Teacher Resources

Dive! Dive!
aka Buoyancy & Density

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2011 Naval Historical Foundation STEM Teacher Fellowship

INTRODUCTION

This lesson allows students to explore the concepts of density and buoyancy and how the two are related. In the first activity, students will conduct an activity that simulates how a submarine is able to submerge. In the second activity, student will determine the density of an egg by making a saltwater solution that is neutrally buoyant and then calculating the density of the solution.

STATE/NATIONAL STANDARDS

National Science Education Standards

STRUCTURE AND PROPERTIES OF MATTER

- The physical properties of compounds reflect the nature of the interactions among its molecules.

DESIGN AND CONDUCT SCIENTIFIC INVESTIGATIONS

- Designing and conducting a scientific investigation requires introduction to the major concepts in the area being investigated, proper equipment, safety precautions, assistance with methodological problems, recommendations for use of technologies, clarification of ideas that guide the inquiry, and scientific knowledge obtained from sources other than the actual investigation .

MOTION AND FORCES

- Objects change their motion only when a net force is applied. Laws of motion are used to calculate precisely the effects of forces on the motion of objects. The magnitude of the change in motion can be calculated using the relationship F = ma, which is independent of the nature of the force. Whenever one object exerts force on another, a force equal in magnitude and opposite in direction is exerted on the first object.

Science Common Core Standards

PS1.A: Structure and Properties of Matter

- Within matter, atoms and their constituents are constantly in motion. The arrangement and motion of atoms vary in characteristic ways, depending on the substance and its current state (e.g., solid, liquid). Chemical composition, temperature, and pressure affect such arrangements and motions of atoms, as well as the ways in which they interact. Under a given set of conditions, the state and “intensive” properties (e.g., density, elasticity, viscosity) are the same for different bulk quantities of a substance, whereas “extensive” properties (e.g., volume, mass) measure the size of the sample at hand. Materials can be characterized by their intensive measureable properties. Different materials with different properties are suited to different uses.

PS2.A: Forces and Motion

- Interactions of an object with another object can be explained and predicted using the concept of forces, which can cause a change in motion of one or both of the interacting objects. An individual force acts on one particular object and is described by its strength and direction. The strengths of forces can be measured and their values compared. What happens when a force is applied to an object depends not only on that force but also on all the other forces acting on that object. A static object typically has multiple forces acting on it, but they counterbalance one another. If the total force on an object is not zero, however, its motion will change.

Virginia Standards of Learning

CH.1 The student will investigate and understand that experiments in which variables are measured, analyzed, and evaluated produce observations and verifiable data. Key concepts include

a) designated laboratory techniques;
b) safe use of chemicals and equipment;
c) proper response to emergency situations;
d) manipulation of multiple variables, using repeated trials;
e) accurate recording, organization, and analysis of data through repeated trials;
f) mathematical and procedural error analysis;
g) mathematical manipulations including SI units, scientific notation, linear equations, graphing, ratio and proportion, significant digits, and dimensional analysis;

CH.2 The student will investigate and understand that the placement of elements on the periodic table is a function of their atomic structure. The periodic table is a tool used for the investigations of

h) chemical and physical properties;

INTRODUCTORY ACTIVITY

Procedure

1. Direct students to the "Dive, Dive: The Submariners" video, on the US Navy Museum Cold War Gallery Youtube site (or download the video from the resource kit). http://www.youtube.com/user/coldwargallery#p/u/31/E_tYb0ws66E
2. After watching the video, divide the class in to small groups and ask them to brainstorm answers to the following two questions:
    a. The submarine is first shown floating on the surface. How does it go from floating to sinking into the ocean?
    b. The sailors controlling the decent of the submarine are told to go to a depth of 200 feet. How can a submarine stay at a constant depth?
3. Ask students to share their answers. Explain to students that the answers to these two questions can be explained using the concepts of density and buoyancy.

SIMULATING A SUBMERGING AND SURFACING SUBMARINE

Teacher Preparation

1. Before class, prepare plastic water bottles to simulate a submarine. Materials required include an empty 500 mL plastic water bottle and 60 cm of flexible tubing with 3/8" outside diameter.
   a. Drill a 3/8" hole in the bottle cap. Drill another 3/8" hole in the bottom of the bottle.
   b. Insert the flexible tubing into the cap so about 2 – 3 cm of tubing is protruding.
   c. Tape or glue the tubing in place.

Procedure

1. Have students complete the activity "**Sink or Swim**."
2. Before each class be sure to clean the end of the tubing that students will be blowing in to.
3. Any solid object with a mass of about 225 g can be used as a ballast weight.
4. Remind students not to cover the hole in the bottom of the bottle when taping the ballast weight to it.
5. To make the activity more quantitative, have the students determine the mass and volume of the bottle assembly with the weight attached before putting it in the water. Once students have made the bottle neutrally buoyant, the can remove the bottle assembly with the water in the bottle and find the mass of everything. They can then calculate the density of the empty system and the neutrally buoyant system. The neutrally buoyant system should have a density close to 1 g/cm^3.

DENSITY OF AN EGG

1. Have students complete the activity "**The Incredible Egg Challenge.**"
2. Be sure students wash their hands thoroughly with soap and water after handling the uncooked egg.