

Several times we have referred to the buoyant force as the “weight of the fluid displaced by the object”. Today we are going to demonstrate that.

We have an object hanging by a string attached to a force sensor. Before we lower the object into water in a beaker, you can see the force measured by the force sensor, the force of tension in the string, is equal in magnitude to the force of gravity, or weight, of the object.

Free body diagram of all the forces acting on the object: initial tension force is up; force of gravity is down.

$$\sum F_y = F_{T_i} - F_g = m_o a_y = m_o (0) = 0 \Rightarrow F_{T_i} = F_g$$

When we lower the object into the water, the upward buoyant force is added to the free body diagram and the tension force is now the final tension force.

$$\sum F_y = F_{T_f} + F_B - F_g = m_o a_y = m_o (0) = 0 \Rightarrow F_{T_f} = F_g - F_B$$

And we can solve for the change in the tension force:

$$\Delta F_T = F_{T_f} - F_{T_i} = (F_g - F_B) - F_g = -F_B$$

The change in the tension force equals the negative of the buoyant force.

Therefore, if we zero the force sensor before we lower the object into the water, and then lower the object into the water, we have now measured the buoyant force acting on the object.

Now, instead of using a beaker full of water, we are going to use a measuring cup with a spout for pouring out the water. And, before we lower the object into the water, we are going to fill the measuring cup to above the spout and allow enough time for the excess water to flow out of the measuring cup.

And we are going to place the beaker under the spout of the measuring cup to collect all the water which leaves the measuring cup as we lower the object into the water in the beaker. All the water in the beaker will then be the water displaced by the object. And we are going to place the beaker on a force sensor to measure the weight of the water displaced by the object. When we zero the force sensor under the beaker and then lower the object into the water, you can see that the buoyant force acting on the object is equal in magnitude to the weight of the fluid displaced by the object. The physics works!!

