How do substances of different densities "stack up" to Zero-G?

Introduction

What happens when you put substances with different densities together in the same container? Does gravity play a role in how these substance interact?
In this lesson we explore relative density, the physical property that determines how substances form layers relative to one another. Students will create a density tower with teacher selected materials, then identify the substances based on density.

What, if anything, would change if these substances were combined on the moon? On the International Space Station? Challenge your students to construct a density tower that could answer this question within the constraints of microgravity on board G-Force One.

Grades: 5th - 9th
Time Frame: 45 minutes

NGSS Standards:

MS-PS1-1: Develop models to describe the atomic composition of simple molecules and extended structures.
MS-PS1-2: Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.
MS-PS1-5: Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.
MS-PS2-2: Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

Objectives:

- Understand the difference between mass, volume, and density
- Calculate the density of materials using mass and volume measurements
- Understand that density of a material is an important property which is often useful to people
- Understand that density is fundamental to many of earth and space process.
- Create a density tower to demonstrate relative density
- Identify materials based on relative density

Materials:

- Clear cups or beakers to hold liquid supplies (4-5 per group)
- Various liquids and solids with different densities (e.g. water, corn syrup, vegetable oil, rubbing alcohol, dish soap, paper clip, styrofoam, wood)
- Food coloring (optional)
- Graduated cylinder (2)
- Scale

Engage

- Hold two objects of similar density but different sizes (bowling ball and marble for instance) and ask which has greatest mass? Volume? Density?
- Demonstrate a container with water with an object on the bottom and an object that floats. Why does one float and one sink?
- Pass around materials with different densities (e.g. rocks, feathers, water, oil).
- Discuss: What determines the density of a material?
- *Note to teacher: you will need to calculate the density of each material provided. Provide students with the material and its density so students can correctly identify their layers at the end of the lesson..*

Procedure:

1. Provide each group with 4-5 differently colored “mystery” liquids at each table
2. Pour 10-20 mL of the first liquid into a graduated cylinder
3. Record volume of liquid
4. Using the scale, record the mass of the liquid (subtract mass of the container!)
5. Pour the liquid into a cylinder
6. Repeat for each liquid, creating a layered tower of liquids with different densities.

Results:

Calculate the density of each material, using the formula **d=m/v**

Substance (description)	Layer (1=bottom)	Mass (g)	Volume (mL)	Density (g/cm3)	Identity of substance

	Illustrate and color your density tower. Label the parts of each layer with the following: Identity of substance Density (g/cm3)

Reflection:

1. Share your density tower with the class!
2. Do all of the density towers look the same? Why or why not?
3. What is the difference between mass, volume, and density.
4. How does the order of layers relate to the density of each liquid?
5. How could pressure and temperature affect the density of a substance? Explain. (Hint: think how the molecules are arranged!)
6. Explain a natural earth process that occurs due to density?
7. What material have you encountered that are useful due to its density? Explain.
8. What role does gravity play in forming layers?
9. Predict whether the tower would look and form the same way if constructed on the moon. Explain.
10. Predict whether the tower would look and settle the same way in microgravity. Explain.

Extensions:

- Why is understanding density important? How is it is used in various fields, such as geology, chemistry,and engineering?
- Use a drop tower to simulate microgravity and test your hypothesis. First redesign the tower so it is in an enclosed container.

Design and Build!

A density tower which could be tested in microgravity and lunar gravity onboard G-Force One!

Maximum volume: 100 mL
Sealed entirely, no leaking!
Must be able to "shake"
No glass or dangerous materials
Consider pressure changes during flight!