Lesson Plan #2—Science
Title: The World's Simplest Cartesian Diver

Introduction:
Cartesian is a term that was named after René Descartes, a French scientist, mathematician, and philosopher. He laid the foundations of analytical geometry, algebra, and other subjects such as buoyancy and pressure. René Descartes sought truth by first doubting everything, even his own existence. However, he concluded that in order to be able to doubt his existence, he must exist.

Objectives:
In this lesson, students will:

- Gain knowledge about buoyancy.
- Construct and operate a Cartesian diver.
- Build valuable investigation skills.
- Explain how changes in pressure influence buoyancy.

Session time: about 60 minutes (depends on the student's writing ability.)

Materials:

- Squeeze condiment packet (soy sauce, ketchup, mustard, etc.)
- Clear plastic bottle with tight-fitting lid (water, soda, etc.)
- A cup of water

Methods: Guided discussion, cooperative learning, interactive participation, written response

Instruction: Cartesian divers are fun and provoke lots of questions. Rather than answer them directly, we can use this as a chance to build valuable investigation skills. Your role as the instructor is to guide the students to define questions and hypotheses they can actually test through a practical experiment. This builds ownership of the process and the product, and results in deeper understanding than simply following the directions in a book.

Procedure:

1. Have students bring in condiment packets.

2. Figure out which ones will make a good Cartesian diver candidate. Fill a glass with water and drop in the packet to be tested. The best packets are ones that just barely float.

3. After you have found the proper packet, fill an empty, clear plastic bottle to the top with water. Shove your unopened condiment packet into the bottle. Replace the cap... and you're done! Squeeze the bottle to make the diver sink, and release to make it rise. Amazing!

4. Have students write a descriptive paragraph in their own words how they think the Cartesian Diver works.

Discussion/Wrap-Up

This experiment demonstrates the property of **buoyancy**. An object is buoyant in water due to the amount of water it displaces or 'pushes aside'. Many sauces in condiment packets are denser than water, but it is the air bubble at the top of the sauce that determines whether the packet will sink or swim.

If the weight of water that is displaced by an object in water exceeds the weight of the object then the object will float. As you squeeze the bottle, you apply pressure to the air bubble in the packet reducing its size. As the bubble's size reduces, the packet becomes less buoyant and begins to sink. Release the bottle and the packet begins to rise back to the top.

Fish keep themselves from either sinking or floating to the surface by using muscles to squeeze or relax a small sac (with a small air bubble inside) in their bodies. By squeezing the sac smaller, the fish will sink. By relaxing their muscles, the sac increases in size, displaces more water, and a fish will begin to rise to the surface. Man uses this same principle to control the buoyancy of a submarine. By pumping water in and out of tanks stored in the submarine, a submarine can be made to rise and sink.

Some material from this lesson is adapted from an article in *The Physics Teacher*, May 1996, by Eric Muller.

Note: This lesson is included in the workshop, ***Weird Science***, available as a Horizon Wimba online professional development workshop. To view a complete list of online offerings go to **www.siue.edu/SIPDC.**