

PSI:

PHYSICAL SCIENCE INVESTIGATION



Teacher's Lesson Description

Title	Oh, Buoy!
Brief Description of the Videos	In these videos, Dante demonstrates whether objects (marble, bowling balls) sink or float in a tank of water. This demonstration introduces the concept of density. Students will use scientific inquiry to ask questions, test hypotheses, analyze data, communicate results and identify questions for further investigations as they experience the relationship between density, mass, and volume.
Time Needed	Two class periods
Ohio Science Benchmarks Addressed in This Activity	<ul style="list-style-type: none">• Grade 6-8 SI Benchmark A & B• Grade 6-8 SW Benchmark A & C• Grade 6-8 PS Benchmark A
Ohio Grade Level Indicators Addressed in This Activity	<ul style="list-style-type: none">• Grade 6 SW Indicators 3, 4• Grade 7 SW Indicator 3• Grade 8 SW Indicator 1• Grade 7 PS Indicator 1
Concepts Developed	<p>Scientific inquiry is the development of a questioning system that allows students to make sense of the world around them. Inquiry includes the processes of observation, inference and prediction. When conducting experiments and investigations, the observations made may lead to new questions.</p> <p>This lesson is to be used after the concept of density has been taught in lesson 1. Lesson 2 builds</p>

	<p>on density by introducing buoyancy and how ships use density and buoyancy to manage cargo and navigate waterways.</p>
Lesson Rationale	<p>In physics terms, density is defined as the mass per unit volume. Meaning the amount of mass in 1 unit volume of the substance. The equation of density is $Density = Mass / Volume$. Students will explore the concept of density and the relationship between mass and volume by making observations and predicting if an object will sink or float when place in water.</p> <p>Buoyancy is defined as the phenomenon (discovered by Archimedes) that an object less dense than a fluid will float in the fluid. More generally, Archimedes' principle states that a fluid will exert an upward force on an object immersed in it equal to the weight of the fluid displaced by the object.</p> <p>The shipping industry uses ballast water to keep the boats buoyant and balanced depending on the cargo the boat is carrying. By exploring how boats remain balanced and afloat student will achieve an understanding how density can be changed to affect buoyancy.</p>
Background Knowledge for Teachers	<p>Scientific inquiry describes how scientists go about finding answers to questions about the natural world. It begins when a question is asked and continues as you look for the answers. The goal of scientific inquiry is to understand and explain the natural world. Scientific observations are a large part of inquiry. They involve using your senses to describe the world. Observations are often made during experiments. Sometimes measurements are taken and added to your observations. These eventually lead to a prediction about what has been observed and measured.</p> <p>Density is defined as the mass per unit volume. Density can also be determined mathematically, $Density = Mass / Volume$. In our examples, we compare mass, weighed in grams, to volume, measured in cubic centimeters. Another way to express this is $D = g/(cm)^3$.</p> <p>Archimedes' principle is the law of buoyancy. It states that "any body partially or completely submerged in a fluid is buoyed up by a force equal to the weight of the fluid displaced by the body." The weight of an object acts downward, and the buoyant force provided by the displaced fluid acts upward. If these two forces are equal, the object floats. Density is defined as weight per</p>

	<p>volume. If the density of an object exceeds the density of water, the object will sink</p> <p>This website explains how the Archimedes' Principle works:</p> <p>http://www.onr.navy.mil/focus/blowballast/sub/work2.htm.</p> <p>A ballast tank is a compartment within a boat or ship that holds water. A vessel may have a single ballast tank near its center or multiple ballast tanks typically on either side. A large vessel typically will have several ballast tanks. A ballast tank can be filled or emptied in order to adjust the amount of ballast force. Ships use water in the ballast help balance the ship and to raise and lower the ship.</p> <p>In the video, Dante states why a large ship like the Steamship <i>William G Mather</i>* that weighs thousands of tons can float. By pausing the video at the scene of the <i>Mather</i> Steamship, teachers can provide an opportunity for visual observation and stimulate discussion of how a ship can float. A picture of a ship discharging ballast water can also be seen at http://massbay.mit.edu/exoticspecies/ballast/index.html.</p> <p>*The Steamship <i>William G Mather</i> Museum is owned and operated by the Great Lakes Science Center.</p>
Classroom Procedures	<p>This lesson is designed to provide students the opportunity to determine that density is a relationship between mass, volume, and the shape of an object. Students will be creating clay ships from a ball of clay that initially sank. Students will load their boat with cargo(marbles) and then use ballast water to balance, raise, and lower their ship.</p> <ul style="list-style-type: none"> • Hold up the ball of clay and ask students to predict if it will sink or float. Drop into the water. • Tell the students that they are each going to get a sinking clay ball that they must design into a floating clay ship. Use the concept of density to create a ship to carry cargo(marbles). • Provide each group of students with a container of water, 3 or 4 marbles, ball of clay, cup of water, pipette, and a toothpick.

	<ul style="list-style-type: none"> • Instruct students that they will be filling their ship with cargo and raising and lowering the ship using ballast water. Ballast water will be added and removed using the pipette and cup of water. • Record various water levels by placing a mark on the ship with the toothpick. Record observations, experiences, and visual data during experimentation. • Circulate the room and observe student experiments. Allow students to explore the concepts of density and buoyancy. Ask students about their designs, ballast water findings, and other experimental observations. • Have students share their findings with the class. Pose questions that guide students and allow them to connect how ballast water can change the density of a ship and alter buoyant forces. <ul style="list-style-type: none"> *What are the variables that affect density? *What variable did you change to increase or decrease your ships density? *What density variable remained the same? *How did you raise your ship? *How did you lower your ship? • Assess student understanding of buoyancy by visiting Buoyancy Brainteasers at http://www.pbs.org/wgbh/nova/lasalle/buoyancy.html. Engage in the Buoyancy Basics and the 3 challenge questions.
Materials Needed	Clear plastic container filled with water marbles Ball of clay Cup of water Pipette/medicine dropper Toothpick
Science Connections	A concept connected to density is that of buoyancy. In buoyant situations, some materials that

	<p>sink when placed under water will float on the surface of the water. This “floating” involves a special relationship between the mass of the water displaced and the volume of the water displaced. For example a lump of clay will sink in water, but that same clay molded into a barge-like “boat” will float. It is the change in shape that allows water’s buoyant force to hold the object on the water’s surface. A connected activity is the penny boat float described in the video. There is a good lesson plan describing the penny boat float activity at this Web site: http://www.lessonplanspage.com/ScienceWillTheBoatSinkOrFloat4.htm</p> <p>Invasive species are often introduced into new ecosystems through discharged ballast water. This lesson serves as a springboard to invasive species education. The following links provide resources for invasive species: http://www.epa.gov/owow/invasive_species/ http://www.sgnis.org/kids/</p>
Additional Web Resources	<p>Buoyancy Basics – Nova http://www.pbs.org/wgbh/nova/lasalle/buoybasics.html</p> <p>Buoyancy Game Show http://www.surfnetkids.com/quiz/buoyancy/</p> <p>Penny Boat Float http://www.lessonplanspage.com/ScienceWillTheBoatSinkOrFloat4.htm</p> <p>How Stuff Works – Density Video http://videos.howstuffworks.com/hsw/5897-scientific-method-measuring-density-video.htm</p> <p>Mythbusters Explore Buoyancy and Density http://videos.howstuffworks.com/discovery/6540-mythbusters-lets-talk-buoyancy-video.htm</p> <p>Science Museum of Minnesota http://www.thinkingfountain.org/d/density/density.html</p>

	Reekos' Mad Scientist Lab—Why Boats Sink and Elephants Float http://www.spartechsoftware.com/reeko/Experiments/floating.htm
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Ohio Science Standards Abbreviations:

ES – Earth/Space Science

SI – Scientific Inquiry

LS – Life Sciences

ST – Science and Technology

PS – Physical Sciences

SW – Scientific Ways of Knowing

