How Dense Can They Be?

Overview:

Students learn about density by conducting a laboratory experiment using common liquids to produce a model of the upper atmosphere where auroral activity occurs.

Objectives:

The students will:

- hypothesize the relative densities of three substances based on information they obtain about the mass and volume of each substance;
- use three common liquids to build a simulation of atmospheric gases; and
- use their observations to gain an understanding of density as it relates to the gases in our atmosphere and the aurora.

Materials:

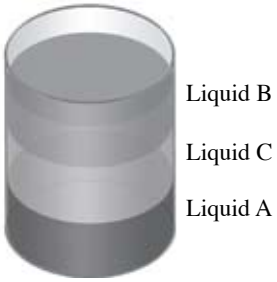
- Pancake syrup (50 milliliter per group of students)
- Vegetable oil (50 milliliter per group of students)
- Water (50 milliliter per group of students)
- 250 milliliter beakers labeled A, B, C (3 per group of students)
- Scale
- VISUAL AID: "Density"
- STUDENT WORKSHEET: "How Dense Can They Be?"

Answers to Student Worksheet:

Background Information: *Results will vary, but liquid A should have the greatest mass, C should be in the middle and B should have the least mass.*

Hypotheses: *Liquid B (least dense)*
Liquid A (most dense)

Data:



Conclusion: *Ideally, results should support hypotheses. If results do not support hypotheses, the student may have misunderstood the relationship between mass/volume and density, or may have made an error when measuring the mass of the liquids.*

Further Question: The lower atmosphere is more dense.

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Activity Preparation:

Prepare the liquids so that there are no visible labels for students to distinguish what they are. Label the syrup "A," the vegetable oil "B," and the water "C."

Activity Procedure:

1. Provide students with a review or an explanation of density. *Refer to the Teacher's Note below.*
2. Divide students into groups of 3 and distribute the STUDENT WORKSHEET: "How Dense Can They Be?" to each student. Distribute 3 beakers (labeled A, B and C) to each group.
3. Use the scale to demonstrate how to determine the mass of a beaker. Ask students to find the mass of each beaker and write the results in the chart on their worksheet.
4. Provide liquids and ask groups to fill beaker "A" with 50 ml of pancake syrup, beaker "B" with 50 ml of vegetable oil, and beaker "C" with 50 ml of water. Ask students to find the mass of each beaker again, this time with the liquid in the beaker, and record results in the chart on their worksheet.
5. After students have determined the mass of the liquid-filled beakers, ask them to complete the "Mass of Liquid" column of the chart by subtracting the mass of the empty beaker from the mass of the liquid-filled beaker.
6. Ask students to form hypotheses about the density of each of liquid based on mass and volume. Students will write their hypotheses on the STUDENT WORKSHEET, then complete the activity.
7. Ask students to add liquid C (water) to liquid B (vegetable oil) slowly and without mixing. Then, instruct students to slowly add liquid A (syrup) to the mixture, pouring it down the inside edge of the beaker to avoid mixing. Ask students to record results on the STUDENT WORKSHEET.
8. Discuss the results. How did the liquids layer? Which liquid was the most dense? Which liquid was the least dense? Did results reflect the students' hypotheses? Why or why not?

Teacher's Note: The density of a substance (gas, liquid or solid) depends on how tightly packed the particles are that make up that substance. A foam ball is a lot less dense than a softball of the same size. The particles that make up the foam ball are more loosely packed and have more air around them than the particles that make up a softball. Density is a measure of the mass of a substance relative to its volume.

Gases have different densities too. Propane tanks contain gas that is so compressed it becomes liquid. If the propane tank valve is left open, the liquid quickly returns to a gas loses density, and escapes into the air outside the tank.

In the upper atmosphere the density of atmospheric gases plays a big role in the colors and intensity of the aurora. Usually, when the solar wind penetrates the thin gases in the uppermost atmosphere, few collisions occur. When the solar wind reaches the more dense gas closer to Earth's surface, more collisions between gas particles and solar particles occur, resulting in an auroral display. Solar winds that are really strong carry a greater density of solar particles, and this results in more collisions with the gases in Earth's upper atmosphere and elaborate auroral displays.

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Testable Question:

What are the relative densities of three mystery liquids?

Background Information:

The density of a substance (gas, liquid or solid) depends on how tightly packed the particles are that make up that substance. Density is the measure of the mass of a substance relative to its volume.

Measure the mass of three liquids with the same volume, then determine the relative densities of the liquids by pouring them into one container. The liquids will layer according to density, with the most dense liquid on the bottom and the least dense liquid on the top.

Complete the chart.

Beaker	Mass (in grams)			Volume of Liquid
	Empty Beaker	Beaker with Liquid	Liquid (Beaker with Liquid - Empty Beaker)	
A				50 ml
B				50 ml
C				50 ml

Hypotheses:

Based on mass and volume, which liquid is the least dense? _____

Based on mass and volume, which liquid is the most dense? _____

Experiment:

Materials:

Liquids A, B and C

Procedure:

1. Pour liquid C into the container of liquid B slowly, without mixing.
2. Slowly add liquid A to the mixture by pouring it down the inside edge of the beaker to avoid mixing.
3. Wait for the layers to separate, then record observations in the "Data" section.

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Data:

Label the layers of liquid in the beaker below to show what happened when liquids A, B and C were poured into one beaker.

Liquid _____

Liquid _____

Liquid _____

Conclusion:

Report your findings. Did the results support your hypotheses? Why or why not?

_____

_____

_____

Further Question:

Based on what you observed about density during this experiment, which is more dense, the upper atmosphere or the lower atmosphere? _____

