Density Lesson

Content Standards Addressed in Lesson:

TEKS4.5 A measure, compare, and contrast physical properties of matter, including size, mass, volume, states (solid, liquid, gas), temperature, magnetism, and the ability to sink or float;
TEKS6.6B calculate density to identify an unknown substance (Reporting Category: 1 Supporting Standard)

NSES (1996) **Grades 5-8 – Content Standard B**

- **Properties and changes of properties in matter:** a substance has characteristic properties, such as density, a boiling point, and solubility, all of which are independent of the amount of the sample.

Scientific Investigation and Reasoning Skills addressed in lesson:

TEKS6.2E analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends.
TEKS6. 3 A in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing
TEKS6.3B use models to represent aspects of the natural world such as a model of Earth's layers;
TEKS6.3C identify advantages and limitations of models such as size, scale, properties, and materials.
TEKS6.4A use appropriate tools to collect, record, and analyze information, including journals/notebooks, beakers, Petri dishes, meter sticks, **graduated cylinders**, hot plates, test tubes, **triple beam balances**, microscopes, thermometers, calculators, computers, timing devices, and other equipment as needed to teach the curriculum;

NSES (1996) **Grades 5-8 – Content Standard A**

- Use mathematics in all aspects of scientific inquiry.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.

I. Student Prerequisite Skills/Understandings

1. Ability to differentiate between mass and weight.
2. Familiarity with the physical properties of mass and volume.

3. Basic sixth grade math skills: rounding and using calculators to perform the four operations.

II. Objectives: Students will be able to

1. Calculate volume by using displacement.
2. Use density to identify unknown substances using the *Density* PhET simulation.
3. Explain why objects sink or float relative to the density of the liquid they are placed in.
4. Calculate density after determining the mass and volume of a substance.

III. Supplies Needed

- Engagement:
  - Post-its (~10 that say "Matter")
  - Scale or Triple Beam Balance
  - Floating toy (such as a wooden ball)
  - Graduated cylinder
- Explore Putty Investigation:
  - Graduated cylinder – 1 per group of 4 students
  - Putty – 30-40 g per group of 4 students
  - Scale or triple beam balance – 1 per group of 4 students
  - Ruler – 1 per group of 4 students
- Explore *Density* PhET Simulation:
  - Calculator – 1 per pair of students
  - Computer – 1 per pair of students
  - Set of post-its with letters A-E – 1 set per pair of students

5E Organization

Engage – Introduction to Matter (5 minutes)

Content Focus: How do you know when something is matter?

Student groups are given cards with words on them (air, light, baseball, milk, lightning, clouds, etc.) and guided to consider which are examples of matter and which are not examples of matter. Students provide justification for their responses and develop a set of criteria that describes all matter.

Questions to guide students' learning and thinking	Questions to gather information about students' understanding and learning
• What do you already know about matter that would help you identify which items are or are not matter? • What do the items that are matter have in common? • What do the items that are not matter have in common?	• What are the characteristics of all matter?

✓ **Checkpoint:** Students can identify the characteristics of matter.

Explore – Introduction to Physical Properties of volume and mass (10 minutes)

Content Focus: Matter has physical properties, such as, mass, volume and density.
Investigation Skills: Identify what tools or processes are used to measure mass and volume.

Using a floating toy, students are guided to identify the physical properties of mass and volume and identify the units used to measure these properties. Students engage in a whole group discussion.

Questions to guide students' learning and thinking	Questions to gather information about students' understanding and learning
• How is the toy an example of matter? • What are some physical properties of this matter (toy)? • What are some observable physical properties of the toy?	• How do we measure different physical properties? • How do we find the volume of any object? • When do you use the displacement method to find volume? Why?

Teacher introduces density as a relationship between two previously identified properties – mass and volume and the Question of the Day: How can we use density to identify matter?

✓ **Checkpoint:** Students can determine the physical properties of mass and volume.

Explore – *Density* PhET Simulation (20 minutes)

Content Focus: Density can be used to identify objects.
Investigation Skills: Use simulation to find mass, volume and using these properties to calculate density. Use models to represent aspects of the natural world. Analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends (using data collected about mystery boxes). Use computers to conduct an investigation.

Students begin computer simulation (see: http://phet.colorado.edu/en/simulation/density) in pairs and are introduced to Mystery Box problem. Teacher introduces job roles of Driver and Navigator and allows students five minutes to explore the simulation. A few students are selected to share what they have discovered the simulation can do using the teacher's computer (projected to class).

Questions to guide students' learning and thinking	Questions to gather information about students' understanding and learning
• How does this simulation model the physical properties of mass and volume?	• How does this simulation model the relationship between these properties?

Students begin investigation using attached student handout *Density Simulation Worksheet.* In the Mystery Box problem, the students calculate the density of the mystery boxes then use the "Show Table" function to determine what is inside the boxes.

Questions to guide students' learning and thinking	Questions to gather information about students' understanding and learning
• What is the mass/volume of each container? • How can you use these physical properties to find the density?	• When two boxes have the same volume, what can you infer about their densities? • When two boxes have the same mass, what can you infer about their densities? • How is density related to an object's ability to float? • How is the work you are doing like the work of a scientist? • How can you use density to identify objects?

✓ **Checkpoint:** Students have completed the investigation and are able to communicate the content of the boxes based on density and relate buoyancy to the density of water.

Explain – *Density* PhET Simulation (10 minutes)

Content Focus: Density can be used to identify different objects. The density of an object relates to whether an object sinks or floats.
Reasoning Skills: Develop descriptions, explanations, predictions, and models using evidence from simulation. Communicate conclusions supported by the data gathered in the simulation.

Students stick post-its (A-E) on the board under the "Mystery Box Contents!" chart. Teacher leads a whole group discussion of the students' findings using the computer simulation.

Questions to guide students' learning and thinking	Questions to gather information about students' understanding and learning
• What is in each box? • How would you order the boxes based on their density (greatest to least)? • Which objects floated? Sank? • What similarities and differences do you notice about the objects that sank and floated?	• What do our results tell us? • Why is density an important physical property to know? Why do we need to learn about it? • How could you use the property of density in your everyday life?

✓ **Checkpoint:** Students are able to communicate their results to the class and engage in a group discussion.

Explore – Putty Investigation (20 minutes)

Content Focus: Determine, through a hands-on investigation, how mass and volume can affect an object's density.
Investigation Skills: Use appropriate tools (triple beam balance, graduated cylinders, calculators, etc.) to collect, record, and analyze information.

Students are introduced to the Question of the Day: How does the density of an object change as its mass changes? In groups of four, students complete the putty investigation with the lab sheet *Putty, Putty Please Find the Density of Putty*. In the putty investigation, students change the mass of putty samples then use the displacement method to find the volume of their putty. Using this information, the students calculate the density of their samples.

Questions to guide students' learning and thinking	Questions to gather information about students' understanding and learning
• How can we use the tools given to use to calculate the density to identify objects? • How can we use a ruler/graduated cylinder to calculate volume? What units are used? • How can we use a ruler/graduated cylinder to calculate volume? What units are used? • What did you calculate as the volume? Mass? • How did you determine the volume? Density?	• If the material is floating above the water, how does this affect the volume measurement? • What did you notice about the density? • How can you explain the variations we have in your averages? • Why are averages used in experiments?

✓ **Checkpoint**: Students have completed the experiment and have formulated a conclusion.

Explain – Putty Investigation (10 minutes)

Content Focus: The density of an object does not change as its mass changes. Density is a unique property to an object.
Investigation Skills: Communicate conclusions supported by the data gathered in the hands-on investigation.

The teacher collects the average density of putty from each group and posts these on the board. Teacher leads a discussion of students' results.

Questions to guide students' learning and thinking	Questions to gather information about students' understanding and learning
• Questions about the scientific process: When were you making observations? When were you experimenting? How was the simulation like an experiment?	• Why did we use the class average? • How does the density of an object change as its mass changes? Why do you think this is the case?

✓ **Checkpoint:** Students are able to say that the density of an object does not change when its mass changes.

Elaborate (10 minutes)

Content Focus: Determining the density of an object has practical applications.
Investigation Skills: Identify limitation of a model such as size, scale, properties, and materials. Understand that investigations are used to learn about the natural world and investigations are conducted for different reasons.

Teacher leads a group discussion of how the physical property density relates to everyday life.

Questions to guide students' learning and thinking	Questions to gather information about students' understanding and learning
• When might finding density be useful? • What have we used it for in our investigations? • What types of objects would you be particularly interested in finding the density of? Why?	• How could the method used in the simulation have problems in real life? • How could the simulation be modified? • What types of careers do you think would use density?

✓ **Checkpoint**: Students connect understanding of density to real world applications.

Evaluate

Use the "Show off what you know!" Quiz or Journal Prompt in the attached documents.

Name: _____

Density Simulation Worksheet

Formulas: **Density =** $\frac{\text{mass}}{\text{volume}}$ OR **Density** = mass ÷ volume

1. What physical properties do you need to know to find the density of an object? How will you use the simulation to find these properties?

2. Fill in the following information about the Mystery boxes. Remember to include units!

Container	Mass (kg)	Volume (L)	Density (kg/L)	Float or sink in water?	Contents (see table)
A					
B					
C					
D					
E					

3. Order the mystery packages from lowest density to highest density:

(Lowest) _____ _____ _____ _____ _____ (Highest)

4. In question 3 above put a SQUARE around the letters for the mystery packages that were able to float in water (or that you had to push down in order to calculate the volume – use your data!).

5. In question 3 above put a CIRCLE around the letters for the mystery packages that had a density less than 1 kg/L.

6. What do you notice about what you have squared and circled in question 3? Are they the same? Different?

_____

Name: _____ Date: _____

Show Off What You Know!

1. You discover a mystery package at your front doorstep and want to figure out what's inside of it without opening it (after all, it could be dangerous!). Luckily, you remember to use the physical property of density to help you identify the contents of the box.

You find the mass of the box to be 120 kg and the volume to be 30 L. What is the object's density? Show your calculations below.

2. Make a prediction – Will this mystery package sink or float in water that has a density of 1 kg/L? Based on what you know about density, explain your choice.

Name: _____

Putty, Putty Please Find the Density of Putty

Data Table

Trial	Mass (g)	Volume (cm^3)	Calculations	Density (g/cm^3)
1	**10 g**			
2	**20 g**			
3	**_____ g**			
Your Average Density:				

Class Average Density: _____ g/cm^3

1. What do you notice about the density of each trial?

2. How did the density change when the mass or volume changed in each trial?

Name:___Key_____

KEY - Putty, Putty Please Find the Density of Putty

Trial	Mass (g)	Volume (cm^3)	Calculations	Density (g/cm^3)
1	10 g	7	10/7	1.43
2	20 g	16	20/16	1.25
3	Student answers will vary.			
Your Average Density: 1.15 g/cm3				

Class Average Density: __1.15__ g/cm^3

1. What do you notice about the density of each trial?

The density of the putty was the same.

2. How did the density change when the mass or volume changed in each trial?

The density of the putty was the same no matter what volume or mass we used.

Name: _____KEY_____

Density Simulation Worksheet

***Density = mass**
volume

1. What physical properties do you need to know to find the density of an object? How will you use the simulation to find these properties?

Mass and volume. You can use the scale to find the mass and the displacement method with the pool of water to find the volume.

2. Fill in the following information about the Mystery boxes. Remember to include units!

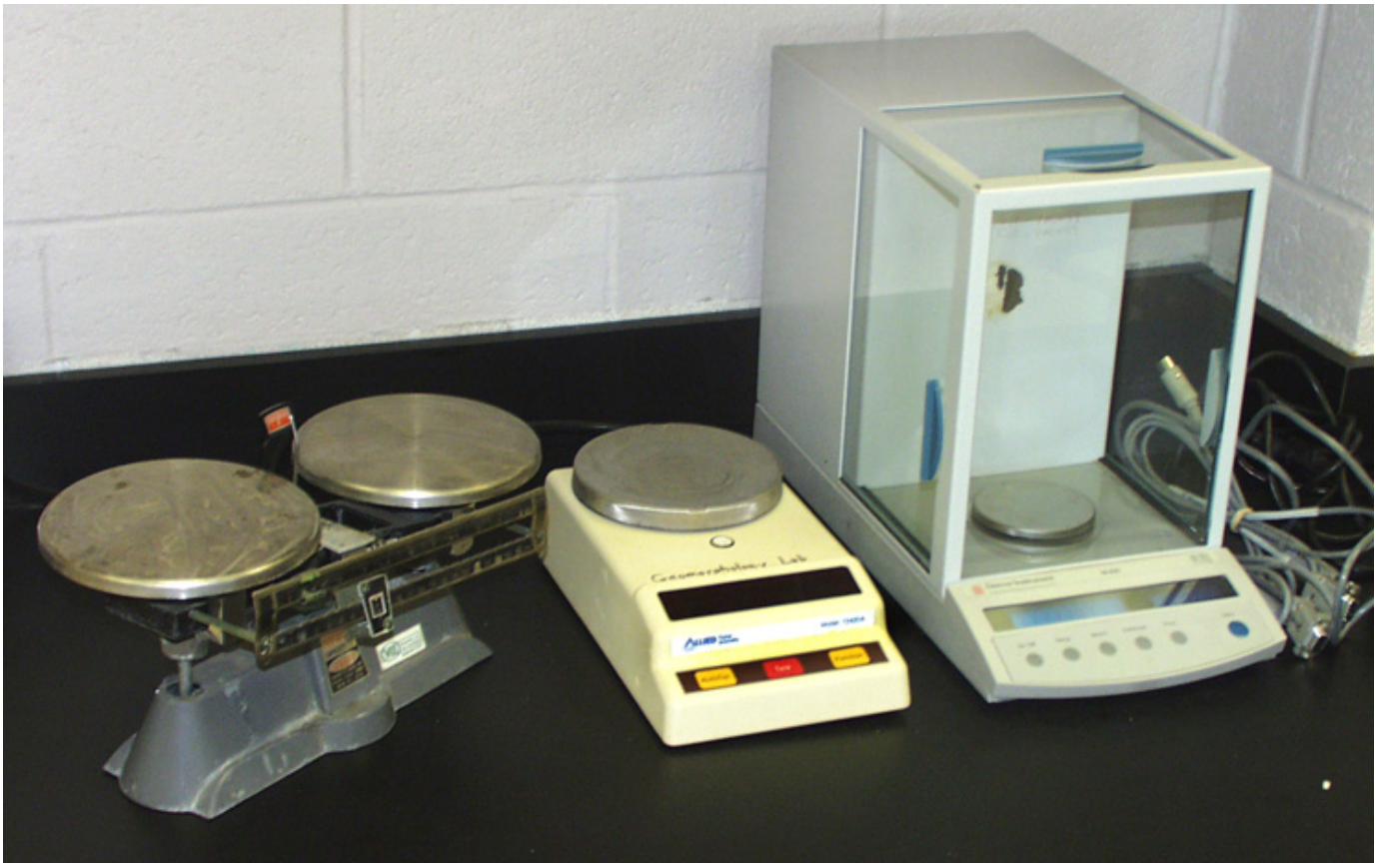
Container	Mass (kg)	Volume (L)	Density (kg/L)	Contents (see table)	Float or sink?
A	65.14 kg	3.38 L	19.3 kg/L	Gold	Sink
B	0.64 kg	1.0 L	0.64 kg/L	Apple	Float
C	4.08 kg	5.83 L	0.70 kg/L	Gasoline	Float
D	3.10 kg	3.38 L	0.92 kg/L	Ice	Float
E	3.53 kg	1.0 L	3.53 kg/L	Diamond	Sink

3. Order the unknowns from least to most dense:

(Least) ____B____ ____C____ ____D____ ____E____ ____A____ (Most)

4-6. **B, C, and D should be squared and E and A should be circled.**

Balances used to measure **MASS**



How can we use density to help us identify matter?

How does the density of an object change as its mass changes?

Density: the amount of matter (given in mass) per volume; density = mass ÷volume

Mass: the amount of matter in a sample; the property of a body that causes it to have weight when it experiences gravity

Matter: what an object is made of; elements, compounds, or mixtures

Volume: the amount of 3-dimensional space occupied by an object

Weight: the force exerted by a mass experiencing gravity

Journal Prompt:

Your friend gives you a rock that looks like gold and insists that it is. What could you use in your science classroom to determine if it's real or fool's gold?