Dynamic Design: The Cleanroom

Washing Dishes

TEACHER GUIDE

BACKGROUND INFORMATION

The contamination control group at Johnson Space Center in Houston, Texas has developed a way to wash tools and parts that were used in the assembly of the collector array. On the wash table, ultra pure water is poured into two tubs. One tub has two or three drops of liquid detergent and the second contains just rinse water. The liquid detergent is used to break the surface tension of the contamination on the object being washed. In the student activity *Washing Dishes,* students will go through a series of steps in which they will test and observe how detergent breaks up contamination in a guided inquiry. Following this they will complete an open inquiry in which they ask questions about variables in washing dishes and design and conduct a test to answer these questions.

Near the surface of water, molecules are engaged in a tug of war with their neighbors on every side. The molecules are pulled from every direction resulting in no net force at all. At the surface however, there is no up pull for every down pull since there is no liquid above the surface. The surface molecules therefore tend to be pulled back into the liquid. When you blow a bubble, the surface of the liquid gets stretched. The “stretchy outer skin” of a liquid is called surface tension. If your students have not worked with surface tension, you may want to try some of the short experiences found in the first procedure steps below.

NATIONAL SCIENCE STANDARDS ADDRESSED

Grades 5-8

Science As Inquiry
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Physical Science
- Properties and changes of properties in matter

Science and Technology
- Understandings about science and technology

History and Nature of Science
- Science as a human endeavor

Grades 9-12

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(View a full text of the National Science Education Standards.)

MATERIALS

For teacher demonstration:

- Two latex gloves for each student
- Thermometer
- Several 1000 mL. Pyrex® beakers
- Hot plates
- Hot pad
- Plastic cups

For each group of two students (optional experiences):

- Two pennies (clean of oil and other contaminants)
- Beaker of soapy water
- Beaker of distilled water
- Empty beaker
- Two medicine droppers
- Liquid detergent
- Ivory soap
- Toothpick
- Pepper (packet)
- Forceps

Teaching Tip

Cleaning pennies with rubbing alcohol is an effective way to eliminate dirt and oil. Students should handle pennies with forceps after cleaning to keep them clean.

Alternate Strategy Tip

If you choose to complete procedure #1, you may have students work on the three experiences while you demonstrate the procedure for water temperature. For the water temperature experience, you may want to have several hot plates heating the water so that you can move all groups through this station.

Soapy water can be prepared by filling a beaker with water and adding 2-3 drops of liquid soap. You may want students to do this.

For groups of four students (washing dishes):

- Nine plastic spoons
- Nine clear plastic cups
- Labeling tape
- 100 mL. graduated cylinder
- Peanut butter
- Three stirring sticks
- Student Text, "The Cleaning Room"
- Student Text, "Terrific Tension"
- Student Activity Sheet, "Washing Dishes"

Alternate Strategy Tip

If some students finish early with the three experiences in procedure #1, you may want to provide the following challenge:

Try to float a paper clip in a beaker of water.

Think of something you can do to the paper clip to get it to float. (Rubbing it on your nose or forehead usually works)

Once you get it to float, add a drop of detergent.

- Why did oil from your skin help it to float?
- What happened when you added detergent?

PROCEDURE

The first procedure listed below is an optional experience for students who have not worked with the concepts of temperature and surface tension before. If your students have completed activities similar to these, go directly to procedure #2.

1. Provide students with the Student Activity Sheet, “Washing Dishes”. Have them complete procedures one and two while you demonstrate the following: In the cleanroom at Johnson Space Center (JSC), the scientists wash components using double gloves in water that has a temperature of 65° Celsius. You may want to have your students experience what this temperature would feel like while wearing a double set of gloves. Before class, fill the beaker to about 500 mL. Using the hot plate and thermometer, heat the water to about 65° Celsius. Find the setting that will maintain this temperature. Remove the thermometer and pour this into some plastic cups. Call up the first group and instruct them to put on the double set of gloves on one hand. Students should carefully put their fingers into the cup to feel what it is like when JSC scientists wash the equipment in the cleanroom. Ask students to return to their seats and write what the temperature felt like in their journal. Repeat this with all groups.

   You may want to provide the following background information instead of having the students do the library or Internet research. Surface tension on water makes a strong skin, which is not very elastic. The pepper stays on the water until

soap or detergent touches the surface. Soap and detergent reduce the attractive forces between water molecules - that is, they reduce surface tension. The skin stretches, scattering the pepper. Likewise this reduction in attractive forces in the water molecules means that fewer drops of soapy water could stay on the penny than drops of tap water. But how does this relate to washing dishes?

2. Explain to students that they will now conduct an experiment to determine if the amount of dishwashing detergent will affect how well spoons are cleaned. Provide the materials for the students and allow them to begin. Students will be given a procedure and be asked to identify variables, make a hypothesis, complete observations and draw conclusions. Once students have set up and made some initial observations, provide a place that the experiments can sit overnight so that final observations can be made the next day. If possible you may want to have students make observations for several days while doing other activities. The results vary from day to day. Once you or your students think they have collected enough observations, have them write conclusion and recommendation statements for this experiment.

3. Once students have performed the guided inquiry described in procedure #2, you may want to have them do some investigations on their own. Encourage your students to think of other variables to test. An example may be testing different water temperatures and controlling the amount of detergent. Another example would be to try a different substance instead of peanut butter. Still another example might be to test different brands of detergent or different types of water controlling all other variables. Encourage students to design their own procedure for cleaning a substance. Remind students to make sure they control their variables as they did in their previous experiment.

4. Have the students work in groups to develop a question about cleaning something. Students should then define the variables and controls. Have them design the experiment by writing out a sample procedure. Once the experiment has been designed ask the group to present it to you. Upon teacher approval, ask students to list the materials they will need. If it is possible students may bring in materials from home to complete this experience. The outline that is on the student activity sheet is provided as a guide. You may want students to keep records of the experiment in their journal.

5. Once students have performed the experiment, ask them to plan a way to communicate their experiment to their fellow classmates. Presentation software may be used to enhance this. During the presentations, students should keep track of what was learned from each group both during the experiment and as a result of the experiment.

6. Ask students to read the Student Text, "The Cleaning Room." Ask students to compare and contrast the procedures for washing samples in the cleanroom environment versus what they have done in their experiences.

7. Ask students to read the Student Text, "Terrific Tension."

8. Monitoring contamination is an important part of the operations at the cleanrooms at Johnson Space Center. Once a sample has been cleaned, verification of clean is an important next step. Ask students to think about how this might be done.

Alternate Strategy Tip

If some students finish early with their experiments and presentations, have them read the Student Texts:

- "The Cleaning Room"
- "Terrific Tension"

The first details information about the cleaning procedures used at the cleanroom at NASA's Johnson Space Center. The second gives background information on surface tension.

TEACHER RESOURCES

Surface Tension

http://quest.nasa.gov/space/teachers/mg/9tension.html
Short experiment similar to what is done in Part I

http://www.exploratorium.edu/ronh/bubbles/sticky_water.html
Background information on surface tension.

Barber, Jacqueline. Bubble-ology. Lawrence Hall of Science. Great Explorations in Math and Science (GEMS).

Johnson, Marilyn. Experiencing Chemistry Teacher Resource Guide. (1998) *Bubble Up*. The Oregon Museum of Science and Industry. Portland, Oregon. pp. 129-142.