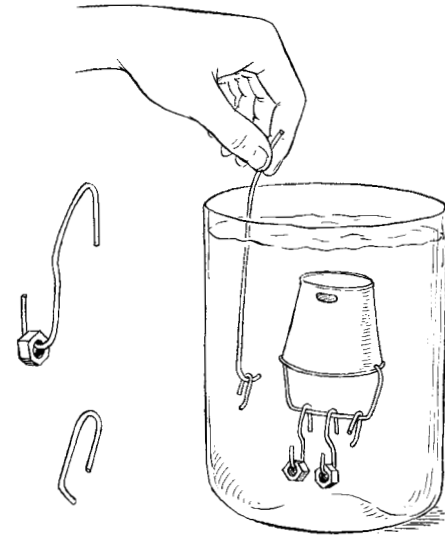**NOVA**

Build Your Own Submarine

A submarine is not just a silent shape gliding smoothly along under the sea. The submarine's crew is constantly making adjustments to keep it from bobbing to the surface or sinking below its safe depth. Here's an activity that lets you be the submarine captain.

Procedure

1 Your teacher will demonstrate how to make your submarine. Use markers to name your submarine.
2 Fill your soda bottle "diving tank" to within a half-inch (12.7 mm) of the top and stir in a few drops of dishwashing liquid. Use the plastic cup and paper clip to make your submarine. Place your submarine bottom-side up in the tank where it will float like an actual submarine floats on the surface.
3 Sink the submarine by pushing lightly with your finger. What happens when you release it?

4 Carefully add ballast by hanging pieces of paper-clip wire and metal washers to the paper clip hanging from your submarine until it starts to dive. What happens to the submarine as you add more ballast?
5 Now for the challenging part. Can you make your submarine behave like a real submarine? Can you get the ballast just right so that it is neutrally buoyant, that is, its weight is equal to the water's buoyant force? You'll know you have succeeded if your submarine goes neither up nor down—it stays at the depth it is at.

Questions

Write your answers on a separate sheet of paper.

1 You are piloting a new research submarine among stony towers rising from the center of the Mid-Pacific Rise. Your guest scientist points to a two-meter-tall tower and asks if you can break it off to take back to the surface. Although the mechanical arm can do that, and you have a forward sample basket big enough to hold the piece, you are doubtful for two reasons. What are they?

2 On the forward surface of your submarine are six large floodlight bulbs. These bulbs are like regular light bulbs, except for their large size. Imagine that something bumps the floodlight rack, breaking the bulbs. How will this affect your submarine? What will you have to do?