**Under Pressure: How deep can they dive? Teacher Notes**

Adapted from: *Partnerships for Reform in Investigative Science and Math* (PRISM)

**Objectives**

* Students will identify and describe the different ocean zones
* Students will test their theories on what will happen as you dive deeper in the ocean
* Students will be able to identify the physical conditions that change as the depth increases (temperature, pressure, light)
* Students will describe different ocean exploration technology

**Materials (for each group)**

2-liter bottle,

Nail or Tack

Electrical Tape, Scissors

Ocean Zones How Deep Can They Go? Requires web access <http://seawifs.gsfc.nasa.gov/OCEAN_PLANET/HTML/oceanography_how_deep.html>

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

**Making Connections**

This lesson will discuss the different zones of the ocean and how pressure increases with depth. Special equipment is necessary to study and observe life in each of the ocean zones. Students will be learning more about this equipment in this exploration and later on in the unit. The relationship between pressure and depth as well as other factors that change with depth are discussed in the accompanying power point “Things are different under water”. It can be shown for class discussion the day before or the day of this activity. Prior to this lesson (or after, depending on time), show *Blue Planet: Deep Ocean*. It will really get students excited to learn about the deep.

**Teacher Prep for Activity**

**This can be done by students. On the student sheet, instructions are included.**

1. Poke 1 or 2 holes in top and bottom bottle with a nail or tack, space them about 3 inches apart (holes should align vertically on both bottles)

2. Put tape over the holes using **electrical tape** and fill with water

3. Put the cap back on

4. Check for leaks and set aside

5. Go to http://oceanexplorer.noaa.gov/technology/technology.html

6. Have students look at the site in advance for homework.

 (They should complete Ocean Zones Fill in: Submersibles; Alvin, SCUBA divers, etc. to get a range of depths)

**Background**

The part 2 activity will represent how atmospheric pressure exerts a force on water. The pressure increases as you dive deeper in the ocean. Water pressure is greatest at the bottom of the ocean and this is one of the reasons that humans cannot tolerate diving in deep water. Not only is the water overhead exerting intense pressure, but the temperature and light availability decreases to levels that humans cannot tolerate (this information was covered in the power point notes “Things are different under water”). Some animals can tolerate these harsh conditions but humans need special equipment to dive to those depths. Ask your students why humans cannot live under water. Many are under the misguided impression that the only limiting factor is lack of breathable air. This was addressed in the power point notes “Things are different under water”. When scientist want to study the animals that live at such great depths they have to use specialized equipment that can tolerate the intense pressure, low temperature and low light levels (animal adaptations at depth was covered in *Blue Planet: Deep Ocean*). Each type of equipment has a unique depth that can tolerate the crushing pressure of the deep ocean. For example a SCUBA diver can go down about 165 feet (with proper training), the Alvin (a deep sea submersible) can take 3 people down to 13,000 feet (2.4 miles), and **ROV**s (stands for Remote Operated Vehicle, no people inside, it is remotely operated by people on land) can go down the deepest to about 35,000 feet, that is about 6.6 miles! **SCUBA** stands for Self Contained Breathing Apparatus it allows people to stay underwater for longer than breath holding techniques used in free-diving or snorkeling by breathing air from an oxygen tank attached to a vest on the back of the diver.

The open sea can be divided into 3 major zones, the **euphotic, bathyal**, and **abyssal** zones. The **euphotic** zone is from the surface of the ocean down 200 meters. This zone is also sometimes called the sunlight zone because there is enough sunlight to have photosynthesis. This zone has the highest levels of sunlight, photosynthesis, and dissolved oxygen. Many large predatory fish live here. The euphotic zone has the lowest amount of nutrients for all of the ocean zones. This can be mitigated by upwellings, cold water from lower zones that flow to the surface. Since the lower levels have more nutrients, upwellings provide a source of nutrients for organisms in the euphotic zone. In between the euphotic and the bathyal zone is the twilight zone, an area that still receives some sunlight, but not enough for plants to grow. The **bathyal** zone (aka midnight) is the middle zone that has no light. Many zooplankton and smaller fish live here. The abyssal zone is pitch black, extremely cold and intense pressure. The deepest zone, the **abyssal** zone, begins at about 1500 meters and continues to the ocean floor. Sunlight does not penetrate this far into the ocean, although there are many more nutrients here than in the euphotic zone. These nutrients often consist of debris and waste that floats down from the upper layers of the ocean. Because the abyssal zone is very difficult to reach for humans, many of the organisms that dwell here are unknown. The organisms that we do know of are unique in their adaptations to the lack of light and other conditions characteristic of this mysterious environment.

**Vocabulary**

**Abyssal** is the deepest zone with no light penetration, animals at this depth are very unique (1500 meters to ocean floor)

**Bathyal** is the zone (aka midnight) in the middle that has no light. Many zooplankton and smaller fish live here (200-1500 meters)

**Euphothic** is the zone that exposed to sunlight, therefore photosynthesis can occur (0- 200 meters)

**Light penetration** is the amount of sunlight that penetrates into the water column

**Pressure** is the force per unit area applied to an object

**ROV** Remote Operated Vehicle, they are underwater robots that are operated by people on a boat

**SCUBA** Self Contained Underwater Breathing Apparatus is a method of swimming underwater with an air tank allowing humans to breath underwater and stay down longer than free diving

**Submarine** is a type of watercraft that can stay underwater for long periods of time (6 months) with people inside

**Temperature** a physical property that indicates how hot or cold something is.

**Procedure**

Talk with the class about pressure and swimming in the ocean (15-20 minutes). Has anyone gone diving in the ocean? Ask the students if they have ever felt their ears pop when they drive up a mountain, or when they dive deep when they are swimming. That feeling indicates a change in pressure!

**Part 1 Can be done as a teacher demo**

I used blue food coloring to dye the water in the bottle so they would see it better when it shoots out of the holes

1. Show the prepared bottle to the class and ask the class to predict what they think will happen when you pull the top/ bottom tape off? Where will the water pressure be greatest? How do you know? How might you find out?

2. Go outside (or over the sink)

3. Have the class estimate which hole will squirt water the farthest.

If you are demoing this, at first the water will dribble out, you must loosen the cap on the bottle to get it to shoot out. Have students try to reach this conclusion at first. Discuss the change in pressure from when the cap is tight to when it is loose.

*Consider structuring the activity so that the whole class removes the tape at the same time. Ask them if the results were what they expected. Most likely, it won’t be because the water will just dribble out of the holes. After they write their first set of observations, instruct them to experiment with the bottles to figure out why the results were not what they expected. After some trial and error, they should reach the conclusion that loosening the cap on the bottle releases pressure forcing the water to shoot out the lower hole farther than the higher hole, thus illustrating greater force at depth.*

*Finally, they must be able to answer the questions:* Where was water pressure greatest and why? How do you know? What does this experiment teach us about water pressure at different depths?

**Part 2 Can be done as homework**

1. Review with the students the diagrams of the “ocean zones” (attached) Point out the zones and briefly discuss what they have learned so far if desired.

2. Open the computer link to “how deep”. From their homework last night, students should be able to tell you what they found out about the different equipment’s strengths and limitations at different depths.

**Assessments**

Class discussion of results after the experiment.

Drawing activity (optional can be homework) have the students draw and describe the different ocean zones.

**Resources**

* Ballard, Robert D. Adventures in Ocean Exploration. National Geographic Society Washington D.C. 2001. (Great information and pictures, this is the written by the man that discovered the sunken titanic using Remote Operated Vehicles)
* Finch, Jenny and Fran Baines. Ocean Atlas- An amazing ocean adventure. DK Publishing New York 2007. (Interactive disc included, great ocean depth pictures and diagrams)
* Silvani, Harold. Off the wall science Grades 3-9 Activities Integrating Mathematics and Science (AIMS) Education Foundation Fresno, CA 1995. (Similar lesson using water bottle to experiment with pressure)
* Interactive chart of diving depths: (can be used to have students select a specific type of equipment to describe)

<http://seawifs.gsfc.nasa.gov/OCEAN_PLANET/HTML/oceanography_how_deep.html>

* Ocean Zones Chart with animals: <http://library.thinkquest.org/04oct/01590/intro/ocean.jpg>
* Pictures and description of a variety of ROVs used by NOAA (can be used to have students select a specific type of equipment to describe)

 http://oceanexplorer.noaa.gov/technology/subs/rov/rov.html

**Extension Activities**

Have them make their own water bottle towers in small groups (add 15 minutes to the lesson) and measure how far each water spout goes. What groups went the farthest? What method were they using? How tall was it?

 Show video that explains how pressure effects animals, humans, and items that go deep. Such as a Bill Nye the Science Guy Ocean Exploration Video that can be rented at most public libraries.

Have the class make their own ROV and participate in a ROV challenge. See link for Hilo competition information and contacts (This is a large commitment – maybe a month of extra time outside of class to work on, maybe a good project for robotics teams at your school).

*See unit 3 Building a working Model ROV* http://www.marinetech.org/rov\_competition/regional\_contests/regional\_contest.php?rov\_competion