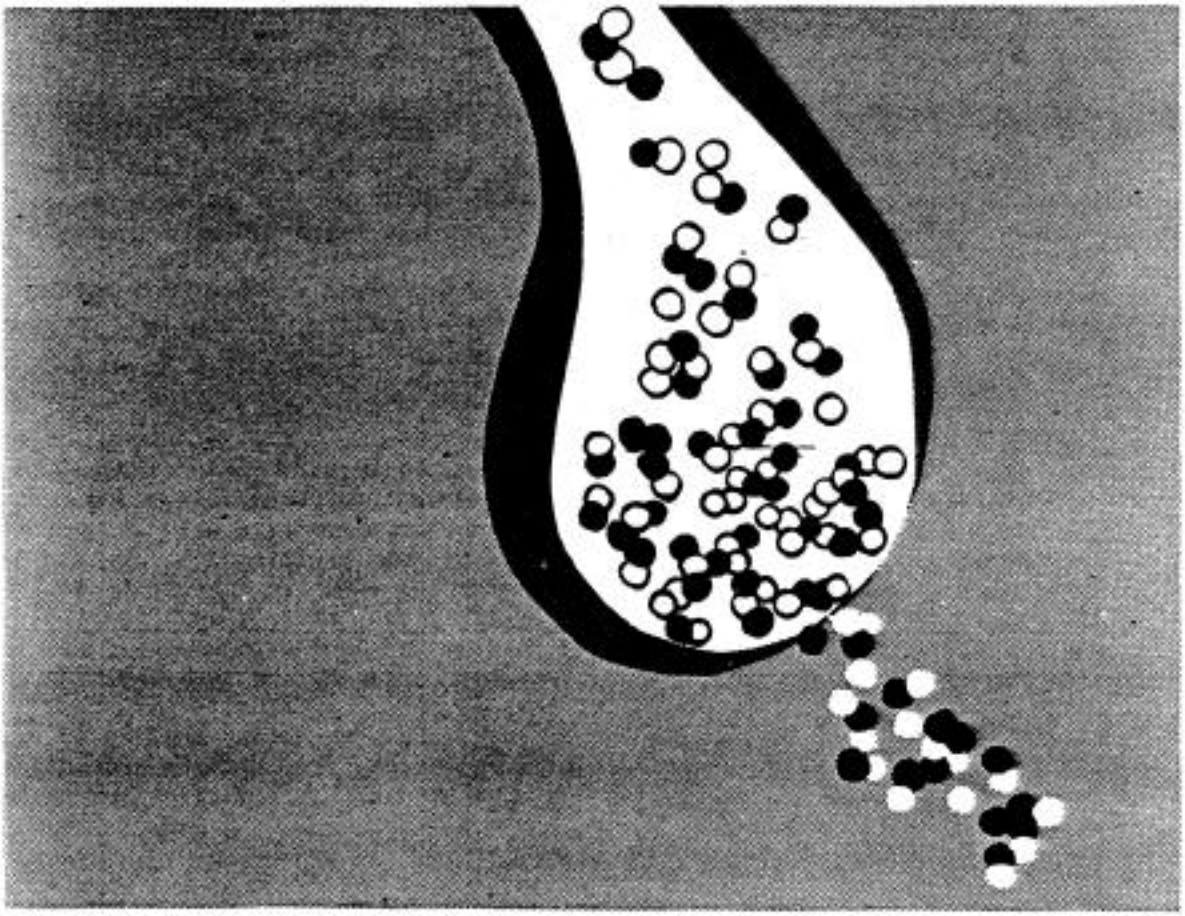
A Teachers Guide for the Videotape
Segment 12

Starts at 23:28:1
Run Time 02:10:(

SOAP AND WATER



NASA
National Aeronautics and Space Administration

FILM FOOTAGE FROM NASA SKYLAB MISSIONS

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I. Introduction

What are the characteristics of a soap and water mixture when they are in a weightless environment? We think of the surface forces of water as very strong, much stronger than the force of gravity. Therefore, it seems that there should be little difference in the behavior of soap and water on earth and in Skylab orbiting around the earth in a "free falling" orbit.

During the 171 days of 1973-74 that astronauts lived in the Skylab, they conducted a number of experiments to exhibit the properties of water and of soap and water. This film shows you some of those experiments.

II. Background Physics

The behavior of soap and water is complex, but for cleaning soap is added to water to reduce the surface tension so that it can wet the surface to be cleaned. At room temperature water has a surface tension measured as about 72 dynes/cm, whereas for a typical soap solution the surface tension is 25 dynes/cm. Soap, though not all detergents, produce electrically negative colloidal ions in solution.

III. Film Synopsis

Scene 1. Single Water Drop. The film opens showing a drop of water, colored red, adhereing to a plastic ring about 5 cm in diameter. Soap is added to the water drop from a syringe. The soap and water mixture is stirred. You will notice that the soap remains in droplets inside of the water drop. Air is then put inside of the soap and water drop from the syringe. The air also forms bubbles inside the soap and water drop and when the mixture is stirred some of the air bubbles coalese to form larger bubbles. As additional air bubbles are added to the soap-and-water drop, the drop expands and finally soap bubbles begin to "boil" out of the drop. They may be seen floating through the Skylab. Near the end of this scene the astronauts withdraws some liquid from the drop using the syringe. He then shoots the liquid against the outside of the large drop. You will notice that some of the liquid goes into the large drop and other liquid droplets bounce off of the external surface of the large drop.

Scene 2. The scene opens with two drops of soap and water on the ends of two aluminum rods, about 3 cm apart and about 0.95 cm (3/8") in diameter. One soap and water drop is colored red. The drops are placed in contact and join to form a bridge between the two rods. Then the two rods are rotated in opposite directions with ever increasing rotational speed. Finally, the rotational motion causes the soap-water bridge to neck down and break.

Scene 3. The rods with separate drops are shaken until the drops join.

Scene 4. The soap-water bridge is oscillated until the bridge breaks.

Scene 5. The soap-water drops are shaken until they join together.

Scene 6. One rod is spun until the soap-water bridge breaks.

Scene 7. The large soap-water drops make repeated hits upon the smaller drop until they join to form a soap-water bridge.

Scene 8. The left rod is rotated until the soap-water bridge breaks.

IV. Discussion and Exercises

1. Take two aluminum rods and construct a soap-water bridge on earth. How long can you make it? How large a diameter can you make it? How do you explain the results of this experiment?

2. Compare the behavior of the soap-water bridges with the plain water bridges shown in the film, Oscillations.* What can you deduce about the surface tension of a soap solution in Skylab?

3. To what physical phenomenon on the earth does the loss of soap drops through the wall of the large water drop (Scene 1) seem similar? What are the similarities? What are the differences?

4. If you were to measure the surface tension of a soap solution on Skylab, would you expect to get the same value as you would measure on the earth? Explain your answer.

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*AAPT Skylab Videotape Segment 9