Determination of Mass, Volume, & Ballast of a SeaPerch

Grade Level: 7th-12th

Length of Lesson: 45 minutes

Goals:
- Students will learn to determine the mass of an object
- Students will learn to determine the volume of an irregularly-shaped object.
- Students will learn to calculate the density of an irregularly-shaped object.
- Students will use these skills on their SeaPerch ROVs in order to determine the amount of ballast they need to add.

National Science Standards:
- PS1.A: Structure and Properties of Matter
- PS2.A: Forces and Motion
- PS2.B: Types of Interactions

Materials:
- Pool float (found in SeaPerch kit)
- String to attach ballast to the floats
- Scale (must weigh in fractions of an ounce)
- One-pound coffee can
- Electrical tape
- Measuring tape or ruler (accurate to 1/16 inch)
- Ballast (metal washers work well)

Background:
Buoyancy is an upward force exerted on an object by the fluid it is surrounded by. How buoyant an object is, is determined by the weight of fluid an object displaces. To determine how buoyant an object is, you need to know the density of the fluid it will be surrounded by. With this information and the known volume of the object, you can determine the buoyant force exerted on the object.

Lesson: LAUNCH
The buoyant force is the force that an ROV would have to supply to submerge itself. A ROV needs to be slightly buoyant so that it will return to the surface if it loses power, but if it is too buoyant, it will take more

energy to submerge it or it may not submerge at all. To adjust the buoyancy of a ROV weight known as ballast needs to be added.

To calculate the ballast needed to make your ROV neutrally buoyant, you need to know the density of the fluid your ROV is submerged in, the density of the ballast weights, as well as the volume and weight of the ROV. Remember that the densities of your weights must be greater than the density of your fluid. Otherwise they just add more buoyant force to the craft. This is why you use lead or steel instead of foam, because lead and steel are denser than water and foam is less dense that water.

Lesson: INVESTIGATE

1. Weigh the pool float and write the weight down.
2. Measure your coffee can diameter and write it down
3. Place ruler or measuring tape into coffee can and tape it to the side with electrical tape
4. Fill coffee can half way up with water
5. Make sure that the ruler is at least partially submerged and write down the height of water
6. Place pool float into coffee can and submerge. You will have to push the float below the water; take care not to submerge your finger too as this will affect your volume calculation. Write down the height of water with the float submerged
7. Subtract the first measurement from the last measurement and use this as your height to calculate the volume of water displaced. This is the volume of your pool float.

Remember: Volume for a cylinder is: $\mathbf{V = Pi * r^2 * H}$

8. Calculate the density of the float by dividing the weight of the float by the volume of the float
9. Determine the density of the ballast you are going to use.
10. Start adding ballast to the float until it just submerges.
11. Weigh the ballast and see how much it took to make the float neutrally buoyant.

Lesson: PRACTICE

Reproduce the following questions and have the students answer them for practice:

1. Calculate the density of a 4-inch piece of PVC plastic used in the SeaPerch frame. Will it float?

2. What happens if you place tape over the ends of the 4 inch PVC piece so water can’t flood the inside?

3. Using the principles of what you just learned, devise an experiment to determine the displacement of a SeaPerch using a 5 gallon bucket.

Copyright ©2017 SeaPerch.org