LAB 23: UNBALANCED FORCES

QUESTION

What happens to an object that has unbalanced forces acting on it?

SAFETY

Be careful with scissors.

MATERIALS

Transparency sheet with boat drawings, liquid soap, large container of water (such as your materials box), scissors

PROCEDURE

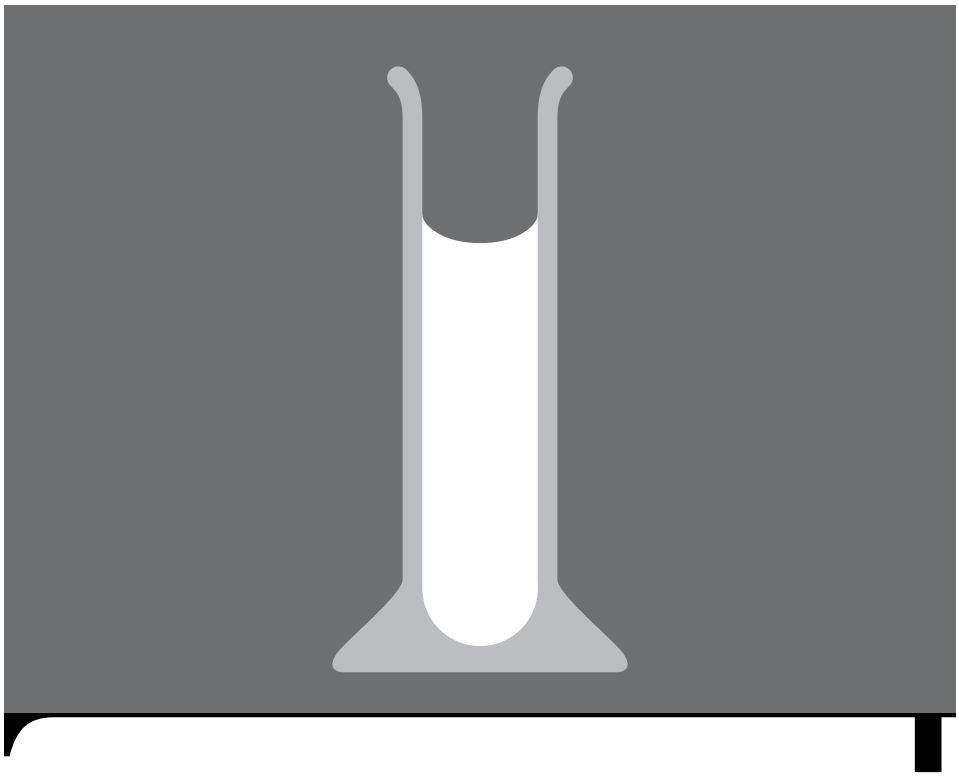
To get an object to move, there must be an imbalance in the forces acting on it. For example, if one person pushes a car forward with a force of 100 N and another person pushes it backward with a force of 100 N, it won't move. But if both people push the car forward each with a force of 100 N, then it will move. Physics also tells us that if the force is not acting through the center of mass, then a torque is applied and the object may rotate.

In this lab, you will be using surface tension to create uneven forces to move a small plastic boat. Water has a property called *surface tension* (technically, it's called *cohesion* if it's pulling other water molecules, or *adhesion* if it's pulling other nonwater molecules). Surface tension is the name of the force created by water sticking to other water molecules and other substances. It is the reason that water's surface is curved in a thin cylinder (called a *meniscus*) as in Figure 23.1, page 96. It pulls on everything that is put into the water.

Soap has the ability to break surface tension, and it will be used to create the uneven forces on the boat.

Figure 23.1

Water in a Thin Cylinder



1. Fill a large container with tap water and let it sit until it is motionless.
2. Cut out the three boats.
3. You will be putting a drop of dishwashing liquid or liquid soap in the center of each boat. This will break up the surface tension in the rear of the boat. Draw a free-body diagram* and a sketch of what you think the motion of each of the boats will be. Some forces that you should include are weight, buoyancy, and surface tension.
4. Now put the first boat in the middle of the bowl of water. Dip a small straw in the liquid soap and put a drop of soap in the hole in the middle of the boat.
5. Completely rinse all of the soapy water out of the bowl and repeat Step 4 for the second and third boats.
6. Draw a diagram of the motion of the boats.

*A free-body diagram is a diagram of the object with arrows representing all the forces on it. The longer the arrow, the larger the force. The direction of the arrow points in the direction of the force.

Post-Lab Questions

1. Why does the boat not move when you first put it in the water? Why does it move after you add the soap?
2. Did the location of the ridge coming out of the back of the boat have an effect on the motion of the boat?
3. Do you think this could work with a small boat in a lake? Explain your answer.

Extensions

There is a classic demonstration involving surface tension that is easy to perform and now should be easy to explain. Get a bowl of water and sprinkle some black pepper on the surface. Put a single drop of dishwashing liquid in the center of the bowl and observe. Can you explain this behavior?

There are bugs that use surface tension to walk on water. Some of them use chemicals to propel themselves through the water by breaking up the surface tension behind them. Use the internet to research these creatures and try to find video of the process.