

Name _____

Density Workbook

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

or, in short form:

$$d = \frac{m}{v}$$

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

Overview of Density Worksheet

Key formulas/Concepts:

Density - Density = Mass divided by Volume ($D = M/V$). The mass of an object is 25 grams. The volume of an object is 5 cm^3 . $D = 25\text{g}/5\text{cm}^3 = 5 \text{ g/cm}^3$.

Volume of a rectangular shaped object/cube - Length \times Width \times Height ($L \times W \times H$).
Example - A cube has a length of 3 cm. (Note - a cube has six equal sides). $V = 3 \times 3 \times 3 = 27 \text{ cm}^3$. A piece of wood has a length of 10 cm, width of 18 cm, and height of 3 cm. $V = 10 \times 18 \times 3 = 540 \text{ cm}^3$.

Volume of an irregularly shaped object - Use a graduated cylinder filled with a fluid. Record the beginning amount of fluid (in mL - milliliters). Drop the object into the graduated cylinder. Record the level of the fluid with the object (in mL). To determine the volume: **Level of fluid with object - beginning amount of fluid**. Example - a graduated cylinder is filled to the 30mL mark with water. You drop in a rock. The water level rises to 48mL. $V = 48\text{mL} - 30\text{mL} = 18\text{mL}$.

Problems (Always Show Your Work and units - g, mL, cm^3 , g/cm^3 , g/mL):

1. $M = 35\text{g}$, $V = 17\text{cm}^3$

2. $M = 40\text{g}$, $V = 31\text{cm}^3$

3. You have a box that has a volume of 412 cm^3 and weighs 42g. What is its density?

4. Calculate the density of a 500 g rectangular block with the following dimensions: length=8 cm, width=6 cm, height=5 cm.

5. One side of a cube is 6 cm long. Its weight is 220 g. What is the density of the cube?
6. You are given a cube with a length of 2.5 cm, a width of 2.5 cm, and a height of 2.5 cm. You place it on a scale, and its mass is 295 g. Calculate the density.
7. You have a piece of balsa wood that is 45 cm long, 8 cm high, and 4 cm wide. It weighs 500 g. What is its density?
8. An irregular object with a mass of 118 g displaces 25mL of water when placed in a graduated cylinder. Calculate the density of the object.
9. A bead weighs 15 g. You place it in a graduated cylinder that has 20mL of water in it. After placing the bead in the cylinder, the water level is now at 30mL. What is its density?
10. A screw weighs 10 grams. After dropping it in a graduated cylinder, you find its volume is 7mL. What is its density?

11. Drop a toy car in a graduated cylinder with 15mL of water. You look at the level after the car is in the cylinder and see that it is now 32mL. The car weighs 127 g. What is its density?

12 - 14. Will it float, neither float nor sink, or sink?

<i>Density of Object</i>	<i>Density of Fluid</i>	<i>Float, sink, neither</i>
17 g/cm^3	17.4 g/cm^3	
1 g/cm^3	3 g/cm^3	
4.17 g/cm^3	4.17 g/cm^3	

15 - 17 Will it float, neither float nor sink, or sink?

<i>Density of Object</i>	<i>Density of Fluid</i>	<i>Float, sink, neither</i>
4 g/cm^3	4 g/cm^3	
1.02 g/cm^3	1.01 g/cm^3	
2.37 g/cm^3	6.07 g/cm^3	

18. A sample has a mass of 1.2g and a volume of 1.1cm^3 , what is its density?

19. A piece of metal has a mass of 32.4g and has a volume of 24.9cm^3 . What is its density?

20. If a sample has a volume of 5.25cm^3 and a mass of 97.4g , its density would be...

21. Godzilla was running wild in Brigham City but was finally captured. The Police Department needs you to tell them his density (the FBI must know this). You have a huge vat of water filled to the 1,000 L level. You drop the kicking and roaring Godzilla into the vat. It now reads 2,716 L. At the bottom of your vat is a scale. You empty the water and weigh Godzilla. His mass is 8,000kg. What is his density?

22. Water has a density of 1 g/cm^3 . You drop an object into the water that has a mass of $.86\text{ g/cm}^3$. What will happen to the object?

23. Mercury has a density of 13.53 g/cm^3 . You drop an object into the mercury that has a density of 18.88 g/cm^3 . What will happen to the object?

24. You drop a rock in water and the rock sinks. What can you infer from this?

25. What is the density of a board whose dimensions are 5.54 cm x 10.6 cm x 199 cm and whose mass is 28.6 g?

26. Calculate the mass of a liquid with a density of 3.2 g/mL and a volume of 25mL.
(Use the formula $\text{Mass} = \text{Density} \times \text{Volume}$)

27. Calculate the density of a 500 g rectangular block with the following dimensions:
length=8 cm, width=6 cm, height=5 cm.

28. An irregular object with a mass of 18 g displaces 2.5mL of water when placed in a large cylinder. Calculate the density of the object.

29. A graduated cylinder has a mass of 80 g when empty. When 20 mL of water is added, the graduated cylinder has a mass of 100 g. If a stone is added to the graduated cylinder, the water level rises to 45 mL and the total mass is now 156 g. What is the density of the stone?

Density Cubed

Materials

- Six metal cubes
- Triple-beam balance

- Calculator

You have six cubes. Your assignment is to determine the mass of each cube. Using that information, you need to identify what metal the cube is made of (densities are approximate).

<i>Metal</i>	<i>Density</i>	<i>Metal</i>	<i>Density</i>
Aluminum	2.85 g/cm ³	Iron	7.36 g/cm ³
Brass	8.16 g/cm ³	Lead	11.3 g/cm ³
Copper	9.15 g/cm ³	Zinc	6.62 g/cm ³

Your task is to calculate the density for each block and identify which metal it is.

Block #	Mass (grams)	Volume (cm ³)	Density (g/cm ³) (D = M/V)	Metal
1				
2				
3				
4				
5				
6				

What a Mass!

Materials

- Triple-beam scales
- Cylinder set (5)
- Calculator

- Ruler

Procedures

1. Measure each cylinder and record its length on the table on the back.
2. Weigh each cylinder and record its mass on the table on the back.
3. Calculate the volume using the following formula: $V = \pi r^2 h$ (π is found on the EXP key on the calculator, r^2 is .6 cm, and h is the length of the cylinder, in centimeters).
3. Determine the density of each cylinder.
4. Once you know the density, identify what material each cylinder is made of.
5. In your science journal, make a chart like the one below and complete it.

Material Table

<i>Material</i>	<i>Density - (g/cm³)</i>	<i>Material</i>	<i>Density - (g/cm³)</i>
Aluminum	2.9 g/cm ³	PVC	1.4 g/cm ³
Copper	8.9 g/cm ³	Nylon	1.2 g/cm ³
Polyethylene	1.02 g/cm ³		

Data Chart

<i>Cylinder (length in cm)</i>	<i>Mass (g)</i>	<i>Volume (cm³)</i>	<i>Density (g/cm³)</i>

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Which Cylinder is Made of Which Material?

<i>Cylinder (length)</i>	<i>Material</i>

Curly

Materials

- Pencil
- Paper cup
- Container
- Warm water
- 2 blue ice cubes

Procedure

1. Use the point of a pencil to punch four small holes near the bottom of the paper cup. The holes should be spaced evenly around the cup.
2. Fill the container with warm water. (You need enough water so you can place the bottom of the cup in the water. You also need enough room for the water that goes into the cup.)
3. Set the paper cup back in the container and place the ice cubes in the cup.

4. Wait 1 minute.
 5. Add three drops of food coloring to the water in the paper cup (avoid the ice cubes).
 6. In your science journal, write the date and experiment title. In your science journal, describe what happens when you put the food coloring in the paper cup.
 7. Explain how density is responsible for your results.
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Changing the Density of a Liquid

Question: *Can the density of a liquid be changed?*

Materials

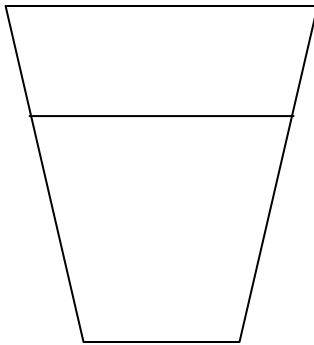
- Two cups
- Slice of carrot
- Salt
- Teaspoon

Procedure

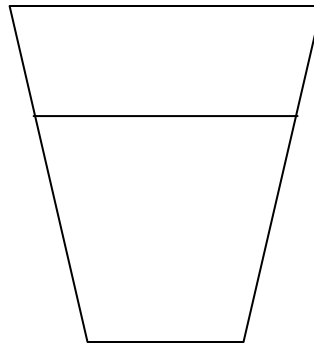
1. Half-fill a plastic cup with room-temperature water.
2. Place a slice of carrot in the cup. It should sink because it is denser than water.
3. Add about 1 teaspoon of salt and stir with a spoon until as much salt dissolves as possible.
4. Continue adding salt and stirring until the carrot floats to the top.
5. **Very carefully**, add fresh water to the top of the salt water until the carrot begins to sink.

6. If the carrot sinks to the bottom, add small amounts of salt and fresh water as needed to cause it to hover.
7. Empty the water and rinse out the cups, throw away the carrot, dry the cups and tray, put all supplies back on the table.
8. Draw a carrot slice in each of the cups below to reflect your observations.

Fresh Water



Salt Water



Is the carrot slice more dense or less dense than the water?

Is the carrot slice more dense or less dense than the water?

Comparing the Density of an Object to the Density of Water

Question: How can you predict whether an object will sink or float in water?

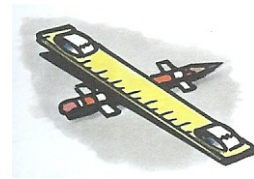
Materials

- Ruler
- Tape
- Marker
- Two candles in metal containers
- Clay

- Clear plastic cup filled with room temperature water

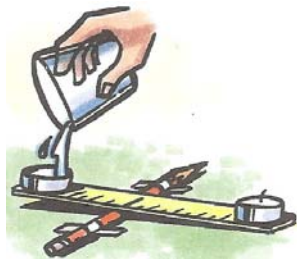
Procedure

1. Tape the pencil down. Roll two small pieces of tape so that the stick side is out. Stick each piece of tape to the opposite ends of the ruler.



2. Remove both candles from their metal containers. Place an empty metal container on each piece of tape. Be sure that the edge of the metal container lines up with the end of the ruler.

3. Lay the ruler on the pencil so that it is as balanced as possible. The spot on the ruler directly above the center of the pencil is your *balance point*. Mark the ruler with the marker at this point.



4. Carefully place one of the candles back into its metal container on one end of the ruler. Be sure to fill the container with water to the same height as the wax fills the other container.

5. Take the other candle and place it in the water. Take it out of the water.



6. Make sure your ruler balance is still balanced.



7. Fill one metal container with clay and replace it on the end of the ruler. Make sure the balance point is centered on the ruler.

8. Slowly and carefully add water to the empty container until it is filled.

9. Take the clay out of the metal container and drop it in the water.



10. Dry off the candle and clay. Make sure the candle metal container is clean and has no clay in it. Empty the cup and dry it out. Take the tape off the ruler and throw it away. Make sure the tray is clean and all supplies are placed back on the tray. Put the tray back on the counter.

Place a check in the boxes below to show what you observed when you compared equal volumes of the following substances.

	Water	Wax	Clay
Which is the lightest?			
Which floats in water?			
Which is the heaviest?			
Which sinks in water?			

Fill in the blank with *float* or *sink*:

If a substance weighs less than an equal volume of water, it will _____.

If a substance weighs more than an equal volume of water, it will _____.

Fill in the blank with *more dense* or *less dense*:

If a substance weighs less than an equal volume of water, it is _____ than water.

If a substance weighs more than an equal volume of water, it is _____ than water.

Draw a picture of a piece of clay in a cup of water.

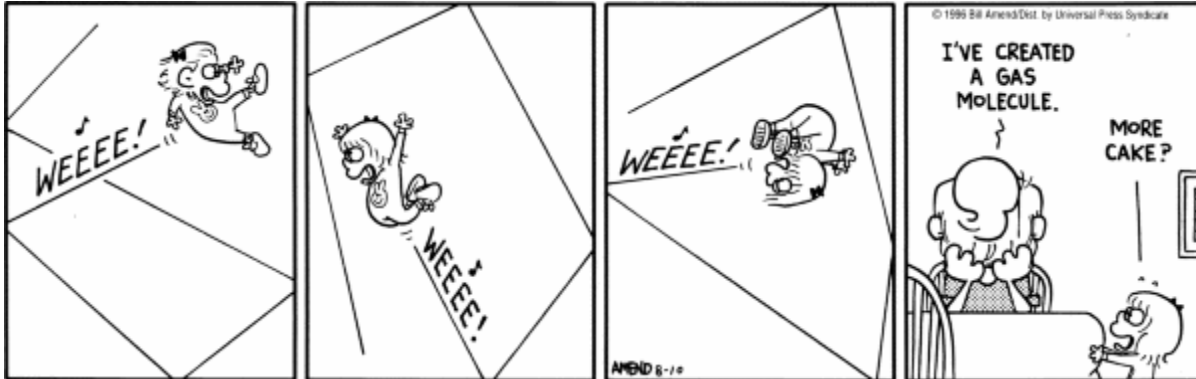
Draw a picture of a piece of wax in a cup of water.



Rank water, clay, and wax according to the densities.

Least Dense	Most Dense

An ice cube will float in a cup of water. What would you expect if you compared the weight of the ice cube to the weight of an *equal volume* of liquid water?



Comparing the Density of Different Liquids

Question: How do the densities of vegetable oil, water, and corn syrup help them to form layers in a cup?



Materials

- Vegetable oil
- Water
- Corn syrup
- Ruler
- Pencil
- Tape
- Four containers
- Clear plastic cup
- Paper clips
- Marker
- Piece of crayon
- Paper clip
- Pasta

- Craft stick

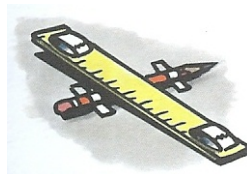
Safety Concerns: None

Procedure



1. Use your marker to label the three small cups **vegetable oil**, **corn syrup**, and **water**. Use your ruler to measure 1 cm up from the bottom of the cup and make a line with the marker.

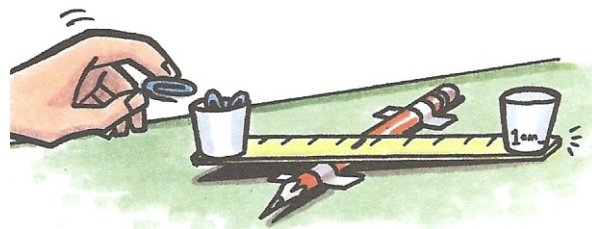
2. Tape the pencil down as shown. Roll two small pieces of tape so that the sticky side is out. Stick each piece of tape to the opposite ends of the ruler.



3. Place the empty vegetable oil cup on one piece of tape and the empty unlabeled cup on the other. Be sure that the edge of the cup comes right to the end of the ruler. Lay the ruler on the pencil so that it is as balanced as possible. Use a permanent marker to mark the spot on the ruler directly above the center of the pencil. This is the *balance point*.

4. Remove the vegetable oil cup very carefully and add vegetable oil until the oil reaches the mark on the cup. Replace the cup on the scale. Be sure the ruler is still on the marked balance point.

5. Add paper clips, one at a time, to the empty cup on the other end. Count the paper clips until the weight of the paper clips causes the oil cup to just lift from the table.



6. Repeat steps four and five for the water and corn syrup.

7. Take some water, corn syrup, and oil and pour it in the clear plastic cup.
8. Drop the crayon, paper clip, pasta, and Popsicle™ stick into the cup *after* it has layered.
9. Throw away your cup, small containers, and clean up any messes on your table and tray. Return your tray to the counter top.

In your science journal, draw the tables below. Write out and answer the questions asked. Draw any required pictures in your science journal as well.

1. Why is important to weigh *equal volumes* of each liquid?
2. What did you do to make sure that you compared equal volumes of water, vegetable oil, and corn syrup?
3. Since you used equal volumes of water, vegetable oil, and corn syrup, you can compare the weight of each to find out about the density of each liquid. List the liquids in order from the least dense to the most dense.

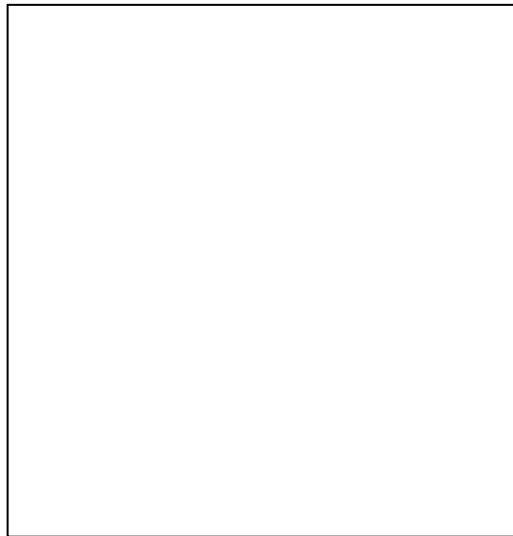
Least Dense	
Most Dense	

4. Record your paperclip data in the table below.

Liquid	Weight in Paper Clips
Corn syrup	
Vegetable oil	
Water	



5. Draw your observations of the liquids and objects in the cup and label them.



6. Use what you know about density to explain why the liquids and objects are positioned where they are in the cup.

7. Do your results from weighing the liquids agree with your observation of the layered liquids?

Assessing the Bulk of an Asymmetrical Thing Through Fluid Displacement

(Say What???????????)

Materials

- Graduated cylinder
- Three-beam balance
- Rock
- Eye-bolt and nut
- Lead Sinkers
- Spool
- Nut
- Washer

Procedure

1. Fill the graduated cylinder with water to the 30mL level.
2. Using the triple-beam scale, weigh each object and enter its mass in the appropriate column (on the back of this sheet).
3. **CAREFULLY!!!!** place each object, one at a time, into the graduated cylinder. Record the level of the water after the object has been placed in the cylinder. Subtract the ending level from the beginning level to find the volume.
4. Calculate the density for each object.
5. In your science journal, write the date, title of the experiment, and the table on the back of this paper. Complete the table in your journal.

"You can listen to thunder after lightning and tell how close you came to getting hit. If you don't hear it you got hit, so never mind."

- An Unknown Middle School Student

Data Table

A	B	C	D	E	F
<i>Object</i>	<i>Mass (g)</i>	<i>Ending Level (mL)</i>	<i>Beginning Level (mL)</i>	<i>Volume (mL) (C - D)</i>	<i>Density (g/mL) (B/E)</i>
<i>Rock</i>			<i>30mL</i>		
<i>Spool</i>			<i>30mL</i>		
<i>Eye bolt/ nut</i>			<i>30mL</i>		
<i>Nut</i>			<i>30mL</i>		
<i>Washer</i>			<i>30mL</i>		
<i>Lead Sinkers</i>			<i>30mL</i>		

You Are My Density!

You have been given the mass and volume of an element. Using that information, identify the element.

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

Element #	Mass (g)	Volume (cm ³)	Density (g/cm ³)	Element
1	108.9 g	5.64 cm ³		
2	763 g	4,238.9 cm ³		

3	17 g	3.17 cm ³		
4	27 g	4.58 cm ³		
5	10,417 g	485.64 cm ³		
6	169.84 g	14.98 cm ³		
7	217.98 g	58.28 cm ³		
8	1,417 g	778.57 cm ³		
9	298 g	33.26 cm ³		
10	108.9 g	33.93 cm ³		
11	42 g	27.1 cm ³		
12	18.4 g	2.34 cm ³		
13	318 g	14.2 cm ³		
14	23.9 g	1.26 cm ³		
15	19.329 g	1.84 cm ³		

<i>Element</i>	<i>Density</i>	<i>Element</i>	<i>Density</i>
Calcium	1.55 g/cm ³	Lead	11.34 g/cm ³
Chlorine	3.21 g/cm ³	Osmium	22.39 g/cm ³
Copper	8.96 g/cm ³	Phosphorus	1.82 g/cm ³
Germanium	5.36 g/cm ³	Platinum	21.45 g/cm ³
Gold	19.31 g/cm ³	Silver	10.5 g/cm ³
Helium	.18 g/cm ³	Uranium	18.97 g/cm ³
Iron	7.86 g/cm ³	Xenon	5.90 g/cm ³
Krypton	3.74 g/cm ³		

“The most exciting phrase to hear in science, the one that heralds new discoveries, is not Eureka! (I found it!) but rather ‘hmm ... that’s funny ...’”

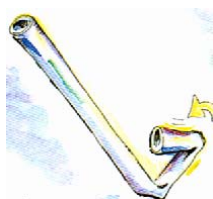
-Isaac Asimov

Layering Salt Solutions

Materials

- 4 clear plastic straws
- Paperclips
- 4 cups with salt solutions
- 4 pipettes
- Straw holder

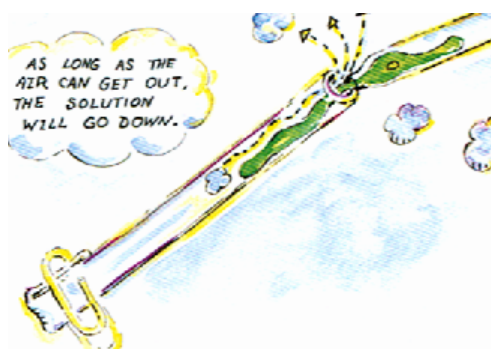
Procedures



1. Before adding the liquids, decide with your group, which color you will add 1st, 2nd, 3rd, and 4th. Write the first letter of each color on the lines near the picture of the straw on the back of this page.



2. Make a miniature test tube out of a drinking straw by folding the straw 2-3 cm from the end and the folding it once more and clamping the folded part with a paperclip.



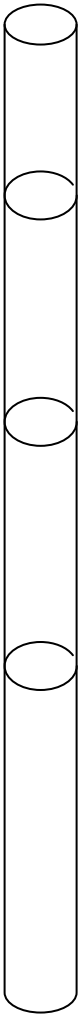
3. While holding the straw at an angle, use a pipette to add several drops of each salt solution to your "test tube." If the tube gets blocked with trapped air, pinch it a few times to release the air. Let the solution dribble down the side of the straw.

4. Add the next three liquids in the same way, following the order that you wrote. Set your straw in the holder. **DO NOT touch or jiggle the straw holder.**

5. Observe the liquids in the straw for a few minutes. The colors should separate. (If they don't, empty the liquids and repeat steps #3 and #4!)

6. If you don't have success after two attempts, try putting the liquids into the straw in a different order.

7. When done, complete the diagram on the back of the sheet, coloring in the appropriate layer on the straw.



Analysis

Based on your knowledge of density, explain why the colors layered in the order they did.
