



Earth Science

Prologue

I. Basic Terms:

1) Observation - _____

Example: _____

2) Instruments - _____

Example: _____

3) Inference - _____

Example: _____

4) Prediction - _____

Example: _____

(a) Cyclic - _____

Example: _____

(b) Non-Cyclic - _____

Example: _____

5) Classification - _____

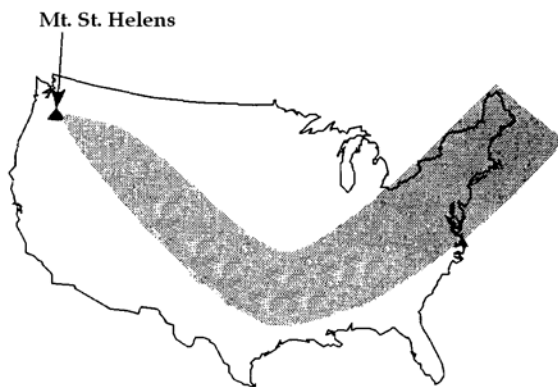
Example: _____

For each statement below, determine if it is an observation, an inference or a prediction and explain your choice.

Statement	Observation Inference or Prediction	Reason
1) The sample was transported by a glacier over 1 million years ago.		
2) The sample is rectangular, with sharp, angular corners.		
3) The water will become unsafe within 5 years.		
4) Some of the snow on the glacier is powdery.		
5) The sample is 8 cm long, 5 cm wide, and 3 cm high.		
6) Hot and humid conditions will continue throughout the week.		
7) There are many cracks in the glacier.		
8) The sample is white in color.		
9) A meteor impact caused the extinction of the dinosaurs.		
10) The rocks in the glacier are different sizes.		
11) The rock is spherical and must have been transported here by a stream.		
12) Some parts of the glacier will start melting this spring.		

Questions: Choose the word or statement that best answers the question.

- 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) 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
- 3) The map below shows the path of an ash cloud that results 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
- 4) An interpretation based upon an observation is called
 - (1) fact
 - (2) an inference
 - (3) a classification
 - (4) a measurement
 - 5) 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.
 - 6) The grouping of objects or events based on similar characteristics is called
 - (1) observation
 - (2) interpretation
 - (3) measurement
 - (4) classification
 - 7) A student classifies several objects. The classification system should be based on
 - (1) hypotheses
 - (2) inferences
 - (3) observations
 - (4) interpretations
 - 8) A prediction of next winter's weather is an example of
 - (1) an observation
 - (2) an inference
 - (3) classification
 - (4) a measurement

1) Measurement - _____

Time _____

Length _____

Mass _____

Volume _____

2) Standard unit - _____

3) Percent Deviation - _____

$$\text{Percent Deviation} = \frac{\text{Difference from accepted value}}{\text{Accepted value}} \times 100\%$$

Examples:

(1) A person measures the length of a piece of wood to be 41 centimeters. If the actual length is 40 centimeters, what is the percent deviation from the actual length?

Step 1: Write out the formula:

Step 2: Substitute with numbers

Step 3: Write down the solution

(2) A student's measurement of the mass of a rock is 30 grams. If the accepted value for the mass of the rock is 33 grams, what is the percent deviation of the student's measurement?

Formula:

Substitute numbers:

Solution:

Practice Problems. Determine the percent deviation for each of the following. Write your answer to the nearest tenth of a percent. *Make sure you put units in your substitutions and in your answers.*

1. Accepted value is 7.1 sec; Measured value 6.4 sec.

Formula:

Substitute numbers:

Solution:

2. Accepted value is 40,000 km; Measured value is 37,600 km.

Formula:

Substitute numbers:

Solution:

3. Accepted value: 3.9 km, Measured value: 4 km

Formula:

Substitute numbers:

Solution:

4. Accepted value: 6.33 grams, Measured value: 6.32 grams

Formula:

Substitute numbers:

Solution:

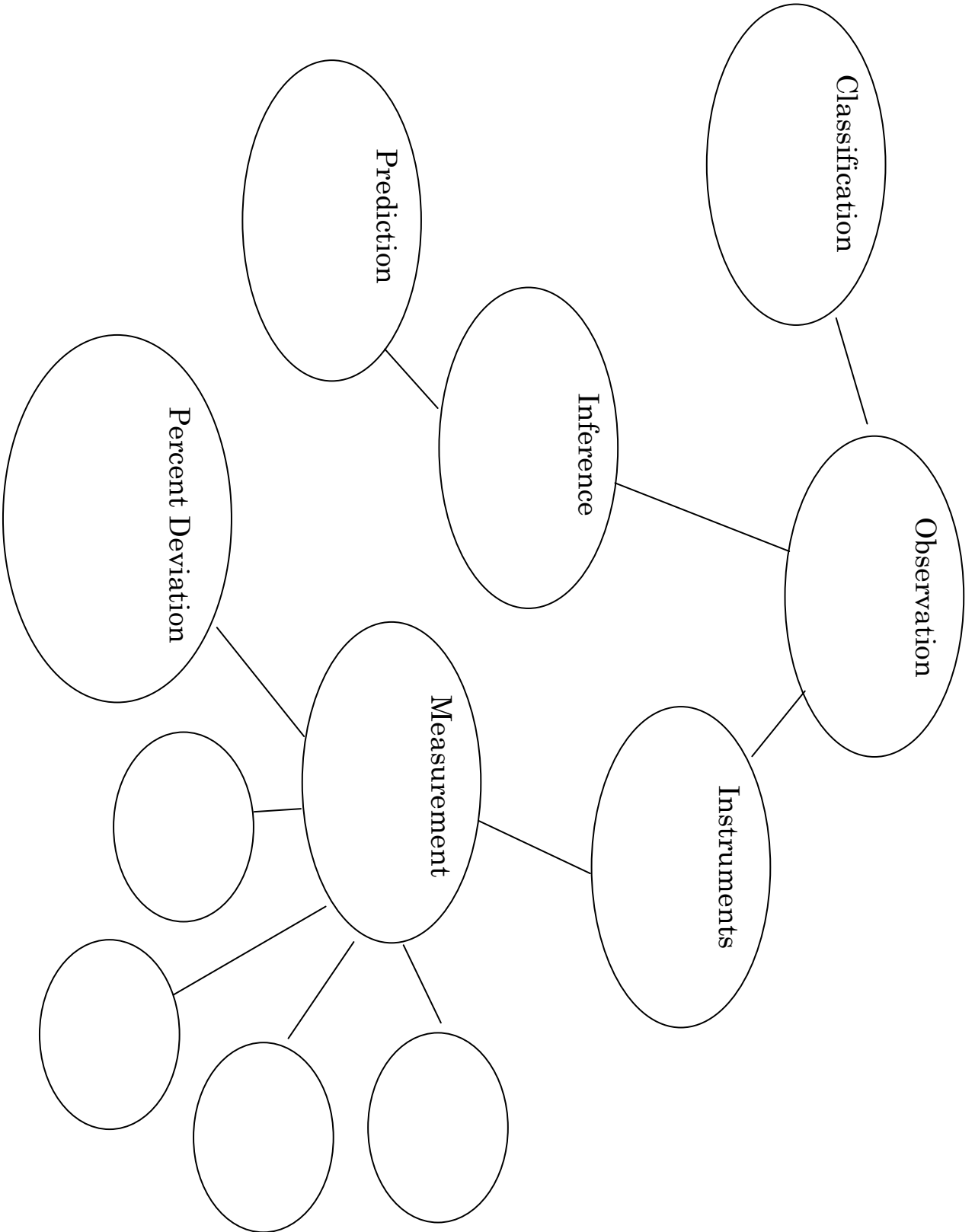
5. A student determines the volume of a cubic crystal to be 8.6 cubic centimeters. What is her percent error if the correct volume of the crystal is 8.0 cubic centimeters?

Formula:

Substitute numbers:

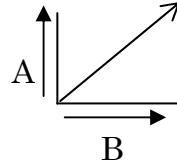
Solution:

- 6) What is the percent deviation if an igneous rock has a measured mass of 51 grams and an accepted mass of 60 grams?
 (1) 9 % (2) 15 % (3) 18 % (4) 85 %
- 7) A student determines the mass of an object to be 81.6 grams. The actual mass is 80 grams. What is the student's percent deviation?
 (1) 0.2 % (2) 10.6 % (3) 2.0 % (4) 1.6 %
- 8) Students calculated the circumference of a globe to be 60 centimeters. The actual circumference of the globe is 63 centimeters. What is the students' percent deviation?
 (1) 4.8 % (2) 0.48 % (3) 5.0 % (4) 21 %
- 9) A person incorrectly measured the length of a room to be 13.0 meters. The actual length was 12.0 meters. What is the person's approximate percent deviation?
 (1) 1.0 % (2) 5.9 % (3) 7.7 % (4) 8.3 %
- 10) A person incorrectly converted 20°C to 64°F instead of 68°F. What is the student's approximate percent error?
 (1) 44 % (2) 5.9 % (3) 6.3 % (4) 4 %
- 11) A person incorrectly measures the mass of a rock as 346 grams. The actual mass is 326 grams. What is the person's approximate percent deviation?
 (1) 5.8 % (2) 6.1 % (3) 8.2 % (4) 16.3 %
- 12) A student measures the volume of water as 72 milliliters when the true volume is 75 milliliters. Which equation should be used to determine the student's percent deviation?
- (1) % deviation = $\frac{72}{75} \times 100$ (3) % deviation = $\frac{75 - 72}{75} \times 100$
- (2) % deviation = $\frac{72 + 75}{75} \times 100$ (4) % deviation = $\frac{75 - 72}{72} \times 100$



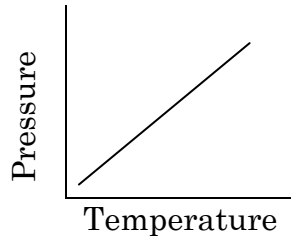
II Line Graphs

When interpreting a graph, read the bottom variable first. This is your independent variable. Then, read the side variable and describe what the line in the center of the graph is doing.

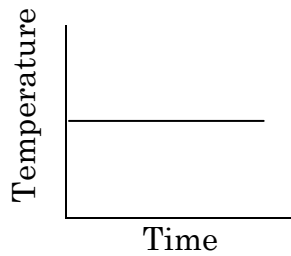


As "B" increases,
"A" increases

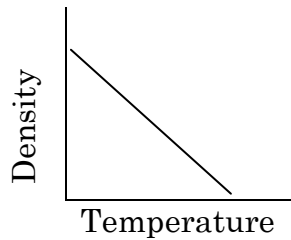
Write out the relationships for each of the following graphs:



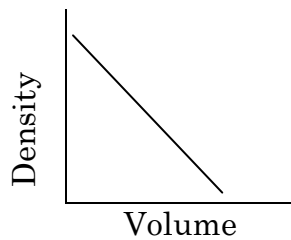
As temperature increases,
Pressure _____



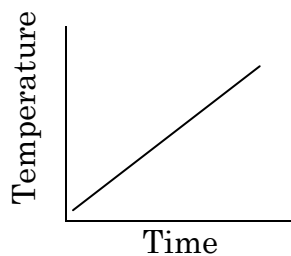
As



As



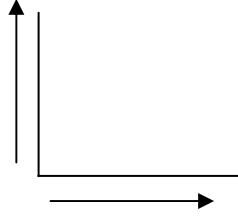
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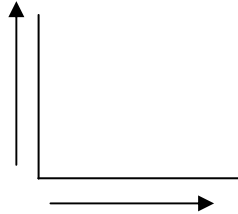
As

Draw a graph for each of the following relationships:

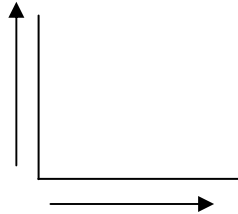
As depth increases,
pressure increases



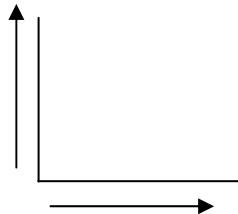
As depth increases,
density increases



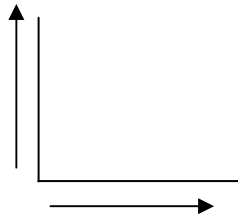
As altitude increases,
temperature decreases



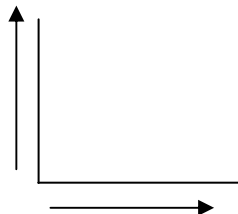
As population increases,
pollution increases



As the amount of studying
increases, grades increase



As time increases,
velocity remains the same



III. Density of Matter

Density - _____

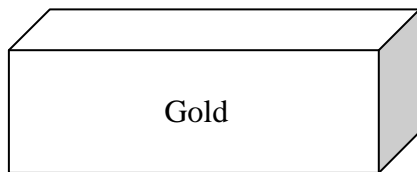
Formula:



A. Density Properties:

- _____
- _____

Example:



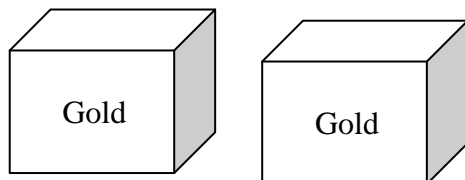
Mass = 162 g

Volume = 8.4 cm³

$$\text{Density} = \frac{\text{mass}}{\text{volume}} = \frac{\text{g}}{\text{cm}^3}$$

$$\text{Density} = \underline{\hspace{2cm}} \text{ g/cm}^3$$

If you take that sample of gold and break it into two exact halves, the mass and volume is half of the original, but the density remains the same.



Mass = 81 g

Volume = 4.2 cm³

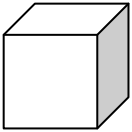
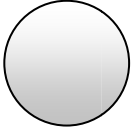
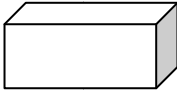

$$\text{Density} = \frac{\text{mass}}{\text{volume}} = \frac{\text{g}}{\text{cm}^3}$$

$$\text{Density} = \underline{\hspace{2cm}} \text{ g/cm}^3$$

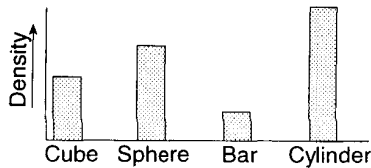
Practice questions:

- 1) If a wooden block were cut into eight identical pieces, the density of each piece compared to the density of the original block would be
(1) less (2) greater (3) the same
- 2) Under the same conditions of temperature and pressure, three different samples of the same uniform substance would have the same
(1) shape (2) density (3) mass (4) volume

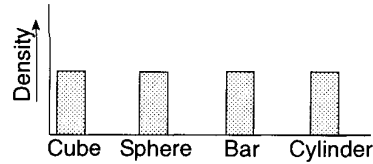
Base your answers to questions 3 through 6 on the diagrams below which represent four solid objects made of the same uniform material. The volume of the sphere and the mass of the bar are not given.

<p>Cube</p>  <p>Mass 81 g Volume 27 cm³</p>	<p>Sphere</p>  <p>Mass 75 g Volume ?</p>	<p>Bar</p>  <p>Mass ? Volume 30 cm³</p>	<p>Cylinder</p>  <p>Mass 60 g Volume 20 cm³</p>
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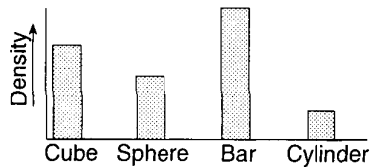
- 3) What is the density of the bar?
 (1) 9.9 g/cm³ (2) 30.0 g/cm³ (3) 3.0 g/cm³ (4) 90.0 g/cm³
- 4) Which graph best represents the relative densities of the objects?



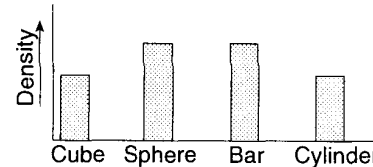
(1)



(3)



(2)



(4)

- 5) What is the mass for the bar?
 (1) 90 g (2) 10 g (3) 30 g (4) 3 g
- 6) What is the volume of the sphere?
 (1) 5 cm³ (2) 15 cm³ (3) 25 cm³ (4) 35 cm³
- 7) An unknown sample has a density of 6.0 grams per cubic centimeter. If the sample were cut in half, each half would have a density of
 (1) 12.0 g/cm³ (2) 9.0 g/cm³ (3) 3.0 g/cm³ (4) 6.0 g/cm³
- 8) The original sample A is cut into several pieces. When compared with the density of the original sample, the density of each piece will be
 (1) less (2) greater (3) the same

B. Change in Density:

Two factors that do effect density are _____ and _____

1. **Temperature** As temperature increases, molecules begin to move a part (expand), which means the volume increases.

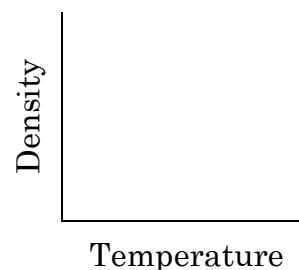
(a) Warm air _____ because it is _____ dense.

An example would be a _____

(b) State the relationship between temperature and density.

As _____,

(c) Draw the relationship between temperature and density in the graph below.



Phases of Matter:

(a) Most materials have their greatest density as a _____
The exception is water, because water _____ when it freezes.

(b) Water is at its greatest density at a temperature of _____ °C
The density of water is _____ g/ml

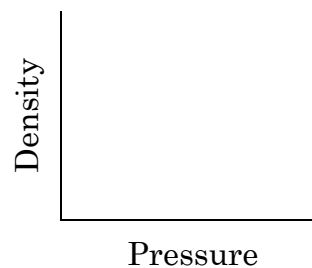
(c) If an object floats on water, it is _____ dense than the water.
If an object sinks in water, it is _____ dense than the water.

2. **Pressure:** When pressure is added, it causes the material to become smaller (compress), volume decreases.

(a) State the relationship between pressure and density.

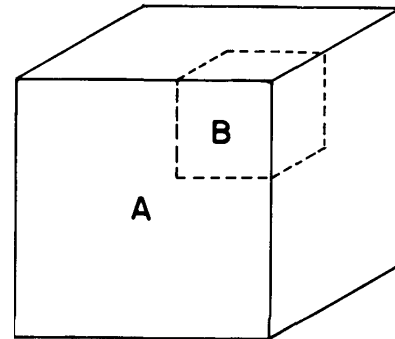
As _____,

(b) Draw the relationship between pressure and density in the graph below.



Practice problems:

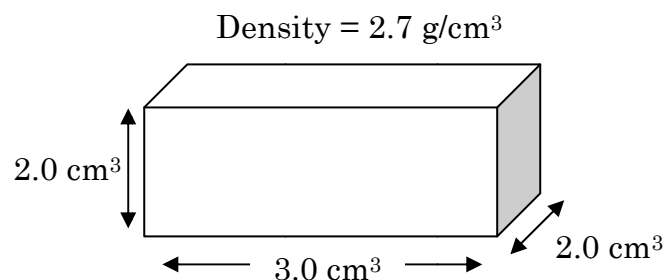
Base your answers to questions 1 through 3 on the diagram below. Object *A* is a solid cube of uniform material having a mass of 65 grams and a volume of 25 cubic centimeters. Cube *B* is a part of cube *A*.



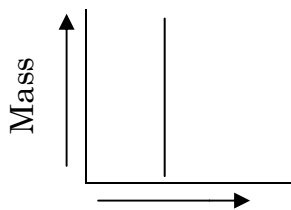
- The density of the material in cube *A* is determined at different temperatures and phases of matter. At which temperature and in which phase of matter would the density of cube *A* most likely be greatest?
 - at 20°C and in the solid phase
 - at 200°C and in the solid phase
 - at 1800 °C and in the liquid phase
 - at 2700°C and in the gaseous phase
- If cube *B* is removed from cube *A*, the density of the remaining part of cube *A* will
 - decrease
 - increase
 - remain the same
- The mass of cube *B* is measured in order to calculate its density. The cube has water on it while its mass is being measured. How would the calculated value for density compare with the actual density?
 - The calculated density value would be less than the actual density.
 - The calculated density value would be greater than the actual density.
 - The calculated density value would be the same as the actual density.

Base your answers to questions 4 through 6 on the diagram below, which represents a solid material of uniform composition.

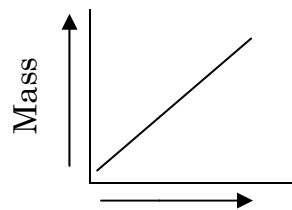
- What is the mass of the material?
 - 18.9 g
 - 32.4 g
 - 4.5 g
 - 40 g
- If this material is heated and expands, the density of the material will
 - decrease
 - increase
 - remain the same



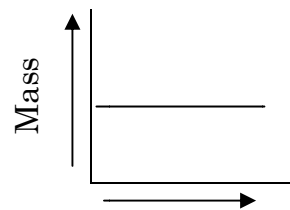
- Which graph best represents the relationship between the mass and volume of various-sized pieces of this material?



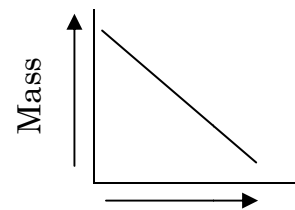
(1)



(2)



(3)

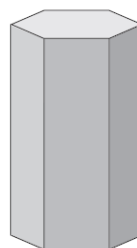


(4)

- 7) As water cools from 4°C to 0°C, its density
 (1) decreases (2) increases (3) remains the same
- 8) As the volume of air expands due to heating, the density of this air will
 (1) decrease (2) increase (3) remain the same
- 9) Water has the greatest density at approximately
 (1) 100°C in the gaseous phase (3) 4°C in the solid phase
 (2) 0°C in the solid phase (4) 4°C in the liquid phase

Base your answers to questions 10 and 11 on the diagram below, which is an irregularly shaped objects in which certain measurements were made.

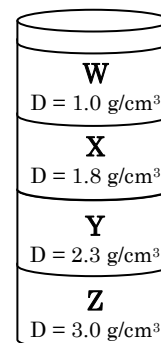
- 10) A student measured the mass and volume of the mineral crystal below and recorded the data shown below. The student used these data to calculate the density of the crystal. What is the density according to the student's data?
 (1) 1.0 g/cm³ (3) 2.0 g/cm³
 (2) 1.5 g/cm³ (4) 2.5 g/cm³



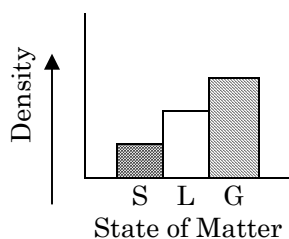
Data	
Mass =	80 g
Volume =	32 cm ³
Density =	?

- 11) What is the student's percent error if the actual density of the crystal is 2.7 grams per cubic centimeter?
 (1) 0.4% (2) 5.0% (3) 7.4% (4) 8.0%

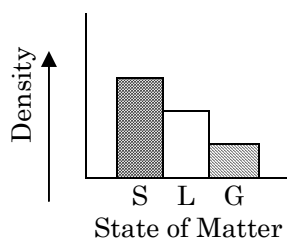
- 12) The diagram to the right represents a cylinder which contains four different liquids, W, X, Y, and Z, each with a different density (D) as indicated. A piece of solid quartz having a density of 2.7 g/cm³ is placed on the surface of liquid W. When the quartz is released, it will pass through
 (1) W, but not X, Y, or Z (3) W, X, and Y, but not Z
 (2) W and X but not Y, or Z (4) W, X, Y, and Z



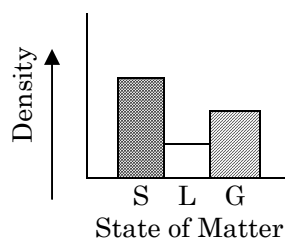
- 13) Which graph best represents the relationship between the density of a substance and its state of matter (phase) for most earth materials, *excluding* water?



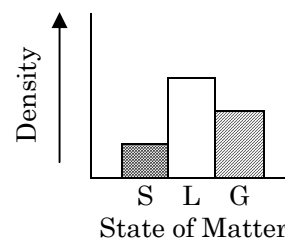
(1)



(2)



(3)



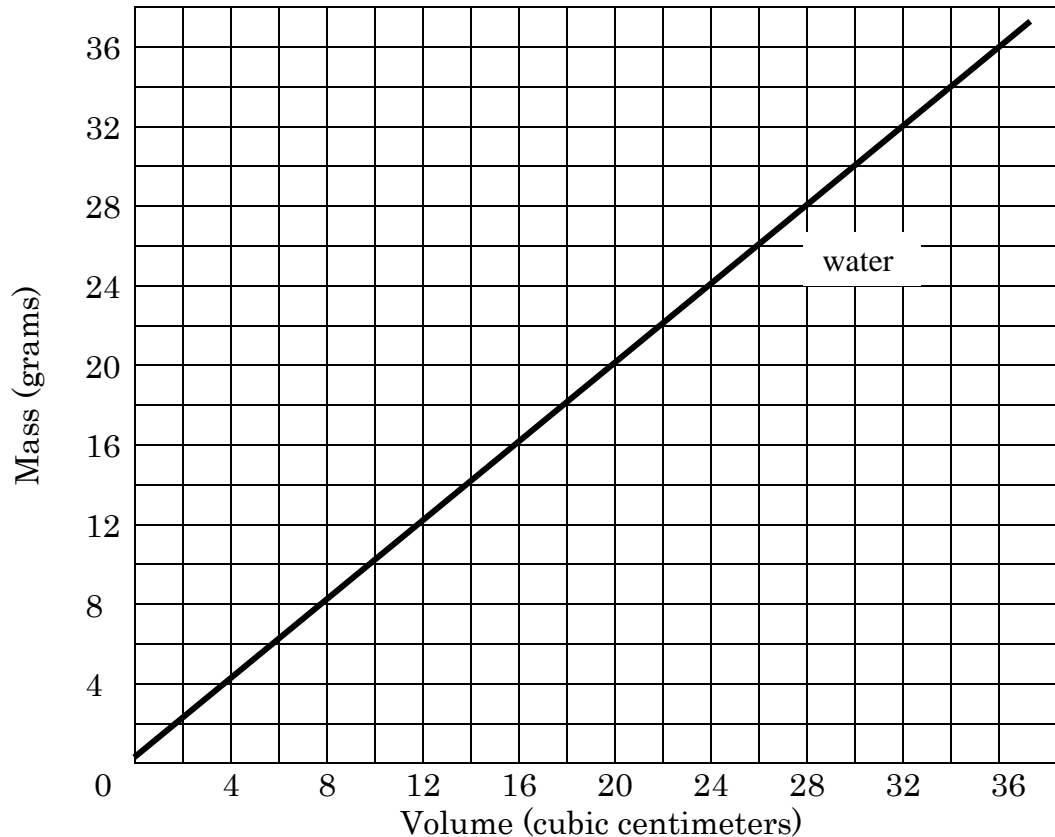
(4)

C. Graphing Density: The data below shows the mass and volume for three samples of two different materials. The density for water has been plotted.

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

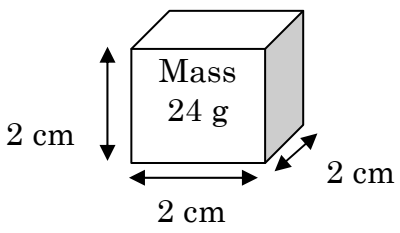
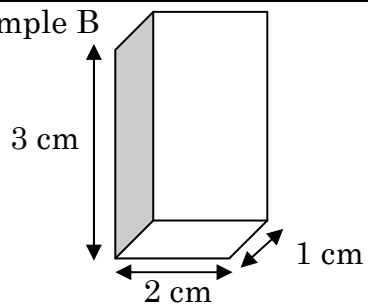
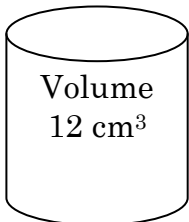
Material A			
Sample	(a)	(b)	(c)
Mass (g)	14	35	21
Volume (cm ³)	8	20	12
Density (g/cm ³)			

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



4. What is the density of material A? _____
5. What is the density of material B? _____
6. Referring to the line graphs above, compare the line drawn for water and the lines drawn for Materials A and B by answering the questions below.
 - (a) How can you tell if a material is less dense than water?
 - (b) How can you tell if a material is more dense than water?
 - (c) The greater the density, the _____ the slope.

Problems: Answer the following questions for each sample below. Each sample is made of the same uniform material.

<p>Sample A</p> 	<p>Sample B</p> 	<p>Sample C</p> 
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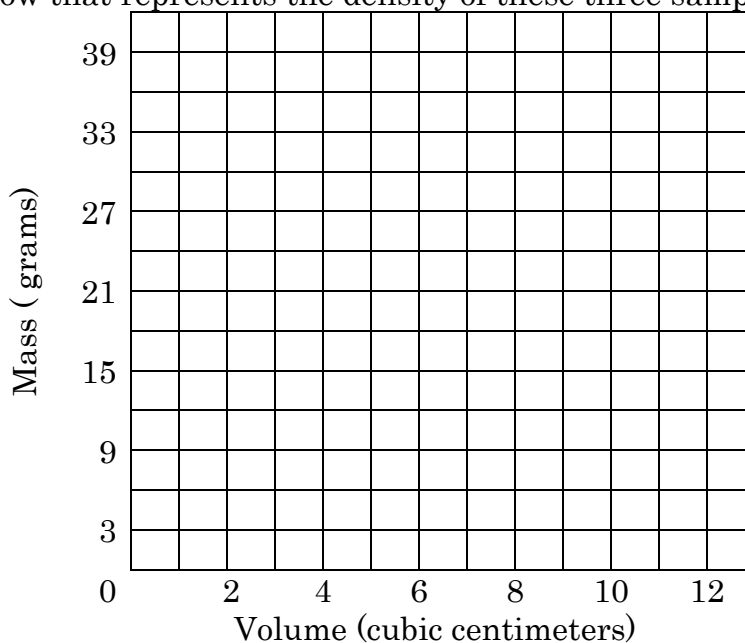
Solve for the following. **Show all work:** write out the formula; substitute numbers; solve.

<p>1. Determine the volume of Sample A: $V = l \cdot w \cdot h$</p> <p>2. What is the density of Sample A?</p>	<p>3. Determine the volume of Sample B.</p> <p>4. What is the mass of Sample B?</p>	<p>5. What is the mass of Sample C?</p>
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6. Fill in the chart below, using the values determined above.

Sample:	A	B	C
Mass (g)			
Volume (cm ³)			

7. Draw a graph below that represents the density of these three samples.

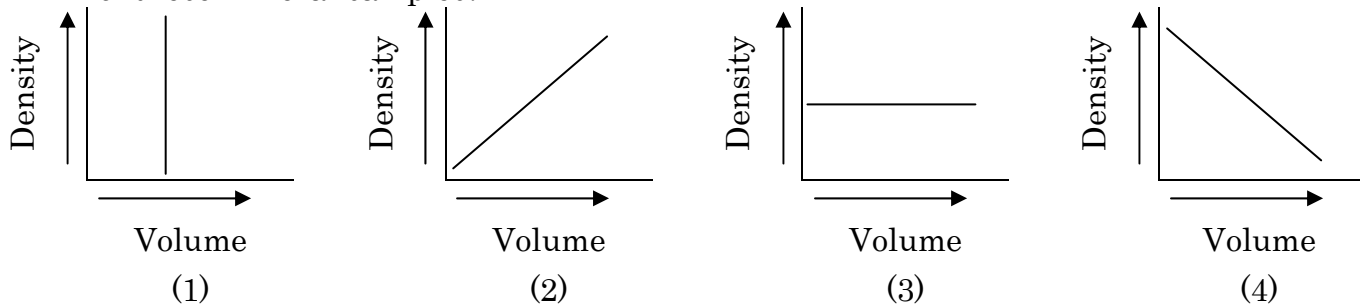


Base your answers to questions 8 and 9 on the data tables below. The data table below shows the mass and volume of three samples of the same mineral.

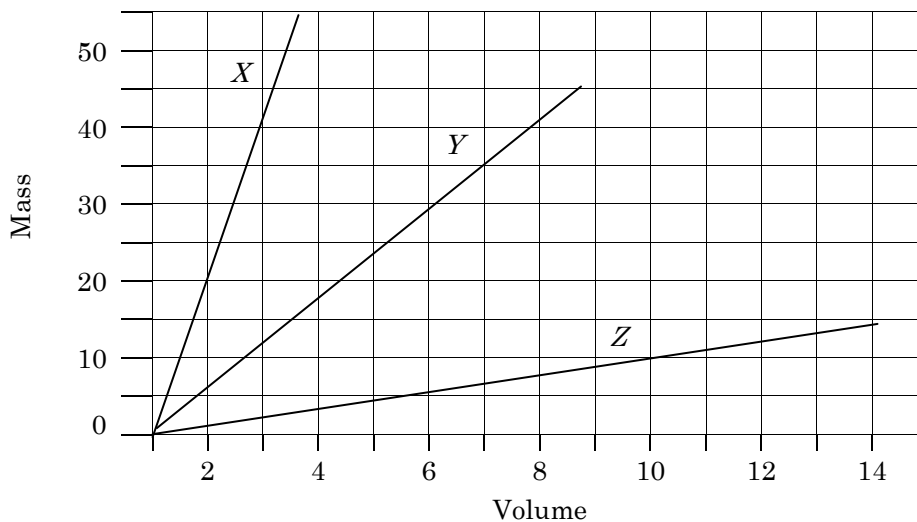
8. Determine the density of each of the samples below.

Sample	Mass (g)	Volume (cm ³)	Density (g/cm ³)
A	50	25	
B	100	50	
C	150	75	

9. Which graph best represents the relationship between the density and the volume of these mineral samples?



Base your answers to questions 10 through 12 on the graph below which shows the relationship between mass and volume for three materials *X*, *Y*, and *Z* which are at a temperature of 20°C.

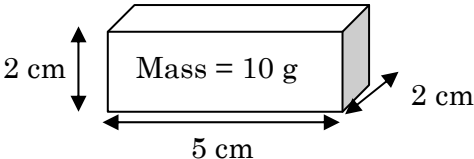

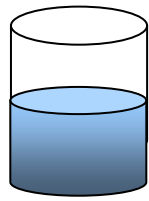
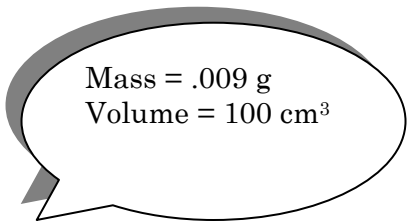
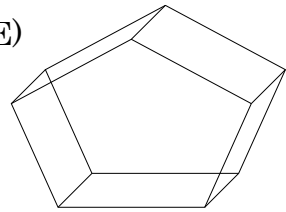


10. What is the approximate density of material *Y*?
 (1) 1.0 g/cm³ (2) 0.2 g/cm³ (3) 5.0 g/cm³ (4) 10.0 g/cm³

11. When the volume of material *Z* is 14 cubic centimeters, its mass is
 (1) 8 g (2) 10 g (3) 14 g (4) 16 g

12. Using the graph above, draw the line graph on for a material that has a volume of 7 cubic centimeters and a mass of 12 grams.

13. Calculate the density of the following 5 different substances, *A*, *B*, *C*, *D*, and *E*. Show all work.

A)	 <p style="margin: 0;">Mass = 10 g</p>
B)	 <p style="margin: 0;">mass = 10.6 g volume = 4 cm³</p>
C)	 <p style="margin: 0;">mass = 35 g volume = 35 ml</p>
D)	 <p style="margin: 0;">Mass = .009 g Volume = 100 cm³</p>
E)	 <p style="margin: 0;">Mass = 80 g Volume = 35 cm³</p>

14. Using the letters for each material, list the materials in order of density from least to Most.

_____ , _____ , _____ , _____ , _____

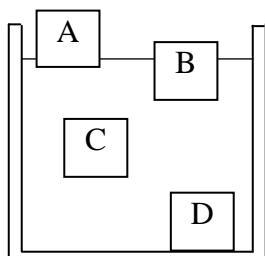
15. What is the density of water? _____
16. Which objects above will float if they were placed in water? _____
17. What happens to the volume of the air as it is heated? _____
18. What happens to the density of the air as it is heated? _____
19. What happens to the volume if a material is placed under pressure? _____
20. What happens to the density as pressure is increased? _____

Review Questions:

1. A student measures the volume of a rock sample to be 48.6 cm^3 . The density of the rock sample is 5.3 g/cm^3 . Calculate the mass of the rock sample.

The correct mass of the sample should have been 259.6 g. What is the student's percent error?

Base your answer to questions 2 through 4 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.



2. Which object is most probably an ice cube?
3. Which object has the same density as the liquid?
4. List the objects in order from highest to lowest density.

5. What is the density of an irregular shaped object that has a volume of 3.0 milliliters and a mass of 12 grams?
6. If the 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 the density.

Base your answers to questions 8 through 10 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	

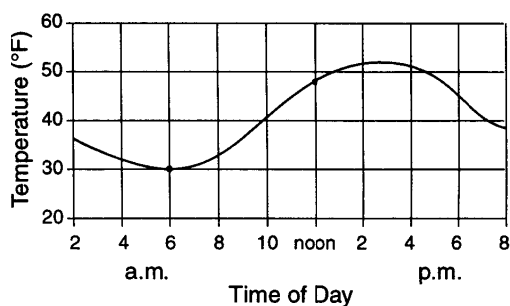
8. List the liquids in order of decreasing densities. _____
9. If half of liquid A is removed from its container, how will the density of the remaining liquid compare to the original density?
10. The accepted mass for liquid C is 600 grams, but a student measures the mass as 612 grams. What is the percent deviation of the student's measurements?

Rate of Change

Formula for
Rate of Change

Graphs

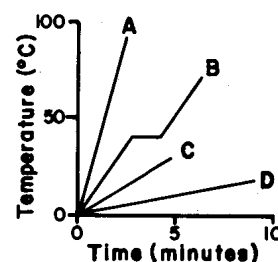
- The temperature of water in a container was 60°C . Ten minutes later, the water temperature was 35°C . What was the rate of cooling of the water?
(1) $25^{\circ}\text{C}/\text{min}$ (2) $2.5^{\circ}\text{C}/\text{min}$ (3) $35^{\circ}\text{C}/\text{min}$ (4) $3.5^{\circ}\text{C}/\text{min}$
- The graph below shows the temperature readings for a day in April.



The average rate of temperature change, in Fahrenheit degrees per hour, between 6 a.m. and noon was

- (1) $6^{\circ}/\text{hr}$ (3) $3^{\circ}/\text{hr}$
(2) $8^{\circ}/\text{hr}$ (4) $18^{\circ}/\text{hr}$

Use the graph to the right to answer questions 3 and 4. The graph represents the relationships between temperature and time as heat is added at a constant rate to equal masses of four substances labeled A, B, C, and D.



- The temperature of which substance increased the most rapidly? _____
- Which substance has a change that is not at a constant rate? _____
- Calculate the average daily rate of movement of the hurricane during the period from 3 p.m. August 24 to 3 p.m. August 28. The hurricane traveled 2,600 kilometers during this 4-day period.

6. A student measures and records the temperature of water in a beaker for 8 minutes as shown below.

	Start								Finish
Time	0 min	1 min	2 min	3 min	4 min	5 min	6 min	7 min	8 min
Temperature	90°C	83°C	78°C	73°C	68°C	64°C	60°C	57°C	54°C

What is the average rate of cooling for the water in the beaker during the 8-minute time interval?

- (1) 3.2 °C/min (2) 3.6 °C/min (3) 4.5 °C/min (4) 4.0 °C/min

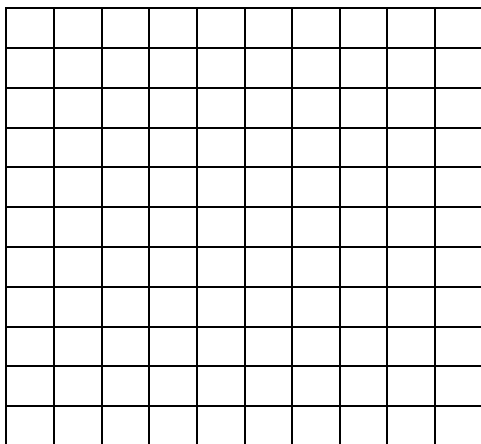
7. The temperature of water in a container was 60°C. Ten minutes later the water temperature was 35°C. What was the rate of cooling of the water?

- (1) 25 °C/min (2) 2.5 °C/min (3) 35 °C/min (4) 3.5 °C/min

8. Create a line graph using the following steps.

- (a) Determine the correct scale that will best fit the data in the table below.
 (b) Remember to label the axis with units.
 (c) Plot the data and connect the points.

Time (min)	0	1	2	3	4	5	6	7	8	9	10
Temperature (°C)	0	0	2	3	4	4	5	6	6	8	10



- (a) Determine the average rate of temperature change that occurred during this experiment.

- (b) By looking at the line graph, did the *rate of temperature change* stay the same throughout the experiment? _____

Explain how you can tell. _____