Engineering & Robotics: Building a Simple Submarine

Legacy SeaPerch Resource www.seaperch.org

Grade Level: 7th – 12th grade

Length of Lesson: 45 minutes

Goals:

- Construct a model of a submarine's ballast system
- Develop an understanding of an active ballast system
- Develop skills to devise a ballast system for a SeaPerch ROV

National Science Standards:

- PS2.A: Forces and Motion
- PS3.C: Relationship Between Energy and Force
- ETS1.A: Defining and Delimiting an Engineering Problem

Materials:

- 24 inches of flexible tubing with a 3/8 inch outside diameter
- 16 oz. plastic soda or water bottle with cap
- Approximately 8 oz. of ballast weight
- Electrical tape
- 3/8 inch drill bit and drill
- 5 gallon bucket filled with water

Background

A submarine controls its ballast by allowing water to fill ballast tanks located around the ship. To make a submarine submerge, vent valves at the top of the ballast tanks open, allowing air to escape and water to fill the tanks through holes in the bottom. To make a submarine surface - the vent valves are shut and high pressure air is released into the tanks forcing the water out through the holes in the bottom.

Lesson: LAUNCH

1. Drill a 3/8 inch hole in the bottle cap and the bottom of the bottle.
2. Tape the ballast weight to the bottom of the bottle.
3. Place the flexible tubing in the hole in the cap and insert it about 1 inch.
4. Tape the tubing in place.
5. Screw the cap onto the top of the bottle.

Lesson: INVESTIGATE

1. Place the bottle in the 5-gallon bucket and make sure your thumb is over the other end of the tubing.
2. Now remove your thumb and watch as the bottle fills with water. You should feel air rushing out of the tubing.
3. When the bottle has sunk to the bottom, blow into the tubing and watch the bottle come back to the surface.

Lesson: PRACTICE

1. Have students analyze the experiment and answer the following questions:
2. What did you observe?
3. Why do you have to place your thumb over the end of the plastic tubing to keep the bottle afloat?
4. How would you be able to put an active ballast system on your ROV?
5. What would be the advantages and disadvantages to an active ballast system?

References:

NPS Physics: How Does a Submarine Sink and Rise? Soda Bottle Diver / Cartesian Diver - https://www.youtube.com/watch?v=tEgIh7dt1C4

Fun Science Demos: Exploring Air & Air Pressure: https://www.youtube.com/watch?v=Grziaq-caVE

Naval Submarine Ballast Tanks: https://www.youtube.com/watch?v=OvI4bFAiwZY