

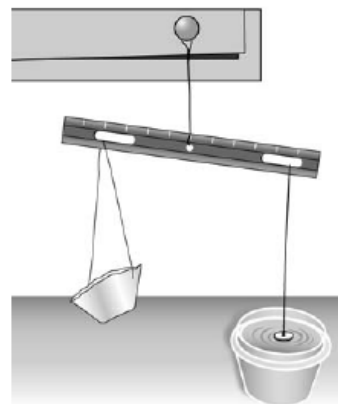
Measuring Surface Tension

Working in her own kitchen in northern Germany, nineteenth century self-taught scientist Agnes Pockels invented new methods of studying the surface tension of water and other liquids. **Surface tension** refers to the attraction that molecules in a liquid have for each other at the surface of the liquid. The property of surface tension explains why water “beads up” on a newly waxed car, and why the water strider, a common insect, can walk on the surface of water.

Pockels wrote a letter to a famous British scientist, Lord Raleigh, about her work on surface tension. He was so impressed that he had the letter translated into English and published in the journal *Nature*. You can make your own “button balance” like the one Agnes Pockels used.

MATERIALS

- Plastic ruler with holes (see diagram)
- Nylon thread or fishing line (works well because it doesn't absorb water)
- Small plastic button with a rim on one side
- Cone-style coffee filter to use as a counterbalance pan
- A small plastic container filled with water (such as a quart-sized bowl)
- Clear tape
- Small weights (try plastic beads, small paper clips, sand, squares of graph paper, etc.)
- Tweezers
- Simple calculator and/or access to a simple computer and spreadsheet program.



DIRECTIONS

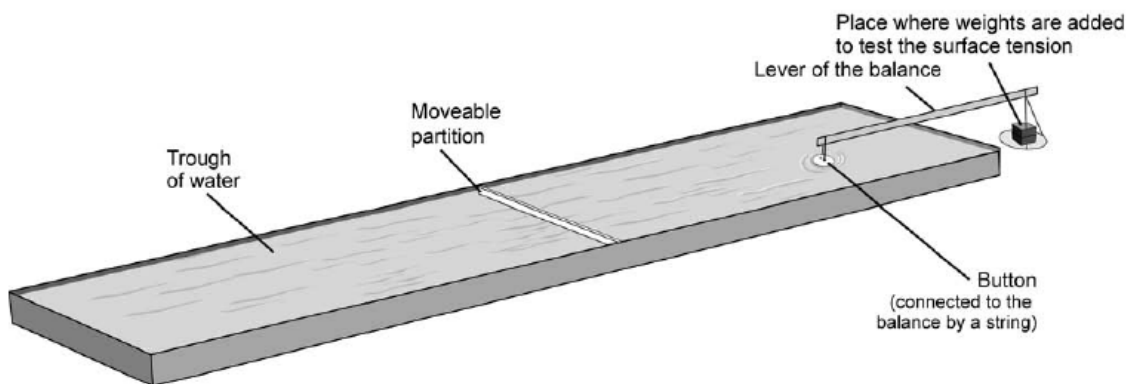
1. Set up the balance as shown in the diagram. Try substituting materials you have around the house if you do not have a coffee filter, ruler, or other item in the list.
2. Hang the balance from a cupboard or doorknob. Or, invent your own balance stand. Make sure the balance is level before you start. If necessary, add a bit of tape to one side to even things out.
3. Next, raise your water container so that the button (rim downwards) settles gently onto the liquid's surface. You should notice the lever tip towards the liquid.
4. Add small weights to your counterbalance pan until the button separates from the water.
5. Record the amount of weight you needed to remove the button from the liquid surface.
6. Try repeating your experiment to see how close together the measurements are. If your results vary a lot, make sure that it is the weight itself, rather than the act of placing it in the counterbalance pan, that is causing the button to separate from the liquid. Try to put the button back on the liquid. If it stays, you haven't used enough weight yet. Try adding the weights with tweezers rather than dropping them in the pan.

ACTIVITIES 

After you are satisfied that your balance is producing reliable results, choose one of these activities:

1. Demonstrate your balance for the class. Describe any design changes that you incorporated to improve its performance.
2. Compare the surface tension of tap water to that of salt water. Be sure to consider which variables you will need to control to make your comparison valid.
3. Agnes Pockels wondered if the same amount of weight would be required to remove the button from a small surface area of water and a large surface area. In order to test this, she made a special container. She describes it in her letter to Lord Rayleigh:

"A rectangular tin trough, 70 cm. long, 5 cm. wide, 2 cm. high, is filled with water to the brim, and a strip of tin about 1 1/2 cm. laid across it perpendicular to its length, so that the underside of the strip is in contact with the surface of the water, and divides it into two halves. By shifting this partition to the right or the left, the surface on either side can be lengthened or shortened in any proportion."



While you may not have a rectangular tin trough on hand, you could try using water containers of varying size. Measure the surface area of the top of each container in units of centimeters squared (cm^2). Fill the containers to the brim with water, then test how much weight is required to remove the button from each. Record your results and then make a graph by hand or using a computer spreadsheet. The data set is "weight versus surface area." The units for weight could be, for example, number of plastic beads or number of paper clips.

4. Put together a talk about Agnes Pockels' life for younger students. Demonstrate your balance during the talk.