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Mountains in the Sea Exploration

Come On Down!

Focus
Ocean Exploration

Grade Level
Grade 7-8

Focus Question
What technological capabilities are required for the operation of deep sea submersibles?

Learning Objectives
Students will research the development and implementation of a research vessel/vehicle used for deep ocean exploration. (Pre-lab Activity 1)

Students will calculate the density of objects by determining the mass and volume. (Activity 2)

Students will construct a device that exhibits neutral buoyancy. (Activity 3)

Adaptations for Deaf Students
One 45-minute class period will be required for each of the three activities.

Materials (per lab group of 4 students)
- ❒ Graduated cylinder, 100 ml., 1
  Balloons, various sizes, 3
- ❒ Cork, 1
- ❒ Film canisters, 2
- ❒ Bobber, 1
- ❒ Non-lead sinkers, assorted sizes, 3
- ❒ Washers, assorted sizes, 8
- ❒ Straws, 2
- ❒ Clay, 1 block
- ❒ String, 1 meter
- ❒ Wire, 1 meter
- ❒ Fishing line, 1 meter
- ❒ Sand, 100g
- ❒ BB's, 10
- ❒ Water, 25 L
- ❒ Tub, 5 gal.
- ❒ Balance Scale
- ❒ Overflow container, 2 L
- ❒ Aquarium, 5-10 gal.
- ❒ Graph paper, cm, 3 sheets
- ❒ Copies of Student Worksheets #1 and #2
- ❒ Pictures of deep-sea research vessels/vehicles (R/V Flip, Trieste, Jason-Medea, ALVIN). See www.onr.navy.mil/focus/ocean/ and click on "Research Vessels."

Audio/Visual Equipment
Overhead projector

Teaching Time
Two 45-minute sessions

Seating Arrangement
Small groups of four

Key Words
Density
Buoyancy
Positive buoyancy
Negative buoyancy
Neutral buoyancy

Submersible
Volume
Mass

Background Information

The buoyancy of an object is determined by its density (mass/volume). An object that is less dense than its surrounding medium will float, or have positive buoyancy. An object that is denser than its surrounding medium will sink, or have negative buoyancy. An object that floats in the middle is said to have neutral buoyancy.

An object submerged in a fluid has a force pushing up on it that is equal to the weight of the fluid being displaced by the object. This is known as the buoyant force. This idea is known as Archimedes' Principle. Like the object, the force exerted by the fluid depends on its density. For example, we float better in the Great Salt Lake than in a freshwater lake.

The shape of an object will affect the buoyant force against the object, since changing the shape changes the volume of the object. Changing the shape can cause the object to displace a greater or lesser amount of water, thereby changing the buoyancy.

Learning Procedure

In these activities students will investigate the principles of density and buoyancy as they apply to deep ocean research vehicles. The Learning Procedure is addressed in each of the activities.

Activity 1. (Pre-Lab) Exploring Deep Ocean Research Vessels and Vehicles

1. The teacher will introduce the class to deep-sea research vessels/vehicles with pictures of the R/V Flip, the Trieste, the Jason-Medea and the ALVIN. Assign one vessel/vehicle to each student group.
2. Using the Internet site www.onr.navy.mil/focus/ocean/ each student group (4 students, may vary with class size) will be responsible for completing a chart with information about their vessel/vehicle. (See Student Worksheet #1).
3. When students have completed their research, have the students record the information about each of the vessels/vehicles using an overhead projector. Students should record information about each of the vessels/vehicles. A class discussion should follow using the following guiding questions:
   a. What is the role of a surface vessel in undersea operations?
   b. What are the advantages/disadvantages of manned vs. unmanned vehicles for deep ocean exploration?
   c. How are these vehicles able to float and sink in the ocean?
   d. What factors determine how deep a vehicle is able to go?

Activity 2. Sinkers and Floaters

1. Distribute a copy of Student Worksheet #2 to each student. Each lab group of 4 students should be directed to choose 4 sample objects from those provided. Identify the object and record information about each object on the data table (for example, red ball, black cube).
2. Use the scale to determine the mass of each object. Record the information on the data table.
3. Use the graduated cylinder and water (an overflow cup may also be needed) to determine the volume of each object by displacement. Record on the data table.
4. Identify each object as a "floater" or "sinker." Record on the data table.
5. As each group finishes their task, their data should be added to a Class Data Table found on the blackboard. Each student should copy the class data onto their data table. (Student Worksheet #2)
6. Students should graph the class data using a line graph, in which the x-axis = volume and the y-axis = mass.
7. When graphs are completed, teacher should have students circle those points identified as "floaters" and draw a box around those points identified as "sinkers."

8. The teacher should then direct the students to draw a line on their graphs where X = Y. Ask students where the "floaters" and the "sinkers" are found. What is the relationship between mass and volume for floating objects and sinking objects?
9. Students should calculate the density of their objects using the following: Density = mass/volume. Infer the relationship between objects with a density > 1. Infer the relationship between objects with a density < 1. What if the mass = volume of the object? (Note: The teacher should introduce the concept of neutral buoyancy.)
10. The teacher should lead a class discussion about the deep-sea vehicles and density. (Since the volume of the vehicle is set, it cannot be changed. The mass can be altered by pumping in water or blowing water out.) They are able to sink to great depths and rise to the surface again.) Make inferences about the mass and volume relationship of these vehicles.

Activity 3. Inquiry: Build Your Own Submersible

Working in groups of four, students will build a device that exhibits mid-water neutral buoyancy, and in doing so, will understand what is required to make deep-sea vehicles hover in the water column.

1. Each group will be given a set of various objects from the Sinkers and Floaters activity; such as corks, lead weights, bobbers, balloons, washers, and string.
2. Each group will choose which objects they would like to use to design a submersible.
3. After designing a submersible, each group will test their device in an aquarium filled with water.
4. Student Self-evaluation
    1. What problem(s) did your lab group encounter with the activities?
    2. Describe your understanding of neutral buoyancy. Why is this an important concept for deep ocean explorers?
    3. If you could build your submersible again, what would you change? Why?

The BRIDGE Connection

www.slackerTV.com/shows/rov.html Students build their own underwater vehicle.

The "Me" Connection

In order to understand the underwater world, submersibles, whether manned or unmanned, must be used. At this point, very little is known about the deep sea. Deep sea exploration is the new frontier.

Connection to Other Subjects

Mathematics
Physical Science

Evaluation

- Group participation
- Graphs
- Density calculations on Student Worksheet #2
- The inquiry lesson can be used as an evaluation tool. The students are trying to achieve neutral buoyancy with their submersible. The students will write a paragraph describing their submersible and explain why it sinks, floats or obtains neutral bouyancy.

National Science Education Standards

Science as Inquiry-Content Standard A:

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Physical Science-Content Standard B

- Properties and changes of properties in matter

Science and Technology-Content Standard E

- Abilities of technological design
- Understandings about science and technology

Science in Personal and Social Perspectives-Content Standard F

- Risks and benefits
- Science and technology in society

History and Nature of Science-Content Standard G

- Science as a human endeavor
- Nature of science
- History of science

For More Information

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Student Handout

Pre-Lab Activity
Student Worksheet #1

Research Vessel/Vehicle Information

Vessel/Vehicle Name	Submersible Vehicle or Surface Vessel	Greatest Depth Capable of Attaining	Manned/ Unmanned	Unusual Features	Uses

Student Handout

Student Worksheet #2

Floaters and Sinkers Data Table

1. Record your group data.
2. Record class data when directed.

Name of Object	Mass (g)	Volume (ml)	Floater/Sinker	Density D = m/v