Pressure



1. Fill one beaker with 200 mL of tap water.
2. Take $\frac{1}{2}$ a slice of bread and cut it in half again. Do not eat the bread, it is stale.
3. Take one quarter of the piece of bread and place it in the water. Describe what happened. ____

   ____

   ____
4. Carefully remove the bread. Place it onto a napkin to throw out when you are done.
5. Take the other quarter piece of bread and apply pressure (squish it) until you form a ball. Place it in the water. Describe what happens. ____

   ____

   ____
6. Take the squished bread out of the water and place it on the napkin. Throw both pieces of bread into the garbage.

✓ **Check Point**

(1) When you placed the first quarter of bread into the water in step 3, was it more or less dense than the water? Explain your answer in a complete sentence.

____

____

____

(2) When you applied pressure and squished the bread in step 5, was it more or less dense than the water? Explain your answer in a complete sentence.

____

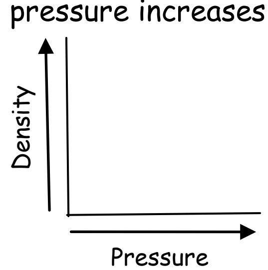
____

____

(3) When you squished the bread into a ball you added pressure to the bread. What happened to the density when pressure is applied to an object? ____________________

(4) Complete the following statement: As pressure increases, density ____________________

Draw the relationship on the graph to the right.



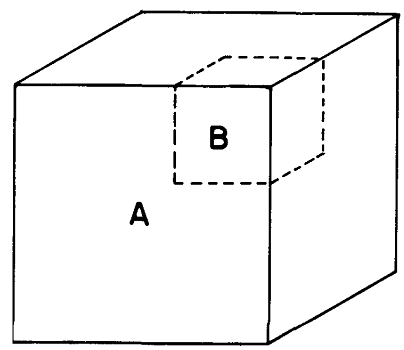
Regents Questions:

_____1. As water cools from 4°C to 0°C, its density
(1) decreases (2) increases (3) remains the same

_____2. As the volume of air expands due to heating, the density of this air will
(1) decrease (2) increase (3) remain the same

_____3. Water has the greatest density at approximately
(1) 100°C in the gaseous phase
(2) 0°C in the solid phase
(3) 4°C in the solid phase
(4) 4°C in the liquid phase

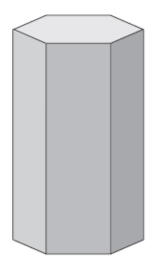
Base your answers to questions 4 and 5 on the diagram below. Object *A* is a solid cube of uniform material having a mass of 65 grams and a volume of 25 cubic centimeters. Cube *B* is a part of cube *A*.



_____4. The density of the material in cube *A* is determined at different temperatures and phases of matter. At which temperature and in which phase of matter would the density of cube *A* most likely be greatest?
(1) at 20°C and in the solid phase
(2) at 200°C and in the solid phase
(3) at 1800 °C and in the liquid phase
(4) at 2700°C and in the gaseous phase

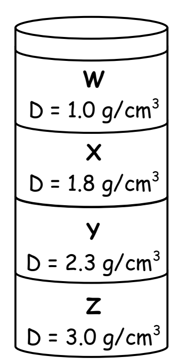
_____5. If cube *B* is removed from cube *A*, the density of the remaining part of cube *A* will
(1) decrease (2) increase (3) remain the same

_____6. A student measured the mass and volume of the mineral crystal to the right and recorded the data shown below. The student used these data to calculate the density of the crystal. What is the density according to the student's data?
(1) 1.0 g/ cm^3
(2) 1.5 g/ cm^3
(3) 2.0 g/ cm^3
(4) 2.5 g/ cm^3



Data
Mass = 80 g
Volume = 32 cm^3
Density = ?

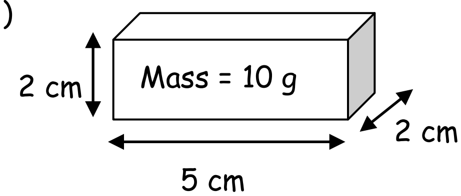
_____7. The diagram to the right represents a cylinder which contains four different liquids, *W, X, Y*, and *Z*, each with a different density (D) as indicated. A piece of solid quartz having a density of 2.7 g/cm^3 is placed on the surface of liquid W. When the quartz is released, it will pass through
(1) *W*, but not *X, Y*, or *Z*
(2) *W* and *X* but not *Y*, or *Z*
(3) *W, X*, and *Y*, but not *Z*
(4) *W, X, Y*, and *Z*



Base your answers to questions 8 through 11 on the diagrams below, which represent five different materials.

8. Calculate the density of the following 5 different substances, *A, B, C, D*, and *E*.
Show all work. [volume = length x width x height]

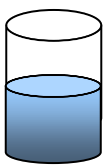
A)



B)

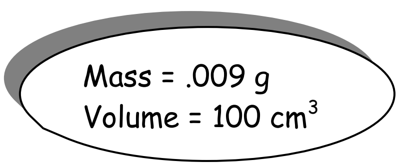
mass = 10.6 g
volume = 4 cm^3

C)

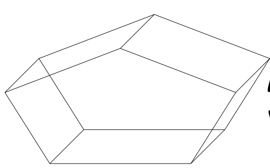


mass = 35 g
volume = 35 ml

D)



E)



Mass = 80 g
Volume = 35 cm^3

9. Using the letters for each material, list the materials in order of density from least to greatest. ________ , ________ , ________ , ________ , ________

10. What is the density of water? (don't forget units) ________________

11. Which objects above will float if they were placed in water? ______________________

Mini Lesson 5: Graphing Density

Density is a physical property of a material and can be used in identifying the material. It does not change when a material is broken into smaller pieces, only the mass and volume changes. When the density of a material is graphed, it is a straight line. The steeper the slope the greater a material's density. In addition, the density of a material can be calculated by interpretation of a density graph.

Need to know:

1. Why is density considered a physical property? ____________________

____

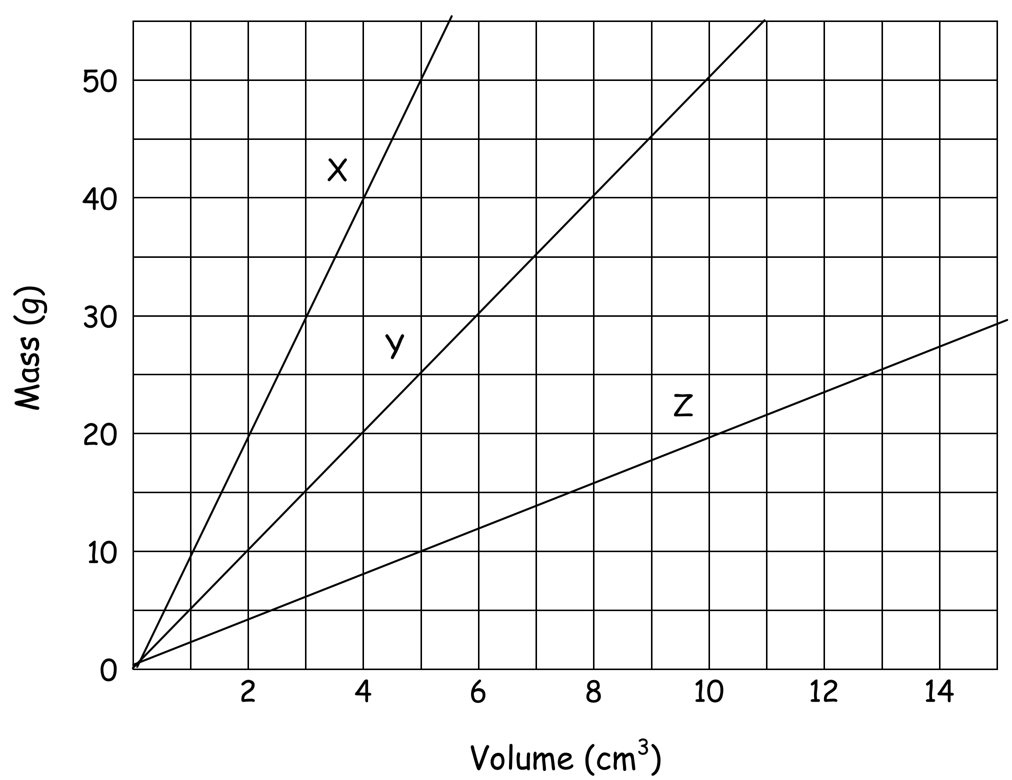
2. What two things change as a material is broken into smaller pieces? ____________________

____

Interpreting a density graph:

In order determine the density of a material illustrated by a graph you need to choose a mass value and find the corresponding value for volume.

3. The graph below shows the relationship between mass and volume for three materials X, Y and Z at a temperature of 20°C.



4. Determine the density of "X" by using the following method:

   a. Using a blue colored pencil, trace the mass value of 40 g until you touch the line for "X".
   b. From that point, using the same color pencil, trace the line down to the value of volume.
   c. When the mass of object "X" is 40 g, what is its volume? ________ cm^3
   d. What is the density of material "X"? _______ g/ cm^3
   e. Using a green colored pencil, trace the mass value of 20 g until you touch the line for "X".
   f. From that point, using the same color pencil, trace the line down to the value of volume.
   g. When the mass of object "X" is 20 g, what is its volume? ________ cm^3
   h. What is the density of material "X"? ______ g/ cm^3
   i. Even though the mass and volume values decreased, what is true about the density of material "X"? ____

5. Determine the density of "Y" by using the following method:

   a. Choose a value for mass (*choose a value that intersects on a line*). Mass = _______ g
   b. Using a red colored pencil, trace the mass value until you touch the line for "Y".
   c. Trace the line down to the value for volume. Volume = ________ cm^3
   d. What is the density of material "Y"? __________ g/ cm^3

6. Determine the density of "Z" by using the following method:

   a. Choose a value for mass (*choose a value that intersects on a line*). Mass = _______ g
   b. Using a purple colored pencil, trace the mass value until you touch the line for "z".
   c. Trace the line down to the value of volume. Volume = ________ cm^3
   d. What is the density of material "z"? __________ g/ cm^3

7. Using the graph on page 23, draw the line graph on it for a material that has a volume of 12 cubic centimeters and a mass of 35 grams. Plot the point and draw a line through that point down to zero.

Drawing a density graph:

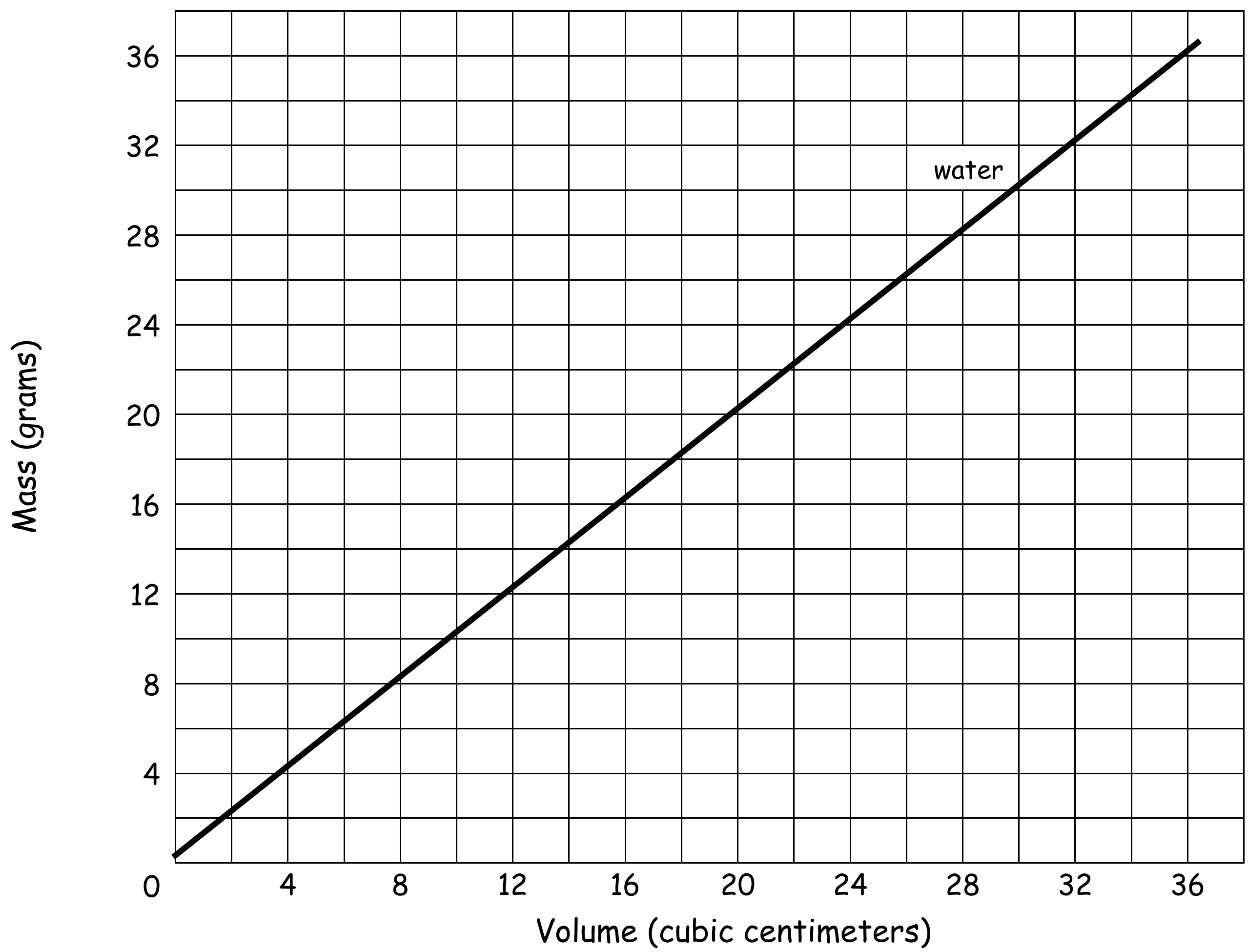
In order determine the density of a material illustrated by a graph you need to choose a mass value and find the corresponding value for volume.

1. Determine the density for Material A samples (a), (b) and (c) and Material B samples (a), (b) and (c) on page 25. Place the density for each in the tables provided.

Material A			
Sample	(a)	(b)	(c)
Mass (g)	14	35	21
Volume (cm^3)	8	20	12
Density (g/cm^3)			

Material B			
Sample	(a)	(b)	(c)
Mass (g)	8	12	4
Volume (cm^3)	20	30	10
Density (g/cm^3)			

2. Plot the three samples of Material A and draw a line to illustrate its density. Label the line Material A.
3. Plot the three samples of Material B and draw a line to illustrate its density. Label the line Material B.



(a) The line for Material A is located [above / below] the line for water.

(b) The line for Material A shows that it is [more dense / less dense] than water?

(c) The line for Material B is located [above / below] the line for water.

(d) The line for Material B shows that it is [more dense / less dense] than water?

(e) The greater the density, the [less / greater] the slope.

✓ **Check Point**

(1) What happens to the volume of the air as it is heated? ______________________

(2) What happens to the density of the air as it is heated? ______________________

(3) What happens to the volume if a material is placed under pressure? ______________

(4) What happens to the density as pressure is increased? ______________________

(5) What is the density of an irregular shaped object that has a volume of 3.0 milliliters and a mass of 12 grams? ____________ g/mL

(6) If an object were cut in half what would the density of each half be? ____________

(7) As the volume of air expands due to heating, describe the change that will occur to its density. ________________________________

(8) The mass of a cube is measured in order to calculate its density. The cube has water on it while its mass is being measured.

a. Will the mass of the cube with water be greater or less than the cube's actual mass? ________________________________

b. Describe how the calculated value for density will compare with the actual density of the cubes. Support your answer with a logical explanation.

____

____

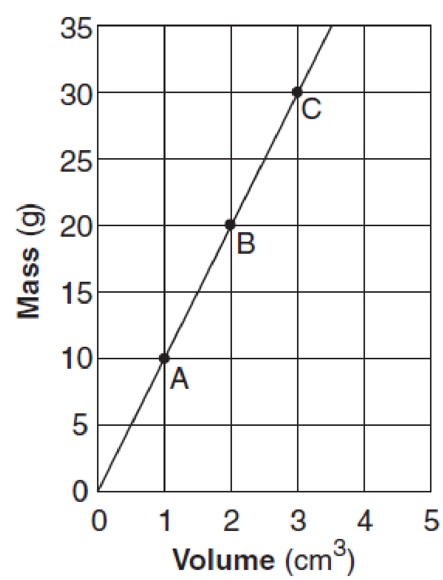
____

____

_____ 9. The graph to the right shows the relationship between mass and volume for three samples, A, B, and C, of a given material.

What is the density of this material?

(1) 1.0 g/cm3
(2) 5.0 g/cm3
(3) 10.0 g/cm3
(4) 20.0 g/cm3



Introduction:

In order to determine the volume of some materials you will need to use water displacement. You measure the volume of water in a graduated cylinder, place the material in the water and determine the new volume. By subtracting the two volumes you can determine the volume of your oddly shaped object and then can determine its density.

Objective:

- To determine the density of a material by water displacement
- Compare the results with mathematical computations
- To determine the material by finding its density

Materials

- ✓ Balance
- ✓ 4 Rod samples of the same material
- ✓ Calculator
- ✓ Graduated cylinder
- ✓ Metric ruler

Procedure Part 1: Mathematically

** Round ALL measurements to the nearest <u>tenth</u> of a centimeter .*

1. Obtain 1 set of 4 rods of the same uniform material. Write the letter of the material in the table next to the word "Rod" in the table below.
2. Using the balance, determine the mass of the smallest rod and place the data in the table below.
3. Using a metric ruler measure the height of the rod by laying it on the table. Remember to place one end at 0 (zero) on the ruler. Place the height of each rod in the table below.
4. Using a metric ruler, place the rod in the standing up position directly on the ruler. Measure the diameter of the rod and place it in the table below.
5. Determine the radius of the rod by dividing the diameter by 2. Place that value in the table below.
6. Determine the volume of the rod by using the following formula for a cylinder:

   $V = \pi r^2 h$ *Use 3.14 as the value for* π

7. Determine the density of the rod. D= m/v

Rod ______	Mass (g)	Height (cm)	Diameter (cm)	Radius (cm)	Volume of rod (cm^3)	Density of the rod (g/cm^3)
Small						
Small / Medium						
Medium / Large						
Large						
					Average Density	

Name of material: ______________________________

8. Repeat procedure 1 through 7 for each of the three remaining rods.
9. Determine the average density of the material [add all four densities then divide by 4].
10. Using the Material Density chart to the right, determine the name of the material you were working with. Write the name of the material on the line provided in the table.

Material Density	
0.90	Polypropylene
1.17	Acrylic
1.37	Polyvinylchloride (PVC)
2.20	PTFE (Teflon)

Procedure Part 2: Water Displacement

1. Using a different set of 4 rods of the same uniform material, record the mass for each rod in the appropriate place on the data table below. (Same mass as in the table on page 27)
2. Place approximately 40 mL of water in the graduated cylinder. Take the exact measurement to the nearest 10^{th} of a mL and place that value in the table below.
3. Carefully drop the smallest rod into the water. Record the new volume of the graduated rod in column labeled "Volume of water + Rod".
4. Determine the volume of the rod by *subtracting* the Volume of water from the Volume of water + Rod. Place this value in the column labeled "Volume of Rod"
5. Determine the density of each cylinder. D= m/v
6. Determine the average density of the material [add all four densities then divide by 4].
7. Using the Material Density chart on to the right, determine the name of the material you were working with. Write the name of the material on the line provided in the table.

Rod ______	Mass (g)	Volume of water (mL)	Volume of water + Rod (mL)	Volume of Rod (mL)	Density of the rod (cm^3)
Small					
Small / Medium					
Medium / Large					
Large					
				Average Density	

Name of material: ____________________________

✓ **Check Point**

1. Explain why it was important to determine the mass before the rod was placed in the water? ____
____
____
____

2. Explain why you can identify a mineral based on its density. ________________________________

____

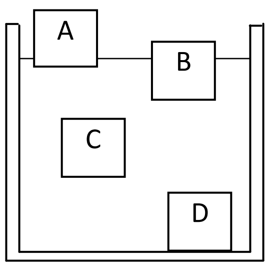
3. Compare the two different ways you determined the density of the rods. Which procedure do you feel was a more accurate way to determine the volume of the rod? Remember to support your answer with a logical explanation. ______________________________

____

____

____

Base your answer to questions 4 through 6 on the diagram below. The diagram shows the location of four objects, A, B, C, and D, after they were placed in a container of water.



4. Which object is most probably an ice cube? ____________

5. Which object has the same density as the liquid? ________

6. List the objects in order from highest to lowest density.

_______ , _______ , _______ , _______

Base your answers to questions 7 through 8 on the data table below. The table shows the mass and volume of three liquids **A, B,** and ***C***.

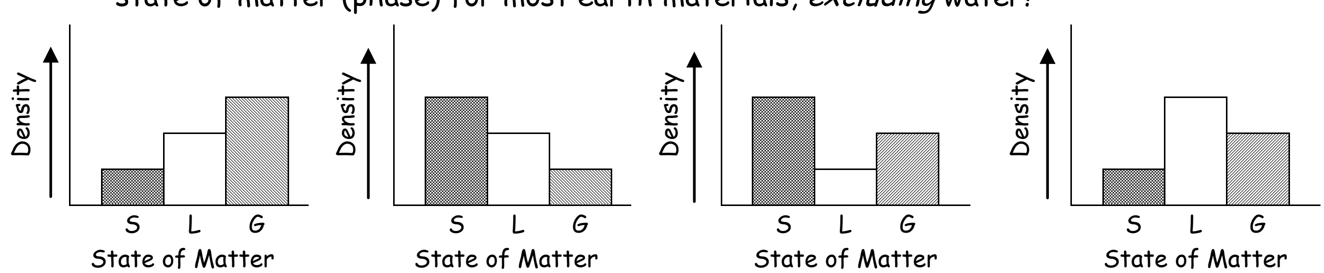
Liquid	Volume (mL)	Mass (g)	Density (g/mL)
A	500	400	
B	500	500	
C	500	600	

7. List the liquids in order of decreasing densities. ________ ________ ________

8. If half of liquid *A* is removed from its container, how will the density of the remaining liquid compare to the original density?

____

____9. Which graph best represents the relationship between the density of a substance and its state of matter (phase) for most earth materials, *excluding* water?



(1) (2) (3) (4)