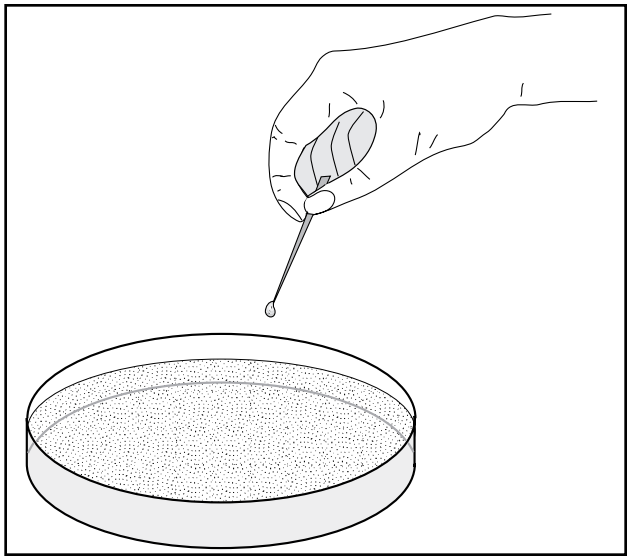
Activity 9

SURFACE TENSION



OBJECTIVE:

To study surface tension and the fluid flows caused by differences in surface tension.

BACKGROUND:

The spherical shape of liquid drops is a result of surface tension. Molecules on the surface of a liquid are attracted to their neighbors in such a way as to cause the surface to behave like an elastic membrane. This can be seen in drops of rain, drops of oil, dewdrops, and water beading on a well-waxed car.

Beneath the surface of a liquid, molecules are attracted to each other from all directions. Because of this attraction, molecules have no tendency to be pulled in any preferred direction. However, a molecule on the surface of a liquid is pulled to each side and inward by neighboring molecules. This causes the surface to adjust to the smallest area possible, a sphere. Surface tension is what allows objects such as needles, razor blades, water bugs, and pepper to float on the surface of liquids.

The addition of a surfactant, such as liquid soap, to a liquid weakens, or reduces, the surface tension. Water molecules do not bond as strongly with soap molecules as they do with themselves. Therefore, the bonding force that enables the molecules to behave like an elastic membrane is weaker.

In a microgravity environment, buoyancy-driven fluid flows and sedimentation are greatly reduced. When this happens, surface tension can become a dominant force. Furthermore, microgravity makes it easier to study surface tension-driven flows then to study them in a normal gravity environment. An analogy to this process would be like trying to listen to a flutist (the surface tension-driven fluid flows) during a thunderstorm (the buoyancy-driven convection).

PROCEDURE:

Step 1. Fill the beaker, jar, or glass with water.

Step 2. Sprinkle some pepper on the water surface. Observe what happens to the pepper.

Step 3. Stir the water vigorously. Observe what happens to the pepper.

Step 4. Add new water to the container and mix in a few drops of liquid soap. Carefully stir the water to dissolve the detergent but try not to create any bubbles.

MATERIALS NEEDED: *
Beaker, clear jar, or drinking glass
Shallow dish or petri dish
Stirring rod
Water
Black pepper
Clear liquid soap
Toothpick
*per group of students

Step 5. Sprinkle pepper on the water surface. Observe what happens to the pepper.

Step 6. Fill the shallow dish or petri dish with water.

Step 7. Sprinkle some pepper on the surface. Observe any movement of the pepper on the surface.

Step 8. Touch one end of the toothpick into a drop of liquid soap to pick up a small amount of the soap. Carefully touch the end of the toothpick to the surface of the water in the center of the dish. Be careful not to disturb the water. Observe any movement.

Step 9 (optional) Steps 6-8 can be demonstrated to the entire class by placing the dish on the stage of an overhead projector.

QUESTIONS:

1. Why did the pepper float on the water?
2. Why did the pepper sink when the water was stirred?
3. Does the amount of liquid soap affect the results of the experiment? Is more or less detergent better?
4. How does liquid soap enable us to wash dishes?

FOR FURTHER RESEARCH:

1. Make a surface tension-propelled paper boat by cutting a small piece of paper in the shape shown below and floating it on clean water. Touch a small amount of liquid soap to the water in the hole at the back of the boat.
2. Design an experiment to test whether the temperature of a liquid has any effect on surface tension.
3. Try floating needles on water and observe what happens when liquid soap is added.

Surface Tension Paper Boat*
(actual size)

*Note: Make sure that there is a small opening between the notch and the hole.