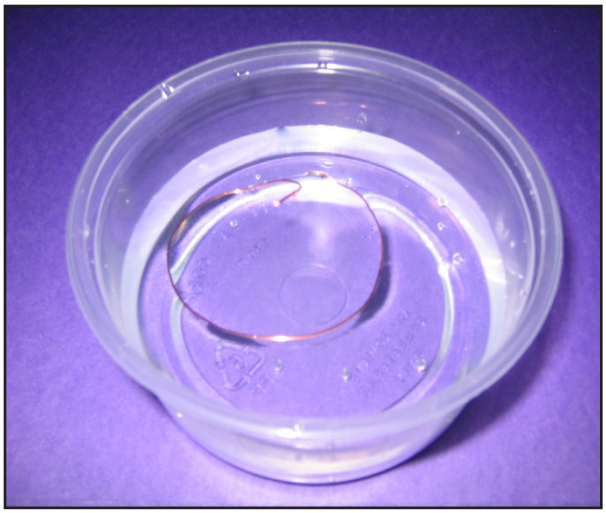
"Cu" at the Bottom: Floaters and Sinkers

Find out why some copper (Cu) wires float while others sink.



Materials

- clear plastic container
- water
- various gauge copper wire, each piece about 6″ long
  (For very thin wire, look for wire used in jewelry making, about 26 gauge.)
- liquid dish soap

To Do and Notice

1. Fill a plastic container or bowl with tap water.

2. Bend one end of each wire up to make a handle, then form the rest of the wire into a loop.

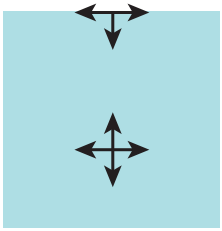
3. Start with the thickest copper wire and try to float it on the surface of the water, much like a water strider floats on the surface of a pond. Slowly lower the wire flat against the surface without touching the water with your fingertips.

4. Try this with each gauge copper wire until you reach one that's thin enough to float.

5. Once you have the wire floating on the surface of the water, put a drop of dish soap in the water. What happens?

What's Going On?

A lightweight wire floats on the surface of the water because of surface tension, a property of liquids that makes the surface behave as if it's an elastic skin. Surface tension results from attractions among the molecules of a liquid. A molecule beneath the surface is attracted equally by molecules in all directions, but molecules on the surface are attracted only by molecules beside them and beneath them. This net downward pull causes the surface to contract as if it's an elastic skin that's been tightened.



The surface tension of water is greater than that of other familiar liquids because water molecules have strong electrical attractions for each other. The oxygen part of an H_2O molecule has a negative charge, while the hydrogen ends have a positive charge. This uneven distribution of charge makes water electrically polar. Because they're polar, water molecules tend to arrange themselves so that a positive end of one is next to the negative end of another. This attraction among polar water molecules makes water extremely cohesive, or "sticky," which accounts for its high degree of surface tension.

At different size scales, different forces dominate. In the case of a thin wire that floats, the force pushing up on the wire due to surface tension is equal to the force due to gravity pulling down on the wire. If a thicker wire sinks, the force due to gravity is greater than the force due to surface tension.

If you increase the diameter of a wire—let's say that you double it—you're actually increasing both the width and height of the wire, which results in a fourfold increase in the wire's volume. The force of gravity is proportional to the volume of the wire, while surface tension is a force per unit length, so even a small increase in the diameter of a wire can help gravity gain the upper hand.

When you put liquid dish soap into water, it disrupts the order of the water molecules and weakens the intermolecular forces. Now the surface tension isn't strong enough to support even the weight of a thin wire.

Going Further

Clean your container and refill it with water. Sprinkle pepper on the surface of the water, then put a drop of dish soap into the center of the bowl. What happens to the pepper?

What's the Nanoscale Connection?

If you had a wire with a diameter of a few nanometers, it would have very little volume compared to its surface area. Because of its tiny volume, gravity would be unimportant. Surface tension, on the other hand, is a dominant force at the nanoscale.

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