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Sponge Analysis

We often do not realize that some of the simplest and most mundane objects are touched by engineers and designers long before they come into our everyday lives. Even the ubiquitous chairs we sit upon at work or school are engineered objects. They are ergonomically engineered for comfort as well as durability.

The common household sponge is probably no exception either, yielding to the inquiries of a design engineer at some point in its life cycle. Here it will be the focus of an interesting experiment in absorption. This experiment involves the comparison of sponges and their ability to retain or absorb water.

Gather a variety of commercially available sponges of equal size. Larger sponges may be cut with scissors to achieve uniform sizes. When the sponges are available, two large flat-bottom laboratory dishes and a scale will be needed as shown in Figure 1.

Measuring the Absorptivity of Sponges

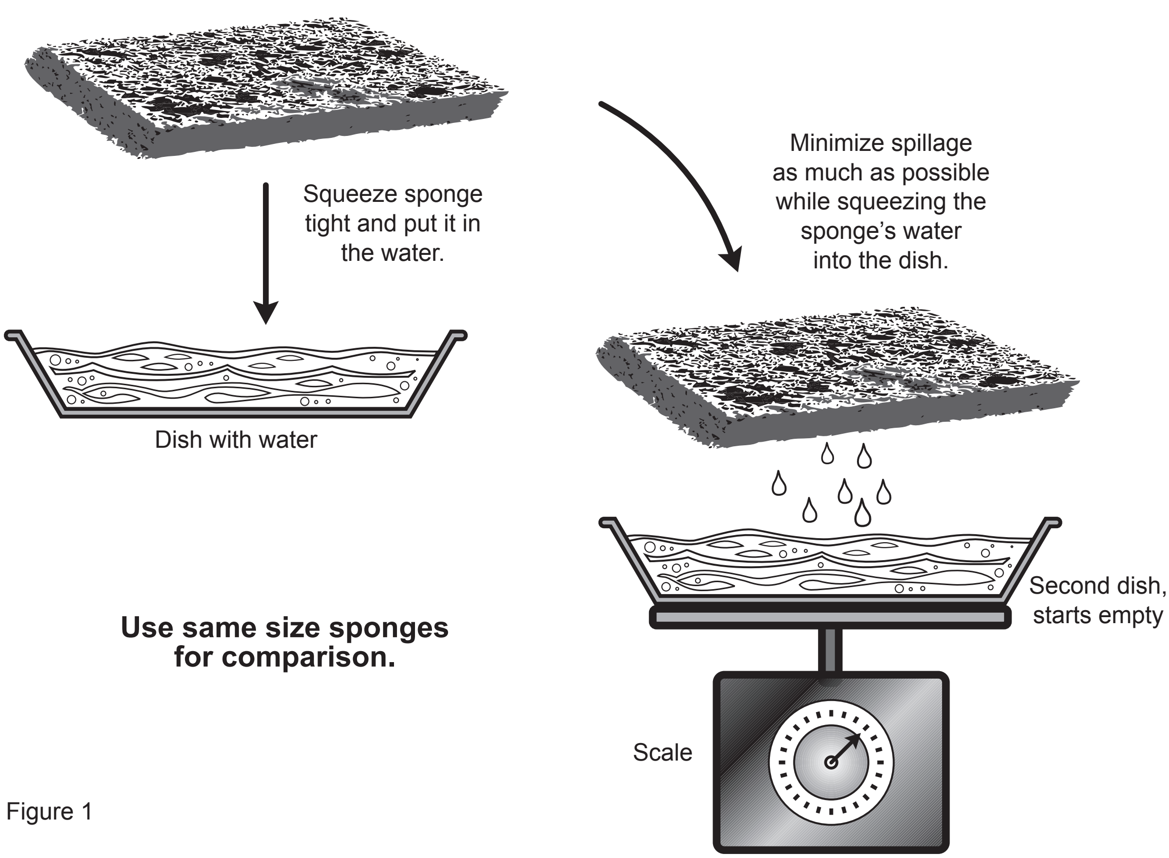

Figure 1

The Homemade Telephone

We all know the old way to make a toy telephone. Using a piece of string and two metal cans, as shown in Figure 6, two kids can transmit their voices along the string while it is kept taut. The acoustic energy in our voices vibrates the bottom of the can, and then that energy travels along the taut string to vibrate the other can bottom, reproducing the vibrations and speech from the first can and making communication possible.

Let's now ask some questions. How far can this simple telephone usefully transmit a voice? How would your students propose to measure this? What if we started with a length of string about 10 feet long and used a standard sound at one end to see if that sound could be heard at the other end? But how do we judge the volume of the sound at the receiving end? We could start with a qualitative scale like "Very Loud," "Loud," "Medium," "Low," and "Very Low."

So now our experimentation can begin. Start this experiment with a 10-foot length of string. Repeat the experiment, each time adding 10 more feet and recording the reception level at the receiving end. Just make sure the same level of sound is initiated at the beginning end. Perhaps something simple and repetitive like a hand cricket toy sound or maybe a small hammer striking a piece of metal will serve as the right initiating sound.

At what string length does the sound

The Old Can Telephone

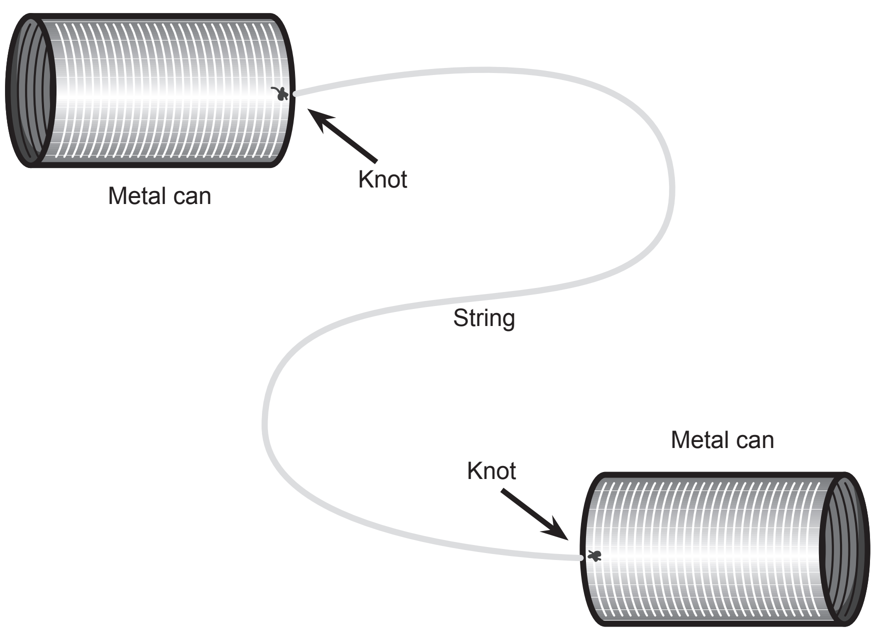

Figure 6

Metal Can Barometer

We live in a giant sea of air that pushes down on us, but it does not always exert the same pressure. As the weather changes, this air pressure varies. Bright sunny days are usually associated with high-pressure conditions; storms with low-pressure conditions. If you had no way of detecting air pressure, how would you detect changes in air pressure?

Obviously we would need something sensitive enough to respond to those changes, something that would change in a way that denotes a change either to higher or lower pressure, as we probably cannot detect absolute air pressure with crude materials.

A container of air itself would be able to change with air pressure, but not in any way we could detect with our eyes or senses – unless we somehow trapped the air and watched its influence on something else as it either expanded or contracted in response to low or high pressures.

How about the setup shown in Figure 10? Here, a rubber/balloon material lapped

Metal Can Barometer

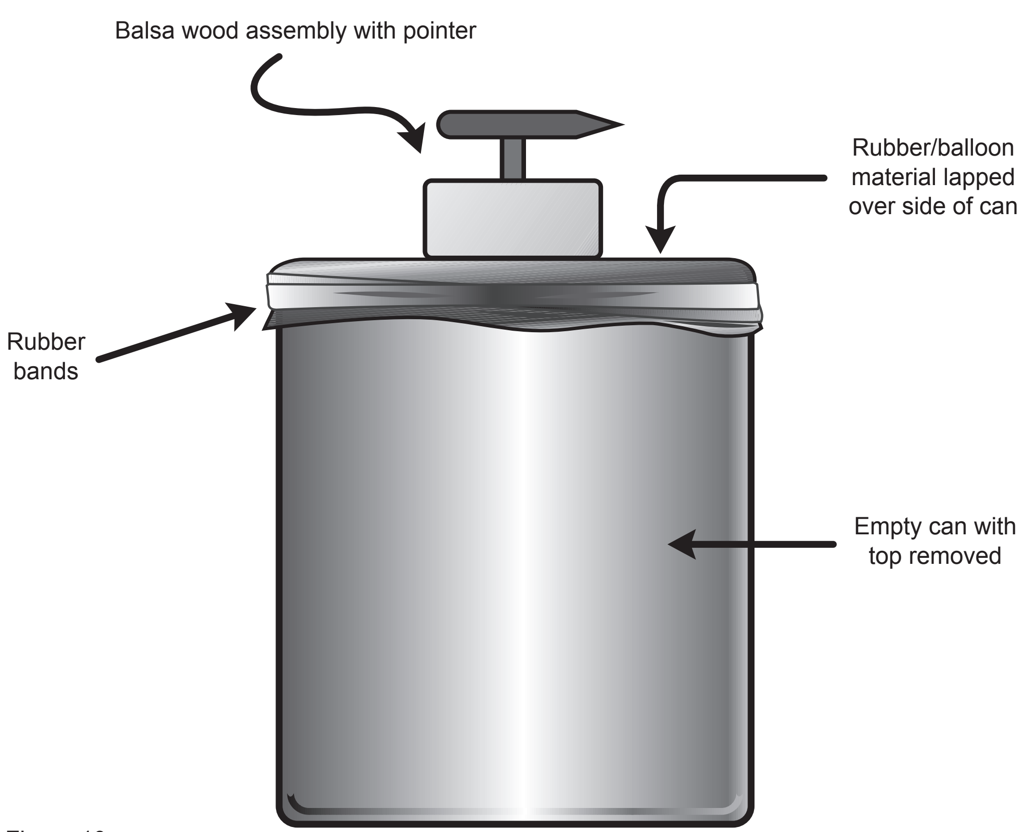

Figure 10

Designing a Watershed Area

It's going to be a rainy day tomorrow, folks. Expect up to an inch of rain, so better take those umbrellas along to work!"

What does the weatherman mean by this: an inch of rain? It probably means an inch of rain across the surface of the viewing area. OK, so what? Why be concerned? It will soak into the ground, run into the streets and sewers, and be gone, right?

Someone pass me my math pencil; I feel an urge to do some estimating.

A Little Rain Math

Let's start with a large surface area, say a square mile. That's a square 5,280 feet x 5,280 feet, or about 28,000,000 square feet.

Because there are 144 square inches for every square foot, that means we multiply 144 x 28,000,000 and that gives us about 4,000,000,000 square inches.

So, 1 inch of rain falling over this entire surface gives us the following – 4,000,000,000 square inches x 1 inch of depth = 4,000,000,000 cubic inches of water.

It's kind of hard to visualize this as anything meaningful, so let's convert this to a water measure we can appreciate, say gallons.

One cubic inch of water equals about .004 gallons; so .004 gallons per cubic inch x 4,000,000,000 cubic inches gives us approximately 16,000,000 gallons of water. Can you picture this?

An aboveground, circular family swimming pool usually contains about 5,000 gallons of water, so this inch of rainfall over 1 square mile of surface area would fill about 3,200 of those swimming pools.

It's Not Just for Swimming

What would happen if we saved that rainwater instead of letting it just soak into the ground or run off into streets and sewers? A moderate-size city of about 75,000 people typically consumes 10,000,000 gallons of water a day. That 16,000,000 gallons falling on one square mile of surface area might supply one to two days of drinking water for residents.

Can you see where I am going with this?

Here we have a way to design a watershed area, a forested area where rainwater is allowed to fall and be impounded in a lake-like area. This is a very common watershed system. The trees are important because their roots knit the soil together so it is not easily washed away by rainwater.

The surface area of the watershed is commonly measured in square miles of land that usually slopes like the shape of a bowl into a lake at the bottom. This water