OBJECTIVES

1. Develop an understanding of water molecules and surface tension
2. Demonstrate principles of surface tension and effects of detergent

BACKGROUND INFORMATION

Surface tension is the property of liquid that allows its surface to act like an elastic sheet. The cohesive forces between liquid molecules are responsible for this phenomenon. Examples of water tension include water droplets seen forming on leaves; and the ability for some insects to “walk on water”. The force of surface tension draws water into pores of the soil and conducts water through plants.

Surface tension is caused by the attraction between the liquid's molecules by various intermolecular forces. At the surface of water the molecules are not completely surrounded and therefore they cohere more strongly to those associated with them on the surface. This forms a surface “film” which is more difficult for an object to move through in comparison to if it was completely submerged. Diagram 1 shows that below the surface of the water the cohesive forces between molecules are shared as molecules are pulled equally in all directions. At the surface with no neighbouring atoms above, they exhibit a stronger force toward adjacent molecules.

Surface tension can be decreased by a rise in water temperature and/or with the addition of detergents. Detergents are able to reduce water tension in the following way. Soap and detergent molecules are composed of long chains of carbon and hydrogen atoms. At one end of the chain is an arrangement of hydrophilic (water loving) atoms and at the other end of the chain are hydrophobic (water hating) molecules. The hydrophobic atoms cause the soap molecules to find their way to the surface and squeeze between the surface water molecules, pushing their hydrophobic ends out of the water and separating the water molecules from one another.

In part 1 of this experiment we use detergent to decrease the water surface tension to allow movement along the surface of the water to occur more easily. In part 2 we see how a small drop of detergent can dramatically affect the surface tension of the water.

WHAT YOU NEED

- A large bowl
- ~5mL liquid detergent
- Water
- Bread tag
- Pepper

WHAT TO DO

Part 1- Speed boat

1. Fill the bowl half way with water
2. Place the bread tag into the water and add a small drop of detergent into the hole in the bread tag. Observe what happens.
Part 2- Pepper panic

1. Rinse the bowl out to remove any traces of detergent.
2. Fill the bowl again to about half way.
3. Sprinkle pepper into the bowl.
4. Poke your finger into the bowl of water and observe what happens.
5. Now put some liquid detergent on your finger (you only need a drop) and put your finger in the middle of the bowl. Observe what happens.

QUESTIONS

1. What happened to the bread tag when you added detergent? *They bread tag moved across the water.*
2. Can you explain what happened? *The detergent decreased the surface tension of the water enabling the tag to move more freely along the surface.*
3. In part 2 what happened when you put your finger in the bowl of pepper? *Nothing.*
4. What happened when you dipped your finger in detergent then placed it in the bowl of pepper? *The pepper scattered.*
5. Can you explain how detergent can decrease water tension? *Soap molecules are long chains with hydrophilic atoms at one end and hydrophobic atoms at the other. The hydrophobic atoms try to escape the water molecules and push their heads to the surface of the water. This forces the tightly meshed water molecules to separate thereby reducing the surface tension.*

REAL WORLD APPLICATIONS OF SURFACE TENSION

**Clinical tests for jaundice:** Normal urine has a surface tension of about 66dynes/cm (a measure of surface tension, water is 72dynes/cm at 25°C) but if bile is present (a test for jaundice) it drops to about 55. In this test sulfur is sprinkled on the urine surface if it floats the test is negative but if it sinks it is positive.

**Washing with hot water:** The reason hot water is more effective when washing clothes and dishes is that the surface tension is lowered and it becomes a better wetting agent. Detergent also lowers the surface tension.

CURRICULUM CONCEPTS ADDRESSED

**Essential Learnings: Natural and processed materials**

By the end of year 5
- Properties of materials are affected by processes of change.

By the end of year 7
- Physical change produces no new substances.

By the end of year 9
- Changes in physical properties of substances can be explained using the particle model.

RESOURCES USED TO DEVELOP THIS ACTIVITY