Name: _____   Date: _____

Student Exploration: Density Laboratory

Vocabulary: buoyancy, density, graduated cylinder, mass, matter, scale, volume

Prior Knowledge Questions (Do these BEFORE using the Gizmo.)

1. Of the objects below, circle the ones you think would float in water.

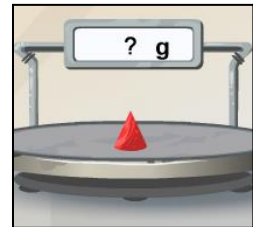Rock   Cruise ship   Quarter   Saturn   Beach ball

2. Why do some objects float, while others sink? _____

   _____

   _____

Gizmo Warm-up
The *Density Laboratory* Gizmo allows you to measure a variety of objects, then drop them in water (or other liquid) to see if they sink or float.

1. An object's **mass** is the amount of **matter** it contains. Mass can be measured with a calibrated **scale** like the one shown in the Gizmo. Drag the first object onto the **Scale**. (This is object **1**.)

   What is the mass of object **1**? _____

2. An object's **volume** is the amount of space it takes up. The volume of an irregular object can be measured by how much water it displaces in a **graduated cylinder**.
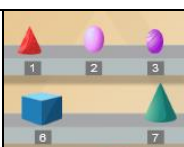
   A. What is the initial volume of water in the cylinder? _____

   B. Place object **1** into the cylinder. What is the volume in the cylinder now? _____

   C. What is the volume of the object? _____

   Note: While milliliters (mL) are used to measure liquid volumes, the equivalent unit cubic centimeters (cm^3) are used for solids. Therefore, write the volume of object **1** in cm^3.

Activity A: **Float or sink?**	<u>Get the Gizmo ready</u>: • Drag object **1** back to the shelf. • Check that **Liquid density** is set to 1.0 g/mL.	

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

1. <u>Observe</u>: Experiment with the different objects in the Gizmo. Observe the mass and volume each object, then drag it into the **Beaker of liquid** to see if it floats or sinks. (Notice a pin holds objects in the graduated cylinder, whether they sink or float.) Try to determine what the floating objects have in common and what the sinking objects have in common.

2. <u>Form hypothesis</u>: Compare the floating objects, then do the same for the sinking objects.

    A. What do the floating objects have in common? _____

    _____

    B. What do the sinking objects have in common? _____

    _____

3. <u>Collect data</u>: Measure the mass and volume of objects 1 through 12, and record whether they float or sink in the table below. Leave the last column blank for now.

Object	Mass (g)	Volume (cm³)	Float or sink?	
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

(Activity A continued on next page)

Activity A (continued from previous page)

4. <u>Analyze</u>: Look carefully for patterns in your data.

   A. Does mass alone determine whether an object will float or sink? _____

      Explain: _____

   B. Does volume alone determine whether an object will float or sink? _____

      Explain: _____

   C. Compare the mass and volume of each object. What is true of the mass and volume

      of all the floating objects? _____

   D. What is true of the mass and volume of all the sinking objects? _____

      _____

5. <u>Calculate</u>: The **density** of an object is its mass per unit of volume. Dense objects feel very
   heavy for their size, while objects with low density feel very light for their size.

   To calculate density, divide the mass by volume: $D = m/V$. If mass is measured in grams
   and volume in cubic centimeters, the unit of density is grams per cubic centimeter (g/cm^3).

   Calculate the density of each object, and record the answers in the last column of your data
   table. Label this column "Density (g/cm^3)."

6. <u>Analyze</u>: Compare the density of each object to the density of the liquid, 1.0 g/mL. This is
   the density of water.

   A. What do you notice about the density of the floating objects? _____

      _____

   B. What do you notice about the density of the sinking objects? _____
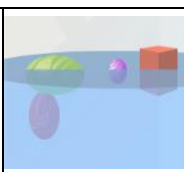
      _____

7. <u>Draw conclusions</u>: If you know the mass and volume of an object, how can you predict
   whether it will float or sink in water?

   _____

   _____

   _____

Activity B: **Liquid density**	Get the Gizmo ready: • Drag all the objects back onto the shelf. • Check that the **Liquid density** is still 1.0 g/mL.	

Question: How does liquid density affect whether objects float or sink?

1. <u>Observe</u>: Place object **1** into the **Beaker of liquid**. Slowly move the **Liquid density** slider

    back and forth. What do you notice? _____

    _____

2. <u>Form a hypothesis</u>: **Buoyancy** is the tendency to float. How do you think the liquid density

    affects the buoyancy of objects placed in the liquid? _____

    _____

3. <u>Predict</u>: In the table below, write the density of each object. Then predict whether the object
    will float or sink in each of the fluids. Write "Float" or "Sink" in each empty box of the table.

Object	Object density	Liquid density		
		0.5 g/mL	**1.0 g/mL**	**2.0 g/mL**
1				
2				
3				
4				
5				

4. <u>Test</u>: Test your predictions using the Gizmo. Place a checkmark (√) next to each correct
    prediction, and an "X" next to each incorrect prediction.

5. <u>Draw conclusions</u>: What is the relationship between the object density, the liquid density,

    and the tendency of the object to float? _____

    _____

    _____

Extension:	Get the Gizmo ready:	
King Hieron's crown	• Drag all the objects back onto the shelf. • Set the **Liquid density** to 1.0 g/mL.	

Introduction: In the third century B.C., King Hieron of Syracuse asked the famous mathematician Archimedes to determine if his crown was made of pure gold. This was a puzzling problem for Archimedes—he knew how to measure the weight of the crown, but how could he measure the volume?

Archimedes solved the problem when he got into his bath and noticed the water spilling over the sides of the tub. He realized that the volume of the displaced water must be equal to the volume of the object placed into the water. Archimedes was so excited by his discovery that he jumped out of the bath and ran through the streets shouting "Eureka!"

Question: How can you tell if a crown is made of solid gold?

1. Think about it: Gold is one of the densest substances known, with a density of 19.3 g/cm^3. If the gold in the crown was mixed with a less-valuable metal like bronze or copper, how would that affect its density?

   _____

   _____

2. Observe: Drag each of the crowns into the liquid. Based on what you see, which crown do you think is densest? Explain why you think so.

   _____

   _____

3. Measure: Find the mass, volume, and density of each of the three crowns.

Crown	Mass (g)	Volume (cm^3)	Density (g/cm^3)
A			
B			
C			

4. Draw conclusions: Which of the three crowns was made of gold? _____

   Explain: _____

   _____