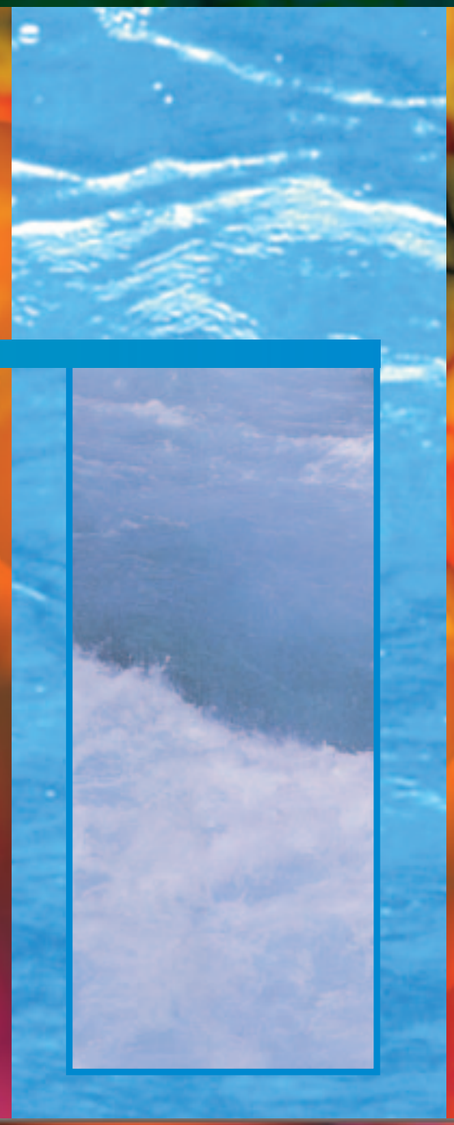
EASY SCIENCE

THE WONDERS OF WATER



Did you know that water covers about $^{3}/_{4}$ of the Earth's surface? It really is just about everywhere! Water also makes up $^{2}/_{3}$ of your body's weight. Everything on Earth needs water to survive.

To help understand what makes water so wonderful, we have to think small – very small. You may already know that everything in the world is made up of atoms. When two or more atoms join together, they make a molecule. A molecule of water is made up of three atoms: one oxygen atom and two hydrogen atoms. That's why scientists call water H_2O.

When water molecules get close to each other, they attract. This is what gives water some of its very interesting qualities.

One of these special characteristics of water is the way it connects to itself and holds together. This is called ***cohesion***. You will also see that water clings to other things. This is called ***adhesion***. Cohesion and adhesion are caused by the attraction of water molecules to each other and to other things.

The cohesion and adhesion of water molecules also help them move up the very thin tubes in the roots and stems of plants. This movement of a liquid up tiny tubes or spaces is called ***capillary action***. Water molecules are attracted to the sides of the tube and to each other as they move up the tube. This water brings the plants the nutrients they need to live.

The cohesion of water molecules also helps form raindrops. In a cloud, water molecules join together until the drops get big enough to fall as rain.

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EasyScience is produced by the South African Agency for Science and Technology Advancement (SAASTA), an operational unit of the National Research Foundation. SAASTA's mission is to promote the public understanding, appreciation and engagement with science and technology among all South Africans.
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SAASTA

COHESION

See yourself

In the following activity, note how water clings to itself and how it clings (or does not cling) to other surfaces.

You will need:

- A piece of cardboard, about 24 cm x 40 cm
- A sheet of white, unlined paper
- Wax paper
- Pencil
- Ruler
- Tape
- Water
- Watch with second hand
- Eye dropper
- Plastic straw

Use a pen or pencil to draw the circles of the water drop game board (see top right) onto one of your sheets of paper. Tape the paper to your piece of cardboard at the corners. Make sure the paper lies very flat.

Place a piece of wax paper over the game board and tape it down at the corners. Be sure there are no bumps or wrinkles in the wax paper. You should be able to see the game board clearly through the wax paper.

Use the eye dropper or straw to put drops of water in each of the outer circles. Each drop should be made up of two or three drops of water.

Ask someone to time you as you tilt and move the game board to make drops of water connect to each other in one big drop of water. When you have one big drop of water, tilt the board to move your drop to the centre circle. Stop the clock and check your time.

Did the drops of water connect to each other easily? How well did the water stick to the wax paper? Did the size of a drop affect how fast the drop moved?

Try another game! Instead of tilting and moving your game board to bring the water drops together, use a plastic straw to drag them together. They should stick better to the straw than to the wax paper, so you should be able to pull them along the wax paper until you have one big water drop in the middle. See how quickly you can do it!

IMPORTANT: In this activity, do not allow your water drops to sit in one place on the wax paper for too long because they may begin to soak in a little. If this happens, simply remove the old wax paper and tape down a new piece.

PINCHED STREAM

The following is another activity to see how water attaches to itself.

You will need:

- A styrofoam or paper cup that holds at least 180 ml
- Pencil
- Tap water

Punch four holes into the cup with the pencil. The holes must be as close together as possible in a straight line at the base of the cup.

Stand the cup on the side of a sink with the holes on the sink side. Now fill the cup with water. Take your thumb and forefinger and pinch the four streams of water together. Water pouring out of the four holes will unite. If the four holes are close enough, one stream forms because the water molecules pull on each other. If not, two streams will be formed.

ICE EXPANDS

Water molecules act in a very special way when water freezes. When most liquids freeze, their molecules get closer together and the substance shrinks or contracts. But when water freezes, water molecules get farther apart and the water expands. After water has expanded to form ice, the ice can float on liquid water. This is very helpful in nature. When dams or lakes freeze, ice forms on the surface and the water underneath stays liquid. This helps living things in the water survive during winter.

To demonstrate that water expands when frozen, try the following:

You will need:

- Clay, about the size of a marble
- A small baby-food bottle
- Tap water
- Blue food colouring
- A spoon
- A straw
- Permanent marking pen

Press the clay against the inside bottom of the jar, and fill the jar with water. Add 10 drops of food colouring and stir.

Slowly lower the straw into the coloured water and push it into the clay. The straw should now stand vertically in the bottle and stick out above it.

Carefully pour all the water out of the jar. Use the pen to mark the height of the water in the straw. Place the bottle in the freezer for a few hours, and then check the height of the water in the straw again. What happened? The height of the frozen water should be above the mark you made on the straw, because water expands when it freezes.

ICE OF A DIFFERENT COLOUR

See for yourself

To see if water freezes the same way when salt or sugar are dissolved in it, try the following activity.

You will need:

- Water
- Ice cube tray
- Three different colours of food colouring
- Freezer
- Sugar
- Salt
- Three plastic or paper cups
- Masking tape
- Pencil
- Newspaper
- Coarse sandpaper
- Empty coffee can
- Sand or gravel

Cover your work surface with a layer of newspaper. Label your cups "tap", "salt" and "sugar". Put one cup of cold tap water in each cup.

Add one level teaspoon of salt to the salt cup and stir until as much salt dissolves as possible. Add one level teaspoon of sugar to the sugar cup and stir until as much of the sugar has dissolved as possible.

Put one drop of a different food colouring in each cup. Write the colour on the cup's label. Take each cup and carefully pour enough liquid to make three of four cubes of each colour in the ice cube tray. Put the tray in the freezer before going to bed.

The next day, take out one cube of each colour and put the rest back in the freezer. Look at the three cubes very closely. Do you see a difference between them? Describe the differences. Feel each ice cube. Describe the way they feel.

Rub each cube on your piece of sandpaper. Is there a difference in the sound they make? Does any cube seem to be easier to sand down than the other?

Fill an empty coffee can with sand or gravel. Put the lid on and tape it all around so the lid is very secure. Place one of each type of ice cube from the freezer on a hard surface outside. Drop the can on each cube from 5 cm above the ground. Remove the can and see what happened to each cube. Did you expect these results? Do the same experiment again with a new set of cubes to check your results.

CAUTION: The empty coffee can may have sharp edges. Be careful when filling it. The filled coffee can is heavy. Do not drop it on your fingers or toes.

Which cube do you think will melt first? Do an experiment and find out!

WATER ACTS

As you have seen, the structure of water molecules makes water act in some interesting ways. The three activities below show you some of these wonders of water.

SURFACE TENSION

How many drops of water do you think you can stack on a five cent coin?

Place a dry, clean five cent coin on your work surface. Use a straw or eye dropper to place drops of water on the coin one by one. Count the drops as you put them on. Watch from the side as the water builds up. The surface tension will eventually break, causing the water to spill. Dry your coin and see if you can pile on more drops next time!

CAPILLARITY

To test water's capillary action is a piece of cake. As you read already, water can climb up thin tubes and tiny holes. This is called capillary action. Even when certain things are dissolved in water, the water can still move up tiny tubes and spaces. This lets you make a capillary pudding!

Dissolve a packet of strawberry or raspberry jelly according to the instructions on the box.

Cut a cube of very fine cake (angel food cake) and a cube of a coarse cake (pound cake) about 5 cm on each side. Pour about 60 ml of the dissolved jelly into each of two clear, plastic cups. While the jelly is still liquid, gently put one of the two cubes of cake into the one cup, and the other cube of cake into the other cup with jelly. Ask a friend to help you so that you can add the cubes at the same time.

Watch as the jelly moves up into the cake. In which cake does it move up the fastest? Why do you think this is so? Put your cups in the refrigerator until they are gelled. Then eat your delicious capillary pudding!

AN ICY TRICK

Play an icy trick on your friends. Tell them you can use a string to remove an ice cube from a glass of water without getting your hands wet. Let them try a few times. They may not be able to do it, but you can!

You will need:

- A glass of water
- An ice cube
- A piece of string
- Salt

Let the ice cube float on the glass of water. Put one end of the string on the ice cube and hang the other end over the edge of the glass. Sprinkle salt on the ice cube and let it stand for about five minutes. Now you can remove the ice from the water by just lifting the string!

Try this a few times at home before you demonstrate it to friends, so that you know exactly how much salt to use and how long to wait before you pull on the string.

How is this possible?

Salt lowers the freezing point of the water to below the usual 5°C, so where the salt falls, the ice melts a little. Then the ice freezes again and traps the string.