Wizards of Wright

Lesson: Density – An Introduction

Use WOW! Lesson Intro to begin.

Background Info for Wizards:	If students are not yet in groups, ask the teacher to place them in 7 groups.
Materials:	Roll of masking tape Poly Density Bottle Tray for each group Cup of water for each group Jug of water Paper towels, in case there is a spill 3 Density spheres (1 steel, 1 cork, 1 wood) per group (constant volume) 1 Density kit per group (aluminum bar, 2 aluminum cubes) Ruler for each student Scale for each group Calculator for each group 1 set of Density cubes per group (constant volume of 15.6 cm^3) Ruler Scale Calculator 1 set of Density cylinders (constant volume of 5.8 cm^3) Scale Calculator Pre-prepared layered liquids
Lesson Time: 45-60 minutes ******To fit within a 45 min period the introduction can be condensed. Activity four can be omitted and the key points discussed as a group.***	Introduction: 6 minutes Guided Lesson: 2 minutes Wizard Demonstration #1: 2 minutes Student Activity #1: 7 minutes Student Activity #2: 10 minutes Student Activity #3: 10 minutes Student Activity #4: 7 minutes Wizard Demonstration #2: 3 minutes Conclusion: 3 minutes

Learning Targets:	Students will learn about matter and density in liquid and solid form. Students will use multiplication and division to solve for volume and density. Students will learn to use scientific equipment such as scales, calculators, and graduated cylinders. Students will be able to explain how density alters the property of solids, and what happens when liquids of different densities are mixed together.
Introduction for Students: 6 minutes	Today we are going to talk about Density. A Science word that talks about how tightly packed the molecules are in an object or a substance. Think about an elevator. As it travels from floor to floor it picks up and drops off passengers. The volume is the size of the elevator (the amount of 3-dimensional space occupied by an object). If two passengers are added…the density will change. (how packed it is) If those 2 passengers were molecules in an object it would have little density. As more mass (people) is added to the volume of the elevator, it becomes more tightly packed. A crowded elevator has more density than when there were just 2 people. An object with tightly packed molecules is denser than one where the molecules are loosely packed. Imagine an empty 2 liter bottle…if we packed it with cotton balls it would be less dense than if we packed it with jelly beans. *(You could have the students visually show this. Use masking tape and create a large square on the floor representing the elevator. Have 2 students stand in the square and show how much room there is. Change the density by continuously adding students until it is very crowded.)*
Guided Lesson: 2 minutes	Let me ask you a common trick question: *Which is heavier, 1 kilogram of gold or 1 kilogram of feathers?* Yep, you can't be tricked, neither one is heavier - they weigh the same. 1 kilogram = 1 kilogram, whether it is gold or feathers. They both weigh 1 kilogram! One more question: *If you had two equal boxes and you filled one with gold and one with feathers, which box would be heavier?* The box of gold would be heavier because gold is denser than feathers. The same volume of feathers would be lighter.

Wizard Demonstration #1: 2 minutes	WOW! the students with the Poly Density bottle… perhaps ask for a few ideas on how it works. Return to the full explanation of how it works in the conclusion. Remind students that density can be thought of as the amount of something packed into a specific volume. For example, if you pack a suitcase (or toy box) in a messy fashion vs folding clothes carefully. The carefully folded suitcase will be heavier, but it will hold more clothes (atoms) than the first. There is more mass in the same volume. Let's explore this further.
Student Activity #1: 7 minutes	*****Pass out worksheet now. 1 worksheet per group of students** Give each group of students a tray to work on, a plastic cup, and three different spheres. Go around and fill each groups' cup halfway with water. They should carefully/slowly place all three spheres in and observe how one sinks (steel ball) while the cork and wood float. The wood ball will be more submerged. This shows a difference in density. When an object has less density than the liquid it is in, it floats. That means it is buoyant. Collect all materials except tray… set cup of water aside for Activity #4.
Student Activity #2: 10 minutes ****** If Students struggle with this part there is no need to measure the cubes in the next demo. Volume in Activity 4 is constant.***	Pass out handouts. As a demonstration, show the students how to find where the bars have been marked with 3 different colors. Discuss measuring the length. Then the width. Then the height. Pass out 1 density kit per group (aluminum bar and cube). Give each group a scale and calculator and a ruler to each student. Show them how to use the materials. Walk students through the measurement and calculation process. **V= lwh** Density of Al is 2.7 g/cm^3 D=m/v

	(Solve as a group.) Walk students through the procedure and calculate the volume, weigh mass, and calculate the density! Use small cube of aluminum to make students understand unit of measurement (1 cubic cm). They will prove that the density of both objects is the same. Collect the kit (bar and cubes) materials and hand out the density cubes.
Student Activity #3: 10 minutes ***Constant Volume of 15.6 cm^3***	Once students have the density cubes tell them that they will look at materials with the same volume and different densities. Ask students if they can figure out… If the volume is the same, what will determine density? (mass) What would be the most dense object? (heaviest) Ask students if they can put these cubes in order of the most dense to least dense with their group by feel first. Once their team agrees, they can check by measuring the cube and using the scale to calculate the density. <u>ANSWER</u>: Copper (8.9-9.2 g/ cm^3), Brass (8.6 g/ cm^3), Steel (7.6-8.0 g/ cm^3), Aluminum (2.7-2.75 g/ cm^3), PVC (1.37-1.38 g/ cm^3), Acrylic (1.16-1.27 g/cm^3), Nylon (1.15-1.20 cm^3), Pine (0.34-0.60 g/ cm^3) There might be a slight variation in the answers. Order will be the same. This is an opportunity to discuss margin of error. Density of polymers is less exact, it depends on the sample. Collect the density cubes and hand out Constant density cylinders.
Student Activity #4: 7 minutes ***Constant Volume of 5.8 cm^3*** $V=\pi r^2 h$ $r = 1/2d$	Let us explore whether shape affects the density of a substance. All of these cylinders are of the same volume (5.8 cm^3) and are made of materials that you have already calculated the density of. Calculate the density of these cylinders, arrange from most dense to least dense, and identify the substance. Answer: Copper (8.9-9.2 g/ cm^3) Brass (8.6 g/ cm^3) Steel (7.6-8.0 g/ cm^3) Aluminum (2.7-2.75 g/ cm^3)

r = radius ***d = diameter*** ***h = height*** ***π = 3.14159***	Did your answers match the previous calculations for the same materials? They should! (there may be slight differences due to error.. see next question) What might have been the cause for any differences? Error in measurement and calculation **KEY POINTS:** For alloys, or mixtures of metals, there may be further variation depending on how much of each element is present. Mixtures of two different substances have a different density than the pure substances would! Brass, for example, is a mixture of copper and Zinc, and therefore has a density that is in between the two materials. This can account for some of the slight variation you might observe (8.4-8.73 g/cm^3). Other factors like the temperature of the material may also affect density. Did shape affect the density of the substance? NO!
Wizard Demonstration #2: 3 minutes	Show students layered liquids (pre prepared), discuss how liquids also have density and due to the properties of liquids they can be "mixed" but will always separate back out and layer in order of density.
Conclusion: 3 minutes	Explain Poly Density Bottle from Activity #1. Do they understand that the items are separating out? Can they relate this to any of the experiments they did? (brass; mixtures change densities) (liquid layers; when liquids of different densities are mixed, they will always separate out) Review what was learned about density and buoyancy. Review the formulas learned and what cubic cm is. Review what determines density when volumes are the same. Review what happens if you mix two liquids with different densities. Q: When using different liquids, in what order would the layers form? A: Most dense (bottom) to least dense (top) Q: Does shape affect density? A: No Q: If you have a larger volume of a substance does this change its density? A: No, mass changes proportionally Q: What if we have a piece of plastic and heat it causing it to expand? Does the density change? A: Yes, the mass has remained the same and the volume has changed, so the density is now less.