Physics 202 Lab 2
Archimedes' Principle

Apr 15, 2013

Equipment

- Force sensors
- Cork rafts
- Vernier calipers
- Thread
- Scissors
- 12" rulers
- Beakers (600 mL)
- Pennies
- Cork stoppers
- Rubber stoppers (#10-0)
- Raquetballs
- Superballs

Buoyant Force

Measure Buoyant Force Directly

Zero the force sensor by holding it vertically, and pressing the "tare" button with nothing suspended from the hook. This calibrates the internal voltage of the sensor to zero force.

Now tie a string around the rubber stopper, and suspend it from the force sensor to measure its weight. This works because the force sensor measures the force required to counter-balance the weight of the stopper. Record this weight reading. With the rubber stopper still suspended from the force sensor, submerge the stopper completely in a beaker of water (make sure that the force sensor doesn't get wet). Record the new reading of the force sensor.

Using a free body diagram in Figure 1, show all forces acting on the submerged stopper including the buoyant force present.

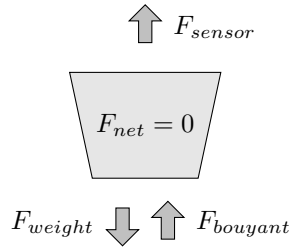

Figure 1: Forces on Floating Stopper

Calculate Buoyant Force

The formula for the volume of the stopper is:

$$V = \tfrac{1}{3}\pi(r_1^2 + r_1 r_2 + r_2^2)h$$

Now calculate the volume of the rubber stopper. Calculate the mass and weight of the displaced water (recall that the density of water is 1000 kg/m^3 and density = mass/volume).

Archimedes' Principle states that the buoyant force is equal to the weight of the displaced water. Verify this by calculating the percent difference between the two.

Floating

Calculate the volume of a racquetball. Calculate the mass of water that would be displaced by the entire racquetball. Compare the weight of the racquetball to the weight of the water it can displace. According to Archimedes, will it float? Test your result.

Using Archimedes' principle, determine the percentage of the racquetball that will be under water as it floats. Test your result visually.

Whatever Floats Your Boat

Initial Raft Measurements

Soak the cork raft until it is saturated with water. We want the raft to be wet for any measurements, since it will be wet when it is floating. Calculate the volume of the wet raft. Measure the mass of the wet raft. Calculate the weight of the wet raft.

Calculate Maximum Load

Similar to the previous calculation, calculate the buoyant force if it were entirely submerged. Use this value to determine the maximum number of pennies that you could stack on top of the raft without sinking it.

Determine the average mass of a penny by measuring the mass of 10 and dividing by 10. How much buoyant force is available to support the pennies? How many pennies can the raft support? Round your calculation down to the nearest penny.

Test Maximum Load

When you are certain of your calculation, place that number of pennies on the raft, verifying that it does not sink. Then verify that placing one more penny on the raft does indeed sink it. Describe your results.