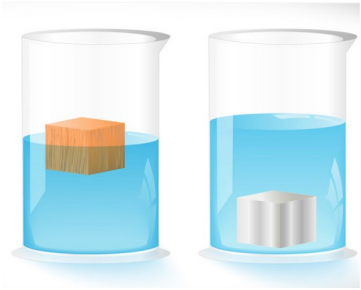
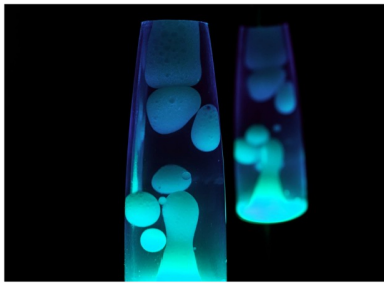
Understanding Materials: Density





Part 1: Measuring Density of Materials

1. Just by handling the following objects, discuss which appears to have lower or higher **mass**. Arrange the objects from least to greatest mass.




(a) big wooden block (b) penny (c) glass marble (d) baby carrot

least mass _____ greatest mass

2. List the objects from lower or higher **volume** (estimate!).

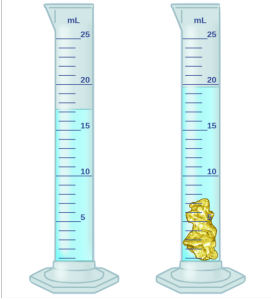
least volume _____ greatest volume

3. Make a hypothesis: how do these materials rank in terms of their **density?**

(a) wood (b) metal used to make pennies (c) glass (d) carrot

least density _____ greatest density

4. We will now measure the density of several different objects.

For each object:
(1) Use the scales provided to measure mass (in grams).
(2) Use the graduated cylinder to measure volume (in cubic centimeters, cm^3). Note the level of the water (eg: 30 mL), submerge the object, and see how much the water level goes up. A milliliter (mL) is the same volume as a cm^3. Use a straw to poke the object under water if it floats.
(3) Calculate density. Figure out what would be the mass of a $1cm^3$ chunk of the object. Leave the material column blank for now.

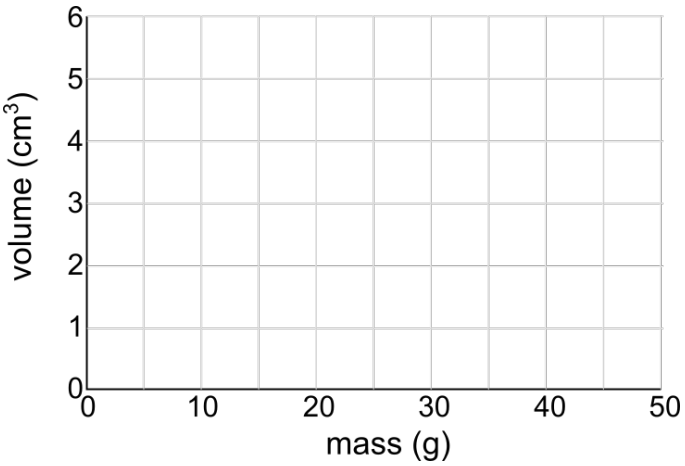
Try to use as much of each object as possible to get a more precise estimate.

Fill in the data sheet on the next page.
Copy your group's result for material densities onto the whiteboard.

Object	#	Material	Mass (g)	Volume (cm^3)	Density (g/cm^3)	Floats on water?
Zinc nuggets		zinc				
Copper nails		copper				
Aluminum foil		aluminum				
Glass marbles (green)		glass				
Plastic marbles (orange & pink)		plastic				
Wooden wedge		wood				
Quartz rock		quartz				
Dimes						
Pennies						
Blue rod						
Green beads						
Legos						
Carrot						
pretzels						
[1]Golden rock						

1 Share with another group

5. Optional: Would your measurement of density for pennies be different if you used different numbers of pennies? Try it and see! Make a graph of mass and volume for different numbers of pennies: measure 4, 8, 12, 16 pennies and plot.
What does the graph look like when you connect the dots, and what does that mean?



Density is a **material property**. It does not matter how much of that material you have or what shape it is in, the density will stay the same. An object made of multiple different materials will have a density that is averaged between them.

6. Based on your table of measurements,
What do you think is the primary material making up: pennies, dimes, blue rod, green beads? Fill in the 'material' column of the table.

7. Gold is a very dense metal, with a density of about 19g/cm$^{3.}$
Is the gold-colored rock actually made of gold? How do you know?

8. Based on your table of measurements,
What do all the objects that float on water have in common?
What about all the objects that sink?

Part 2: Density and Floating

1. Now let's measure the density of water itself. Measure the mass of an empty cup, then use the graduated cylinder to pour in 10cm^3 of water. Compute the mass of that amount of water. Then compute the density.

(Leave the other liquids blank for now)

Liquid	Mass of cup (g)	Mass of cup + liquid (g)	Mass of 10cm^3 of liquid	Density of liquid (g/cm^3)
Water				
Vegetable oil				
Pancake syrup				

The density of water is: _____ g/cm^3

2. Using your observations, can you hypothesize a general rule for whether an object will float or sink in a fluid?

An object will float in a fluid only if its _____ is _____ than that of the fluid.

3. Go back to step 1 and carry out the measurements to find the density of vegetable oil and pancake syrup.

4. Use your measurements above to predict:
What will happen if you put the following into a cylinder together? How will they layer from bottom to top?

piece of carrot, piece of foil, Lego block,
piece of pretzel, water, oil, syrup

Bottom layer _____ Top layer

13. Put all the solid objects in the cylindrical bottle (use small pieces so they can pass each other). Pour in the liquids and let the objects float to where-ever they want to settle. Were you right?

Part 3: Make your own Lava Lamp

1. An Alkaseltzer tablet contains **baking soda** (a base) and **citric acid** (an acid). When dissolved in water, they produce a chemical reaction.

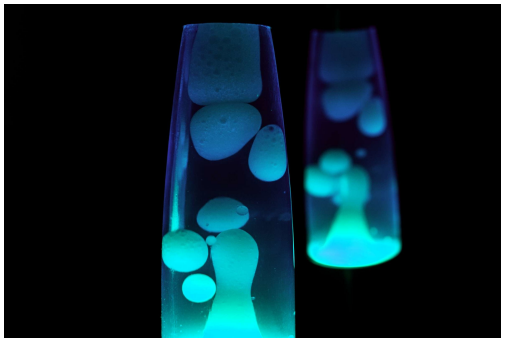
Baking soda + acid → carbon dioxide gas

Drop half a tablet into a small amount of water in the cup. What happens? Rank the following from least dense to most dense:

water Alkaseltzer tablet carbon dioxide

least dense _____ most dense

Now let's make our "Lava Lamp"!



5. Pour oil through a funnel into the test tube until it is about 1 inch from the top.

6. Pour in some water until the tube is nearly full.

7. Add a drop of food coloring. Stir it in with a stick.

How does the density of food coloring compare to the density of oil? Of water?

8. Break up an alkaseltzer tablet into small pieces and add the pieces to your test tube.

Discuss what happens and why! What do you see floating? What do you see sinking?