

# Surface Tension: Liquids Stick Together

## Student Version

In this lab you will learn about properties of liquids, specifically cohesion, adhesion, and surface tension. These principles will be demonstrated by adding drops of different liquids to pennies to determine the strength of molecular attraction.

### Key Concepts:

- **Cohesion** is the attraction of molecules among its own kind; i.e. between two water molecules. Because of cohesion, water and other liquids form thin films and drops. This is why water bugs can walk on water, and why a carefully placed paper clip will float.
- **Adhesion** is the attraction between different substances; i.e. between a water molecule and a copper molecule. Adhesion powers a certain process that allows water molecules to move upward through a narrow tube. The attraction of water to the walls of a tube sucks the water up more strongly than gravity pulls it down (i.e. water moving up a plant's roots).
- **Surface tension** is a property of a liquid that allows them to resist external forces. It combines the concepts of cohesion and adhesion. Surface tension is caused by a strong attraction between the molecules (cohesion) that cause them to link together and remain uniform, even when placed on differing surfaces (adhesion). When the molecules possess weak positive interactions, as is the case with rubbing alcohol, surface tension will be small compared to other liquids.
- **Hydrophobic** or “water-fearing” molecules are molecules that do not like to be near water. Water molecules have a **dipole**, meaning that one side of the molecule has a slightly positive charge and one part has a slightly negative charge.

## Part 1 - Drops of Water on a Penny

(Adapted from [www.middleschoolscience.com](http://www.middleschoolscience.com))

In this portion of the lab you will determine which liquid has the highest surface tension: water, soapy water, or rubbing alcohol. In order to do this, you will determine the number of droplets that can fit onto a penny without spilling over for each liquid. The liquid that can fit the most droplets onto the penny has the highest surface tension, because it can hold onto itself the tightest!

*Q1. Using your own words, define surface tension.*

*Q2. List two examples of surface tension that you have observed in your own life.*

1)

2)

*Q3. Make a prediction: the penny will hold the greatest number of drops when I use...*

- (a) clean water
- (b) soapy water
- (c) rubbing alcohol

*Q4. Approximately how many drops of clean water do you think the penny will hold?*

- (a) 10 drops
- (b) 40 drops
- (c) 100 drops

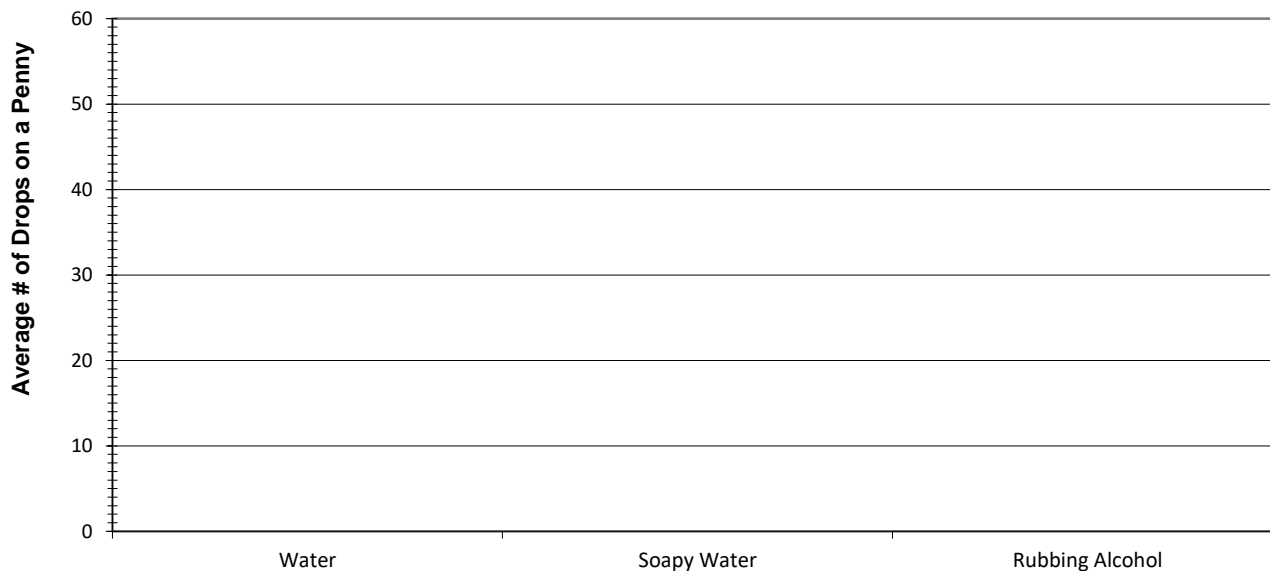
**Procedure:**

1. **Fill a dropper** with water.
2. **Place the penny**, heads up, on top of a paper towel.
3. **Hold your dropper** about 1-inch above the penny and **add drops of water** to the surface of the penny until it overflows.
4. *Record the number of drops of water* the surface of the penny can hold in the table on the next page under the column labeled "Run 1."
5. **Repeat** steps 2-4 two more times and record your results for "Run 2" and "Run 3."
6. **Repeat** the experiment (steps 2-6) for rubbing alcohol and then soapy water. Be sure to rinse and dry the penny thoroughly between experiments! You should also clean the droppers if you are reusing them.
7. *Add the number of droplets of water the penny held for Run 1, Run 2, and Run 3 and write this total in the column labeled "Sum of Runs."*
8. *Divide this number by three, the number of runs performed, and record this number in the column labeled "Average."* This is the average number of drops the penny held for your three runs.
9. **Repeat** this process with the results from soapy water and rubbing alcohol.
10. *Plot* the average number of droplets for each liquid using the bar graph provided on the next page.

**Data Table 1: Drops of liquid on a penny.**

Name of Liquid	Number of Droplets			Sum of Runs	Average = $\frac{\text{Sum of Runs}}{\text{Number of Runs}}$
	Run 1	Run 2	Run 3		
Water					
Soapy Water					
Rubbing Alcohol					

Record your data in the table below and calculate the average for each liquid.



Q5. Were your predictions from the beginning of the lab correct?

- (a) Yes
- (b) No

Q6. How were your predictions different from your experimental results?

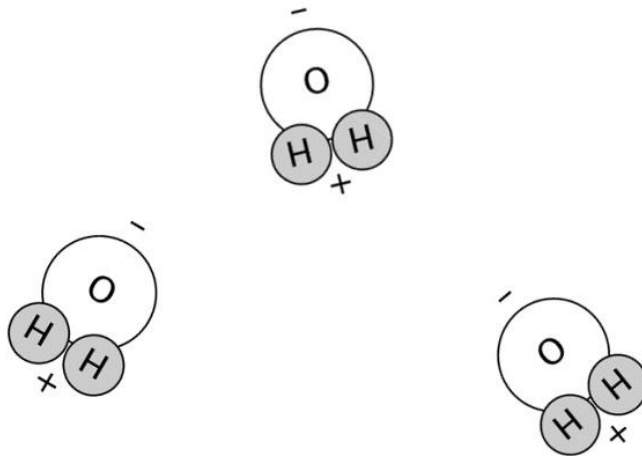
Q7. Which liquid do you think has the strongest molecular interactions? In other words, which liquid can hold onto itself the tightest?

- (a) clean water
- (b) soapy water
- (c) rubbing alcohol

Q8. The surface tension of water is 72.8 millinewtons per meter and the surface tension of rubbing alcohol is 23.0 millinewtons per meter. The higher the number, the stronger the molecular interactions between the liquid molecules. Do these values match what you would have expected given your experimental results?

- (a) Yes
- (b) No

Q9. Below is a cartoon depicting three water molecules. Draw lines to indicate how you think the molecules “bond” or interact with one another.

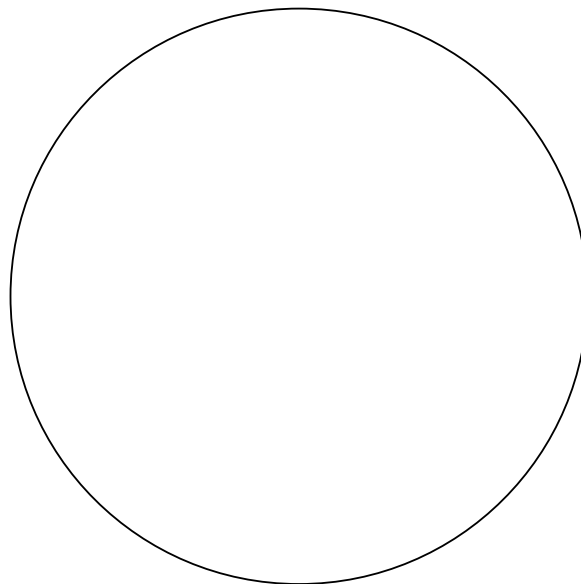


## Part 2 - Tie Dye Milk

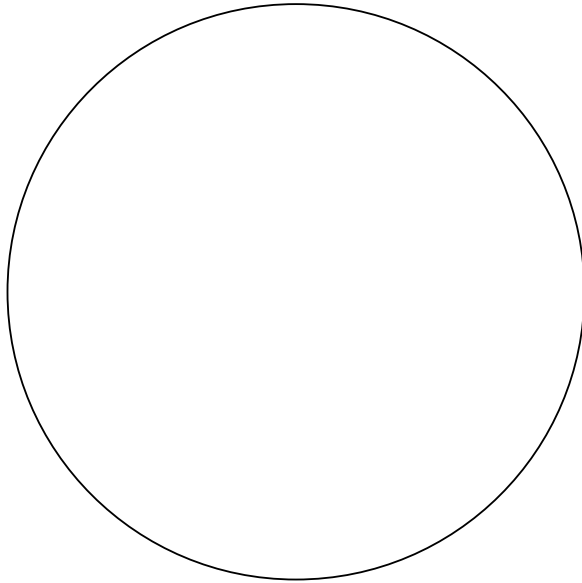
In this portion of the lab you will alter the *surface tension* of milk by adding a very small amount of dishwashing liquid to it. Milk produced by cows is mostly water (87.7%), but it also contains protein (3.4%), fat (3.6%), sugar (4.6%), and minerals (0.7%). When you add dishwashing liquid to the milk, the soap molecules move to the surface of the milk. They prefer the surface of the milk because they are *hydrophobic* or “water-fearing” and they can interact with air molecules at the surface versus being surrounded by water molecules in the bulk liquid. The soap molecules have to squeeze between the water molecules to gain access to the surface of the liquid. When the soap molecules get in between two water molecules, they decrease the water’s ability to hold onto itself. This in turn causes the *surface tension* of the milk to decrease. To visualize the change in surface tension you will first add food coloring to the milk to create a design of your choosing. Then watch what happens you add soap using a toothpick!

### Procedure:

1. **Fill** bowl  $\frac{3}{4}$  full with milk.
2. **Place** a few droplets of food coloring into the milk (have fun making your design!).
3. *Draw* a picture of the design you made below in the space provided below.



4. **Dip one end** of the toothpick into dishwashing soap.
5. **Lightly touch** the soapy end of the toothpick to the milk surface.
6. *Draw a picture* of the design you made after you touched the surface of the milk with the soapy toothpick in the space provided on the next page.



*Q10. Describe what happened when you touched the surface of the milk with the soapy end of the toothpick.*

*Q11. What do you think is happening to the **surface tension** of the milk when you add the dishwashing soap?*

*Q12. If you repeat the experiment using the same milk does it work as well as the first time you did it?*

- (a) Yes
- (b) No

*Q13. Why do you think this is?*