

Miami-Dade County Public Schools  
**Science**



# Success Academy

Grade 8  
**Transparency Packet**  
**Session 1**

**Strand A: Nature of Matter**

**Benchmark**

**SC.A.1.3.1** The student identifies various ways in which substances differ (e.g. mass, volume, shape, density, texture, and reaction to temperature and light).

2009-2010

Curriculum and Instruction



## Learning Objectives



### Strand A: Nature of Matter

**SC.A.1.3.1** The student identifies various ways in which substances differ (e.g. mass, volume, shape, density, texture, and reaction to temperature and light).

Therefore, students will:

- Identify physical properties of matter.
- Explain why materials with different masses have different densities.

## Vocabulary



buoyancy

density

graduated cylinder

mass

matter

scale

volume

## Lesson Overview/Scientific Background



Properties can be classified as intrinsic or extrinsic, depending on whether the value changes with the size of the sample. Mass, length, and volume are extrinsic properties because their values depend on the sample size. Density is an intrinsic physical property that relates the mass of an object to its volume. Density is also temperature dependent because most substances change in volume when heated or cooled. Density is an extremely important concept, but one that students often find confusing. The *Density Laboratory Gizmo™* shows how mass, volume, and the tendency to float are related.

### 3. Discussion Questions and Answers

(🕒 15 minutes)

As students are working or just after they are done, discuss the following questions:

- A. If you know the mass and volume of an object, how can you immediately predict whether it sinks or floats without calculating density? **[Compare the mass to the volume: If an object's mass is less than its volume, it will float. If the mass is greater than the volume, it will sink.]**
- B. What are some ways you can compare the density of floating objects without measuring their mass and volume? **[Denser objects will float lower in the liquid.]**
- C. What are some ways you can compare the density of sinking objects without measuring their mass and volume? **[Denser objects will sink faster.]**
- D. In the Gizmo, how could you estimate the density of an object without using the scale or graduated cylinder? **[You can use the Liquid Density slider.]**

#### Assessment Review Protocol

- A. Students should respond to the items individually.
- B. Review answer selections by asking students to raise their hands or a pre-prepared index card with the letter representing their responses.
- C. Place the number of responses next to the letter selection.
- D. Review each answer choice and eliminate the ones that are incorrect with a discussion as to why that selection is incorrect. Draw a line through the incorrect choices and write the reason why beside it. Note: Show calculations for gridded response.
- E. Ask students to correct their papers and indicate reasons why the selection is the best answer.

**INTERACTIVE LABORATORY DEMONSTRATION:  
DENSITY LABORATORY: GIZMOS ACTIVITY (TEACHER VERSION)**

## Density Laboratory

## Answer Key

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

*[Note: The purpose of these questions is to activate prior knowledge and get students thinking. Students are not expected to know the answers to the Prior Knowledge Questions.]*

1. Of the objects below, circle the ones you think would float in water. *Predictions will vary. Correct answers are shown:*



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

*Answers will vary. [An object floats when the weight of the liquid it displaces is equal to the weight of the object. Objects sink when they are heavier than the equivalent volume of liquid. In other words, objects sink when they are denser than the liquid.]*

### 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. The mass of an object 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.)

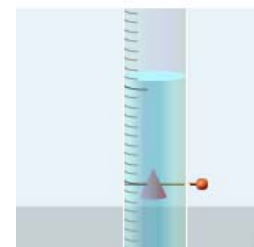
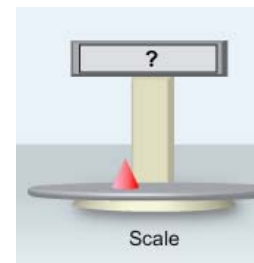
What is the mass of object 1? **19.5 grams (19.5 g)**


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**. Place object 1 into the **Graduated Cylinder**.

What is the volume of object 1? **14.0 cm<sup>3</sup> (equivalent to 14.0 mL)**

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

3. Drag object 1 into the **Beaker of Liquid**. Does it sink or float? **It sinks.**



<b>Activity A:</b>  <b>Float or sink?</b>	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> <li>• Drag object <b>1</b> back to the shelf.</li> <li>• Check that <b>Liquid Density</b> is set to 1.0 g/mL.</li> </ul>	
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**Question: How can you predict whether an object will float or sink?**

1. Observe: Experiment with the different objects in the Gizmo. Try to determine what the floating objects have in common and what the sinking objects have in common.
2. Form hypothesis: Compare the floating objects, then do the same for the sinking objects.
  - A. What do the floating objects have in common? *Answers will vary.*
  - B. What do the sinking objects have in common? *Answers will vary.*
3. Collect data: 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 (cm <sup>3</sup> )	Float or sink?	Density (g/cm <sup>3</sup> )
1	19.5 g	14.0 cm <sup>3</sup>	Sink	1.39 g/cm <sup>3</sup>
2	11.0 g	9.0 cm <sup>3</sup>	Sink	1.22 g/cm <sup>3</sup>
3	4.0 g	5.0 cm <sup>3</sup>	Float	0.80 g/cm <sup>3</sup>
4	135.0 g	7.0 cm <sup>3</sup>	Sink	19.29 g/cm <sup>3</sup>
5	4.0 g	3.5 cm <sup>3</sup>	Sink	1.14 g/cm <sup>3</sup>
6	78.0 g	29.0 cm <sup>3</sup>	Sink	2.69 g/cm <sup>3</sup>
7	2.0 g	21.0 cm <sup>3</sup>	Float	0.10 g/cm <sup>3</sup>
8	24.0 g	26.0 cm <sup>3</sup>	Float	0.92 g/cm <sup>3</sup>
9	99.0 g	44.0 cm <sup>3</sup>	Sink	2.25 g/cm <sup>3</sup>
10	42.0 g	61.0 cm <sup>3</sup>	Float	0.69 g/cm <sup>3</sup>
11	65.0 g	40.0 cm <sup>3</sup>	Sink	1.63 g/cm <sup>3</sup>
12	104.0 g	114.0 cm <sup>3</sup>	Float	0.91 g/cm <sup>3</sup>

(Activity A continued on next page)

## Activity A (continued from previous page)

4. Analyze: Look carefully for patterns in your data.
- A. Does mass alone determine whether an object will float or sink? **No**  
Explain: **Object 12 is relatively heavy but floats, and object 5 is fairly light but sinks.**
  - B. Does volume alone determine whether an object will float or sink? **No**  
Explain: **Object 3 has a small volume but floats, and object 9 has a relatively large volume but sinks.**
  - C. Compare the mass and volume of each object. What is true of the mass and volume of all the floating objects? **The mass is less than the volume.**
  - D. What is true of the mass and volume of all the sinking objects? **The mass is greater than the volume.**
5. Calculate: 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.

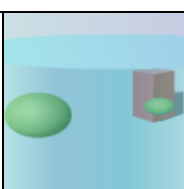
To calculate an object's density, divide its mass by its volume. If mass is measured in grams and volume in cubic centimeters, the unit of density is grams per cubic centimeter ( $\text{g/cm}^3$ ).

$$D \text{ (density)} = \frac{M \text{ (mass)}}{V \text{ (volume)}}$$

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

6. Analyze: Compare the density of each object to the density of the liquid, 1.0  $\text{g/mL}$ . This is the density of water.
- A. What do you notice about the density of the floating objects?  
**The density of the floating objects is less than 1  $\text{g/cm}^3$ .**
  - B. What do you notice about the density of the sinking objects?  
**The density of the sinking objects is greater than 1  $\text{g/cm}^3$ .**
7. Draw conclusions: If you know the mass and volume of an object, how can you predict whether it will float or sink in water?

**To predict if the object will float or sink in water, compare the mass to the volume. If the mass is larger, the object will sink. If the volume is larger, the object will float. You could also find the density of the object by dividing mass by volume. If the density is greater than 1  $\text{g/cm}^3$ , the object will sink. If the density is less than 1  $\text{g/cm}^3$ , the object will float.**

<b>Activity B:</b>  <b>Liquid density</b>	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> <li>• Drag all the objects back onto the shelf.</li> <li>• Check that the <b>Liquid Density</b> is still 1.0 g/mL.</li> </ul>	
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**Question: How does liquid density affect whether objects float or sink?**

1. Observe: Place object 1 into the **Beaker of Liquid**. Slowly move the **Liquid Density** slider back and forth. What do you notice?

*When the liquid density increases, object 1 starts to float. When the liquid density decreases, object 1 sinks again.*

2. Form a hypothesis: **Buoyancy** is the tendency to float. How do you think the liquid density affects the buoyancy of objects placed in the liquid? *Hypotheses will vary.*


3. Predict: 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.

*Predictions will vary. Correct results are shown below.*

Object	Object density	Liquid density		
		0.5 g/mL	1.0 g/mL	2.0 g/mL
1	<i>1.39 g/cm<sup>3</sup></i>	<i>Sink</i>	<i>Sink</i>	<i>Float</i>
2	<i>1.22 g/cm<sup>3</sup></i>	<i>Sink</i>	<i>Sink</i>	<i>Float</i>
3	<i>0.80 g/cm<sup>3</sup></i>	<i>Sink</i>	<i>Float</i>	<i>Float</i>
4	<i>19.29 g/cm<sup>3</sup></i>	<i>Sink</i>	<i>Sink</i>	<i>Sink</i>
5	<i>1.14 g/cm<sup>3</sup></i>	<i>Sink</i>	<i>Sink</i>	<i>Float</i>

4. Test: Test your predictions using the Gizmo. Place a checkmark (✓) next to each correct prediction, and an “X” next to each incorrect prediction.
5. Draw conclusions: What is the relationship between the object density, the liquid density, and the tendency of the object to float?

*If an object is less dense than the surrounding liquid, it will float. If an object is denser than the liquid, it will sink.*

<b>Activity C:</b>  <b>King Hieron's crown</b>	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> <li>• Drag all the objects back onto the shelf.</li> <li>• Set the <b>Liquid Density</b> to 1.0 g/mL.</li> </ul>	
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**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<sup>3</sup>. If the gold in the crown was mixed with a less-valuable metal like bronze or copper, how would that affect its density?

*If the gold is mixed with other metals, the density of the crown will decrease.*

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.

*Crown B sinks most quickly in the liquid, so crown B is probably the densest crown.*

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

Crown	Mass (g)	Volume (cm <sup>3</sup> )	Density (g/cm <sup>3</sup> )
A	325.0 g	65.0 cm <sup>3</sup>	5.00 g/cm <sup>3</sup>
B	1250.0 g	65.0 cm <sup>3</sup>	19.23 g/cm <sup>3</sup>
C	306.0 g	65.0 cm <sup>3</sup>	4.71 g/cm <sup>3</sup>

4. Draw conclusions: Which of the three crowns was made of gold? **Crown B**

Explain: *Only crown B had a density close to the density of pure gold, 19.3 g/cm<sup>3</sup>.*

## Equations

$$\text{Acceleration } (\bar{a}) = \frac{\text{change in velocity (m/s)}}{\text{time taken for this change (s)}} \quad \bar{a} = \frac{v_f - v_i}{t_f - t_i}$$

$$\text{Average speed } (\bar{v}) = \frac{\text{distance}}{\text{time}} \quad \bar{v} = \frac{d}{t}$$

$$\text{Density (D)} = \frac{\text{mass (g)}}{\text{Volume (cm}^3\text{)}} \quad D = \frac{m}{V}$$

$$\text{Percent Efficiency (e)} = \frac{\text{Work out (J)}}{\text{Work in (J)}} \times 100 \quad \%e = \frac{W_{\text{out}}}{W_{\text{in}}} \times 100$$

$$\text{Force in newtons (F)} = \text{mass (kg)} \times \text{acceleration (m/s}^2\text{)} \quad F = ma$$

$$\text{Frequency in hertz (f)} = \frac{\text{number of events (waves)}}{\text{time (s)}} \quad f = \frac{n \text{ of events}}{t}$$

$$\text{Momentum } (\rho) = \text{mass (kg)} \times \text{velocity (m/s)} \quad \rho = mv$$

$$\text{Wavelength } (\lambda) = \frac{\text{velocity (m/s)}}{\text{frequency (Hz)}} \quad \lambda = \frac{v}{f}$$

$$\text{Work (W)} = \text{Force (N)} \times \text{distance (m)} \quad W = Fd$$

## Units of Measure

cm = centimeter  
g = gram

Hz = hertz  
J = joule (newton-meter)

kg = kilogram  
m = meter

N = newton  
s = second

## ASSESSMENT

NAME: \_\_\_\_\_

DATE: \_\_\_\_\_

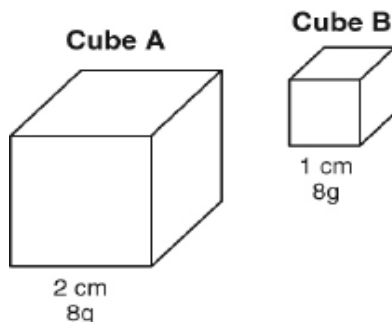
### STRAND A: Nature of Matter

**SC.A.1.3.1** The student identifies various ways in which substances differ (e.g. mass, volume, shape, density, texture, and reaction to temperature and light).

#### Multiple Choice

*Identify the choice that best completes the statement or answers the question.*

1 The diagrams give you some information about Cube A and Cube B.



Which of these statements is true?

- A The substance in Cube A is the same as the substance in Cube B.
- B The substance in Cube B is twice as dense as the substance in Cube A.
- C The substance in Cube B is eight times as dense as the substance in Cube A.
- D The substance in Cube A is eight times more massive than the substance in Cube B.

2 The properties of four substances were observed and recorded in a table.

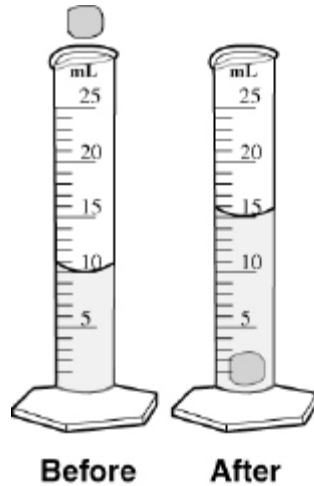
Data Table

Substance	Mass (g)	Volume (cm <sup>3</sup> )	Shape	Texture	Reaction to Light
1	15.6	5.78	Rectangular	Smooth	Reflects
2	19.4	16.17	Cube	Smooth	Absorbs
3	26.2	9.70	Cylinder	Smooth	Reflects
4	18.6	5.31	Rectangular	Smooth	Absorbs

Which of the substances are MOST likely made of the same material?

- F 1 and 3
- G 1 and 4
- H 2 and 3
- J 2 and 4

- 3 An unknown substance having a mass of 56.5 grams is placed in the graduated cylinder.



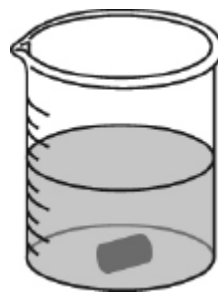
Density Table

Substance	Density (g/cm <sup>3</sup> )
Aluminum	2.7
Gold	19.3
Iron	7.87
Lead	11.3

What is the identity of the unknown substance?

- A Aluminum
- B Gold
- C Iron
- D Lead

- 4 A beaker contains a liquid and a small object.



What **MUST** be true regarding the liquid and the object seen in the beaker?

- F The liquid is denser than the object.
- G The object is denser than the liquid.
- H The object has more mass than the liquid.
- J The liquid has more mass than the object.

- 5 When geologists are trying to identify certain rocks, they often place a few drops of diluted hydrochloric acid on the rocks. Sometimes bubbles form on the rocks when acid is dropped on them.



What are the geologists MOST likely trying to determine?

- A the age of the rocks
- B the density of the rocks
- C the amount of minerals in the rocks
- D the chemical properties of the rocks

- 6 During a lecture, a professor was talking about the potential that hydrogen has for exploding under certain conditions. Which was MOST likely the topic of the professor's lecture?

- F Conductivity of Gases
- G Phase Changes in Matter
- H Chemical Properties of Gases
- J Physical Properties of Elements

- 7 A teacher asks her students to write a paper on chemical changes. At the end of class, she asks a student to select a topic that would MOST likely contain an investigation on chemical changes. Which of these topics should the student MOST likely choose?

- A How Baking Soda Reacts with Vinegar
- B How Rust Can Be Scraped Off of Metal
- C How Metals Respond as Electricity Flows Through Them
- D How Elements Can Change Phase When Heat Is Applied to Them

8 A teacher breaks a bar of pure copper into two different-sized pieces. Which is the MOST likely difference between the two pieces?

- F Mass
- G Texture
- H boiling point
- J melting point

9 A chart is shown that contains information on mass and weight.

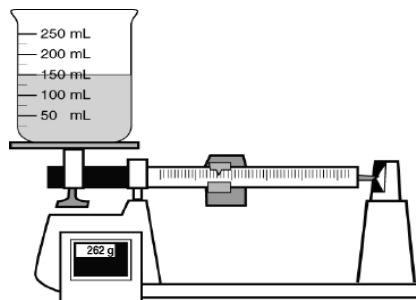
### Differences in Mass and Weight

1. Is always constant at any location
2. Is measured using scales
3. Depends on amount of gravity
4. Is measured in Newtons
5. Is measured using a balance
6. Is measured in kilograms in SI Units

Which of the numbered items corresponds ONLY to mass?

- A 2, 3, 4
- B 1, 2, 4
- C 1, 4, 5
- D 1, 5, 6

10 A 250-mL beaker contains 150 mL of a liquid. When the beaker is placed on a balance, the mass measures 262 g.



If the mass of the empty beaker is 112 g, how much is the mass (g) of the liquid inside the beaker?

## EXTENSION

### Density Column Activity:

A great follow-up activity is creating a density column. You can make a four-layer column using corn syrup, water, vegetable oil and alcohol. Dye the water green and the corn syrup red for effect.

**Problem:**

Do different liquids have different densities?

Do different solids have different densities?

**Hypothesis:**

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**Procedure: Part A**

1. Separately mass each of the 4 empty labeled cups. Record their mass in the chart as W1.
2. Pour 5 ml of each liquid into the corresponding empty cup.
3. Take the mass of each cup again. Record the mass in the chart as W2.
4. Find the mass of each liquid by subtracting W1 from W2. Record this value in the chart as mass (g).
5. Calculate the density of each liquid. **Density = mass (g)/ volume (ml)** and record in the chart. Remember to use the appropriate units: **g/ml**.

**Procedure: Part B**

1. Pour each liquid into a graduated cylinder in the following order: corn syrup, colored water, oil, and alcohol.
2. Record observations
3. Drop the following solids into the graduated cylinder: cork, rubber, metal, and wood.
4. Draw and record observations.

**DATA:**

Liquid	Volume of Liquid (ml)	W1(mass of empty cup)	W2 (mass of cup + liquid)	(W2 – W1) Mass (g)	Density (g/ml)
Corn Syrup	5				
Water	5				
Oil	5				
Alcohol	5				

### Conclusion Questions:

1. What does the stratification of the liquids demonstrate?
2. List the four liquids you used in this experiment in order of increasing density.
3. What does the sinking and floating of the solids in the different liquids demonstrate?
4. Which has the greater mass, 1 liter of water or 1 liter of alcohol? Why?
5. Which is denser, 1 ml of water or 50 liters of water? Why?

### EXTENSION ANSWER KEY

#### Density Column Activity:

Density of Corn Syrup: **1.36 g/ml**

Density of Water: **1.0 g/ml**

Density of Vegetable Oil: **0.93 g/ml**

Density of Isopropyl Alcohol: **0.8 g/ml**

#### Conclusion Questions:

1. **The stratification (layering) of the liquids demonstrates that each liquid has a different density which explains why the liquids are in a stratified layer.**
2. **Liquids in order of increasing density: alcohol, vegetable oil, water and corn syrup.**
3. **The sinking and floating of the solids demonstrates the varying densities of the solids. Solids in order of increasing densities: cork, wood, rubber and metal.**
4. **One (1) liter of water has a greater mass because water is denser than alcohol.**
5. **Both have equal densities because both are the same substance.**