



Properties of Water

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Topic

Properties of water



Time

1½ hours



Safety

Please click on the safety icon to view the safety precautions. Adult supervision is necessary for Part D. Be careful when using matches. Make sure to use tongs. Keep flame away from alcohol. Clean up any spills.

Materials

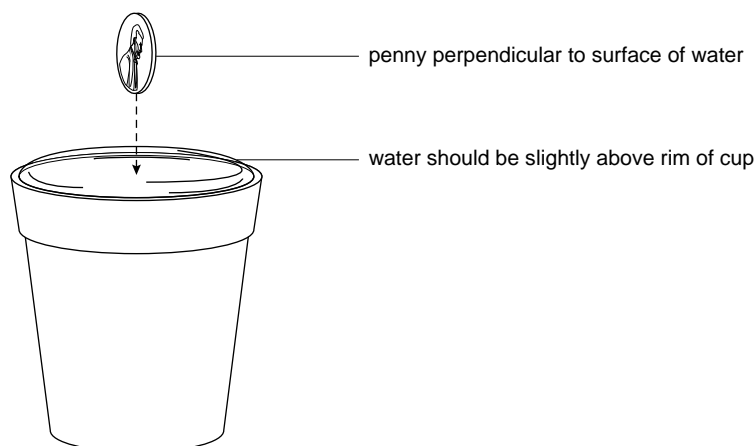
water
matches
ice cubes
rubbing alcohol
table salt
food coloring
short piece of string
tongs
plastic or paper cups

celery stalk
tall drinking glass
dishwashing liquid
small beaker or measuring cup with
milliliter markings
staples
30 to 40 pennies
dollar bill

Procedure

PART A: SURFACE TENSION

1. Fill a paper or plastic cup almost to the top with water. Make sure the cup is on a level surface.
2. Slowly and carefully fill the cup the rest of the way, until the water is slightly above the rim of the cup. If you work slowly and carefully enough, the water will not spill.
3. Repeat steps 1 and 2 using rubbing alcohol instead of water. Kneel down so that the rims of the cups are at your eye level. Compare the height of the water above the cup with the height of the alcohol.
4. Now add pennies to the cup of water, one at a time, edge first. The edge of the penny should be perpendicular to the water's surface (see figure 1). On the data table, record how many pennies you add. Keep adding pennies one at a time until the surface of the water spills over.

Figure 1

5. Now try adding pennies to the cup filled with alcohol. Record the number of pennies you can add before the alcohol spills. Save the alcohol for use in Part D.

DATA TABLE		
Procedure	Observations	
Adding pennies to liquids	Number added to water _____	Number added to alcohol _____
Placing staple on alcohol's surface		
Adding soap to water with staple floating		
Setting fire to dollar bill soaked in alcohol solution and water		

PART B: DESTROYING SURFACE TENSION

- Carefully place a staple on the water's surface. If you place it flat on the water, it will float. Keep trying until one floats.
- Now try to place one on the alcohol's surface. Note what happens on the data table.
- Using a dropper, place 1 or 2 drops of liquid soap on the water's surface. Do not put soap directly on the staple.

PART C: FREEZING POINT

- Float an ice cube in a cup of cold water.
- Your objective is to remove the ice cube without putting your fingers in the water. Looking at the materials list, decide what materials you could use to accomplish this task.

3. Use the table salt and the string.
 - a. Cut a piece of string 15 to 18 cm long.
 - b. Wet one end of it, and place this on top of the ice cube.
 - c. Sprinkle table salt over the string and the surface of the ice cube.
 - d. After a minute or two, lift the string.

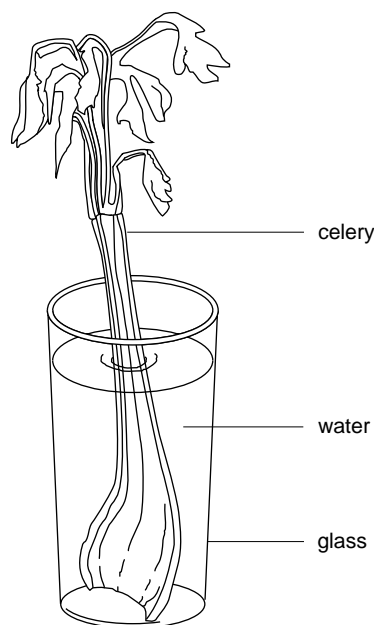
PART D: BURNING MONEY

1. Mix together 25 mL water and 25 mL rubbing alcohol in a beaker.
2. Soak a dollar bill in this solution for 1 min.
3. Remove the dollar bill from the solution, and using a pair of tongs hold it by a corner.
4. Darken the room. Light a match to the dollar bill. Observe, and record on the data table what happens.

PART E: CAPILLARY ACTION

1. Fill a tall glass with water. Add 3 drops of food coloring.
2. Stand a fresh stalk of celery, including the leaves, in the glass, root side down (see figure 2).
3. Allow this to stand overnight.
4. Observe what has happened the next day.

Figure 2



5. The first and second procedures demonstrate surface tension, that is, the property whereby the surface of a liquid acts as a flexible and permeable membrane. This is due to cohesion, or the attraction between the molecules of the liquid. Which liquid do you think has a higher surface tension, water or alcohol? Why?
6. How can you explain what happened when you placed a drop of liquid soap on the surface of the water?

7. Salt lowers the freezing point of water: Explain what happened in Part C.
8. Combustibility is the property displayed by a substance when, in reaction with oxygen, it produces light, heat, and flame—in other words, when it burns. Given that a dollar bill is made from a combustible substance (paper), and combustion of some element in the procedure took place, explain what happened.
9. The fifth procedure is a demonstration of capillary action, which is the ability of a liquid to climb, or to recede, past the surface of the liquid when contained in small (narrow) spaces. Based on what you observed, why is this ability important to life on earth, especially plant life?

┌ What's Going On

Water has a higher surface tension than alcohol. When you pour the liquids into the cups, the water level can be visibly raised above the cup's rim without spilling, while the alcohol level cannot. More pennies can be added to the water than to the alcohol before the liquid spills. A staple will float on top of the water's surface but not on the alcohol's. Adding soap breaks up the surface tension of the water. This happens because the soap molecules get in the way of the attractive forces between water molecules. Soaps aid in cleansing by lowering the attraction of water molecules to each other. This spreads the water molecules over the surface to be cleaned, and allows them to penetrate between the material and the substance to be cleansed, lifting the substance off the material. By lowering the freezing point of water, salt also melts ice. When the air temperature is below freezing, spreading salt on ice will melt it, even though the outside temperature is lower than the normal freezing point of water. The salt placed on the ice cube melts the surface of the ice, allowing the string to sink below the surface. After the salt has dissolved, the temperature of the ice refreezes the water, and the string becomes frozen under the surface of the ice, so you can lift the ice cube with the string.

Of the three substances in the fourth procedure, only water is noncombustible. Not only will water not burn, but because it takes an extended period of high temperature for it to heat, any substance or object capable of holding water will not burn until the water reaches a temperature sufficient to cause it to evaporate. Alcohol burns at a low temperature. The alcohol's kindling point does not change in mixing with water, while the water that the dollar bill soaks up is capable of keeping the overall temperature below the kindling point for paper. As a result of this the alcohol burns, while the paper does not. The very high heat capacity of water makes it a moderating influence on the earth's climate. Because of the capillary action of water, tall plants and trees are able to move water from root systems below ground, through very small vascular tubes all the way to their tops, and out to their leaves. This property is based on the combined force of the attraction between the liquid's molecules, and the molecules of the container. The force of attraction between the water molecules and the sides of the container is called *adhesion*.

In this experiment you observed some of water's properties and its interactions with other substances.

└ Connections

All liquids have certain properties in common that make them recognizable as liquids. However, each liquid exhibits these properties in different ways, making it possible to distinguish one liquid from another. The capacities for boiling (changing from liquid to gas) and freezing (going from liquid to solid) are two properties all liquids share, but which occur differently in each liquid. For example, water boils at a higher temperature than alcohol. The specific properties of water make it especially well suited to support life on earth. You should drink at least 1 liter of water a day in order to maintain the ionic balance in your body. This amount may increase or decrease according to your surrounding environment. For instance, in a hot, dry climate, you may need to drink more water because you lose water from sweat and evaporation.

Safety Precautions

READ AND COPY BEFORE STARTING ANY EXPERIMENT

Experimental science can be dangerous. Events can happen very quickly while you are performing an experiment. Things can spill, break, even catch fire. Basic safety procedures help prevent serious accidents. Be sure to follow additional safety precautions and adult supervision requirements for each experiment. If you are working in a lab or in the field, do not work alone.

This book assumes that you will read the safety precautions that follow, as well as those at the start of each experiment you perform, and that you will *remember* them. These precautions will not always be repeated in the instructions for the procedures. It is up to you to use good judgment and pay attention when performing potentially dangerous procedures. Just because the book does not always say “be careful with hot liquids” or “don’t cut yourself with the knife” does not mean that you should be careless when simmering water or stripping an electrical wire. It *does* mean that when you see a special note to be careful, it is extremely important that you pay attention to it. If you ever have a question about whether a procedure or material is dangerous, stop to find out for sure that it is safe before continuing the experiment. To avoid accidents, always pay close attention to your work, take your time, and practice the general safety procedures listed below.

PREPARE

- Clear all surfaces before beginning work.
- Read through the whole experiment before you start.
- Identify hazardous procedures and anticipate dangers.

PROTECT YOURSELF

- Follow all directions step by step; do only one procedure at a time.
- Locate exits, fire blanket and extinguisher, master gas and electricity shut-offs, eyewash, and first-aid kit.
- Make sure that there is adequate ventilation.
- Do not horseplay.
- Wear an apron and goggles.
- Do not wear contact lenses, open shoes, and loose clothing; do not wear your hair loose.
- Keep floor and work space neat, clean, and dry.
- Clean up spills immediately.
- Never eat, drink, or smoke in the laboratory or near the work space.
- Do not taste any substances tested unless expressly permitted to do so by a science teacher in charge.

USE EQUIPMENT WITH CARE

- Set up apparatus far from the edge of the desk.
- Use knives and other sharp or pointed instruments with caution; always cut away from yourself and others.
- Pull plugs, not cords, when inserting and removing electrical plugs.
- Don’t use your mouth to pipette; use a suction bulb.
- Clean glassware before and after use.
- Check glassware for scratches, cracks, and sharp edges.
- Clean up broken glassware immediately.

- Do not use reflected sunlight to illuminate your microscope.
- Do not touch metal conductors.
- Use only low-voltage and low-current materials.
- Be careful when using stepstools, chairs, and ladders.

USING CHEMICALS

- Never taste or inhale chemicals.
- Label all bottles and apparatus containing chemicals.
- Read all labels carefully.
- Avoid chemical contact with skin and eyes (wear goggles, apron, and gloves).
- Do not touch chemical solutions.
- Wash hands before and after using solutions.
- Wipe up spills thoroughly.

HEATING INSTRUCTIONS

- Use goggles, apron, and gloves when boiling liquids.
- Keep your face away from test tubes and beakers.
- Never leave heating apparatus unattended.
- Use safety tongs and heat-resistant mittens.
- Turn off hot plates, bunsen burners, and gas when you are done.
- Keep flammable substances away from heat.
- Have a fire extinguisher on hand.

WORKING WITH MICROORGANISMS

- Assume that all microorganisms are infectious; handle them with care.
- Sterilize all equipment being used to handle microorganisms.

GOING ON FIELD TRIPS

- Do not go on a field trip by yourself.
- Tell a responsible adult where you are going, and maintain that route.
- Know the area and its potential hazards, such as poisonous plants, deep water, and rapids.
- Dress for terrain and weather conditions (prepare for exposure to sun as well as to cold).
- Bring along a first-aid kit.
- Do not drink water or eat plants found in the wild.
- Use the buddy system; do not experiment outdoors alone.

FINISHING UP

- Thoroughly clean your work area and glassware.
- Be careful not to return chemicals or contaminated reagents to the wrong containers.
- Don't dispose of materials in the sink unless instructed to do so.
- Wash your hands thoroughly.
- Clean up all residue, and containerize it for proper disposal.
- Dispose of all chemicals according to local, state, and federal laws.

BE SAFETY-CONSCIOUS AT ALL TIMES