

Title:

Grades: 4-8

Subject: Science/LA

Overview of Lesson:

Students seek to answer the question, what makes Capt'n Eli's submarine float, sink and resurface? Through a series of experiments, they learn about the relationship between mass, buoyancy and density. After understanding how a submarine works, students discover the legendary "Alvin", the first deep-sea submersible able to carry passengers. Through research, students come to understand how scientists conduct underwater studies while learning about hydrothermal vents. The lesson ends with the writing prompt: How might Commander X and Capt'n Eli have used hydrothermal vents in combating the evil forces attacking Aquaria?

Time for completion:

1-2 weeks

Materials per Group:

metric ruler

triple beam balance

plastic dishpans

water

graduated cylinders

10 objects of different volume

10 objects of different mass

10 objects with a regular shape (for determining cubic volume)

10 objects to use to discover the density of each

10 objects irregular in shape

quart soda bottles-one per group

one medicine dropper per group

Salt water

Lab Notebook

Laptop or desktop computer

Main Learning Results

Science

THE EARTH

Students will gain knowledge about the earth and the processes that change it. The earth's surface undergoes steady or sudden changes due to forces of wind, water, ice, volcanism, and shifting of tectonic plates.

INQUIRY AND PROBLEM SOLVING

Students will apply inquiry and problem-solving approaches in science and technology.

Scientific inquiry, problem solving, and the technological method provide insight into and comprehension of the world around us. A variety of tools, including emerging technologies assist, the inquiry processes. Models are used to understand the world.

ECOLOGY

Students will understand how living things depend on one another and on non-living aspects of the environment. Balance in ecosystems is based on an intricate web of relationships among populations of living organisms and on non-living factors such as water and temperature. Changes in specific populations or conditions affect other parts of the ecosystem. Individual systems continually change in response to human and other factors.

National Science Standards

NCTE/Language Arts Writing Standard:

Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

Objectives:

Students will:

- Design and conduct investigations to demonstrate an understanding of scientific inquiry.
- Identify and create questions and hypotheses that can be answered through scientific investigations.
- Comprehend scientific material for later use in writing

Students will:

Skills

A. SKILLS and TOOLS

- Students will know how to conduct experiments using the scientific method.
- Complete lab reports detailing hypothesis, procedure and results
- Read and understand science based electronic resources
- Write a creative essay applying scientific knowledge gained

Technology Integration:

Technology as an essential tool will be integrated throughout this lesson for a variety of purposes. While recording scientific data when conducting experiments, students should have either Noteshare or a program for detailing the procedure and lab results. Teachers may want students to graph data in a program such as Data Studio. An electronic sketchpad would be helpful in creating visual representations of the concepts.

As students conduct research on under-sea hydrothermal vents, an online computer is necessary. Access to email for communicating with the mission scientist should be readily available.

Procedure:

Guiding Questions:

How do all the underwater vehicles in the graphic novel float, sink and resurface?

Lesson One Overview:

Students learn about the relationship between buoyancy, density, and mass through hands on experimentation. They measure various objects in calculating the density of each one. After measuring they record and graph the information. The goal is to have them understand how the mass, volume and density affect the buoyancy of an object. Through this activity, they learn how the undersea vehicles in the graphic novel are able to operate.

Classroom Lab :

In cooperative learning groups of 4, have students predict the mass of the 10 different objects. Have the group assign one person to record predictions. If Noteshare is available to the students, have them create a Notebook specifically for this Lab. If not, choose a program for recording results. They should also sketch the materials and procedure as they take lab notes.

1. **Mass-** Have the students determine the real mass by passing the object (s) around the group having each student measure the object. Students should then look at the data and discuss any discrepancies between predictions and actual data. Inevitably, they will discover that the size of an object does not determine the mass.

2. **Volume-** Students then predict the volume of 10 different objects. For this activity students observe 3 different methods to determine the volume. One is the formula method where they apply length x width x height (to be used with their regular shaped objects and the overflow method to be used with irregular shaped objects. The next method for calculating is capacity or how much the object will hold. Have them use the same procedure as determining mass, recording all results in the Notebook.

3. **Density-**Students use a triple beam balance and a metric ruler to determine the density of objects. The dishpan for overflow will also be used. The objects available should include those that will sink and those that will float. The discussion here should focus on how the density changes according to the volume or mass of each object. Using the mass per unit volume or one gram per cubic centimeter, students should see the relationship to density.

4. Floating objects and sinking objects from the previous activity now should be examined to find out exactly why. Looking at the data that they have collected on density, students should be able to see that the relationship of mass to volume determines the ability of these objects to float or to sink.

5. How do submarines such as the one designed by Capt'n Eli, dive into the water and resurface? Using this simple procedure, students answer this question.

- Begin by filling a glass with water and put a medicine dropper in it. With the dropper, suck enough water in so that it floats with just a little bit of the rubber part bobbing out of the water. This becomes the "diver" and the term for this is "neutral buoyancy"

meaning that the water it displaces is the same as the diver. The diver stays in one spot because the displaced water pushes up on the diver with the same amount of force that the diver itself pushes down on the water thus the diver remains in one spot and does not float up or sink down (neutral).

- Now that the dropper is ready, fill a plastic quart soda bottle to the top leaving no space between water and cap. Lower medicine dropper into bottle and screw on the cap tightly.
- Squeeze the bottle thus increasing pressure and what do you observe? (They should see that as pressure is increased, the water in the dropper increases causing it to sink) Students should experiment applying varying amounts of pressure to make the dropper hover in the middle of the bottle.
- How does this experiment answer the question regarding submarines? Have students research how submarines operate in a similar fashion. They will discover that submersibles have ballast tanks that fill up with water to make them dive and when it is time to resurface, air is pumped into the tanks forcing water out and allowing it to float.

Question:

Capt'n Eli is operating his submarine in the ocean rather than in fresh water. How can you repeat the diver experiment to simulate these conditions. What do you predict will happen? Record your results.

(Students will find that salt water is denser than fresh water

Lesson II Overview:

After fully understanding the concepts behind submarines, students apply this knowledge as they discover Alvin, the first deep sea submersible owned by the Woods Hole Oceanographic Institute (WHOI). Students learn how real world scientists gather information on the ocean floor as they gather information on hydrothermal vents. Hydrothermal vents are geysers located on the floor of the deep sea. Students view photos, movies, and websites to collect data on these vents and the life systems that they support.

- Instruct students to go to this website and watch the video on Alvin. After viewing the short video, have them read the material provided by NOAA. Use the question form for them to record information on the **vehicle, its history and purpose**.

<http://oceanexplorer.noaa.gov/technology/subs/alvin/alvin.html>

[Worksheet](#)

- After answering the questions, students become familiar with the term hydrothermal vents. Review the general concept of **plate tectonics**. For further clarification, have students visit this site to more fully understand how plate tectonics plays a part in the formation of these vents.

<http://www.ocean.udel.edu/deepsea/level-2/geology/plate.html>

[Worksheet](#)

- Tell the students that this site describes the vents and the organisms supported by these vents. It also points out just why it is so important for scientists to study these vents.
<http://www.ocean.udel.edu/deepsea/level-2/geology/vents.html>

[Work sheet](#)

- Tell students that they will be reading about a scientist who went on a mission in Alvin to observe under-sea hydrothermal vents. As they read about the mission, have them take careful **Lab Notes** on the mission describing the discovery and detailing the life forms in the location of the vents.
<http://www.ocean.udel.edu/deepsea/level-2/mission/mission.html>

Students are welcome to email a scientist on the mission to ask any questions that they might have. The address is: MarineCom@udel.edu

Language Arts Essay Writing Prompt

Question: When combating the evil forces attempting to take over Aquaria, how could Commander X and Eli have used hydrothermal vents? When answering this question include scientific data to reinforce your thoughts.

Evaluation:

[Rubric](#) for experiment (rough)