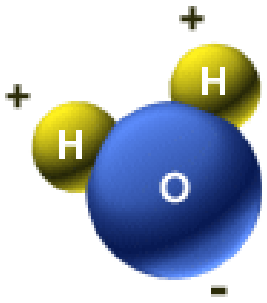


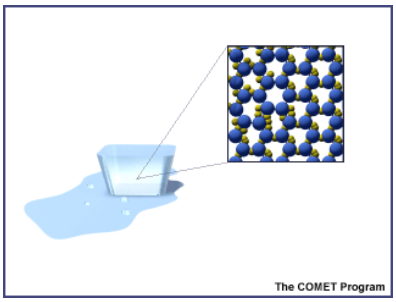
Station 4 - States of water

Students have watched 'the water molecule' video pre-visit and/or have a preliminary understanding that H_20 exists in nature as a solid, liquid and gas, depending on the water molecules level of agitation and proximity to one another.

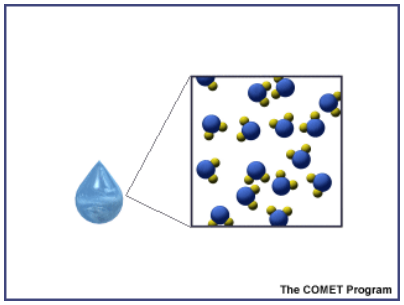
At this station students heat a block of ice in a clear kettle predicting, observing and considering the changes in solid, liquid and gaseous water states. They use a data logger to record and graph the temperature.

Key concepts

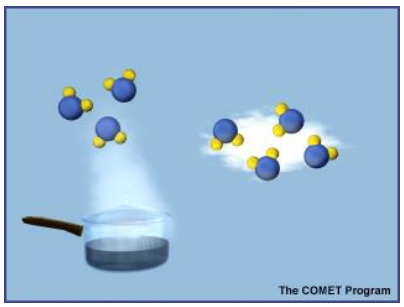
Water is an essential part of the earth system. Water is special not only because it covers over 70% of the earth's surface, but also because it is the only known substance that can exist in gaseous, liquid and solid phases within the relatively narrow range of temperatures and pressures found on earth.



Water's special qualities come from the unique shape of the water molecule. Each molecule contains two atoms of hydrogen and one atom of oxygen, arranged such that one side of the molecule (nearest the hydrogens) is positively charged while the other side (nearest the oxygen) is negatively charged. If two water molecules come together, the positive side of one is attracted to the negative side of the other, making the molecules cling together. This simple fact accounts for the high heat capacity, surface tension, cohesion, adhesion, and other characteristics that make water so important to the earth's biosphere.



When water is in its **solid state (ice)**, the water molecules are packed close together preventing it from changing shape. Ice has a very regular pattern with the molecules rigidly apart from one another connected by the hydrogen bonds that form a crystalline lattice. These crystals have a number of open regions and pockets making ice less dense than liquid water. This is why ice floats on water. Ice forms when the temperature is below freezing (0°Celsius).



When ice is warmed above freezing, it melts and becomes **liquid water**. As a liquid, the attractive forces between molecules weaken and individual molecules can begin to move around each other. Because the molecules can slip and slide around one another, water takes the shape of any container it is in.

The third state of water is the **gaseous state (water vapour)**. In this state, water molecules move very rapidly and are not bound together. Although we cannot see water in its gaseous state, we can feel it in the air on a hot, humid day. Commonly, water boils at a temperature of 100°C, forming water vapour. Many people believe that the visible plume of steam from a boiling kettle is water vapour. However, the steam that you see consists of very small water droplets suspended in the air, while water vapour is the invisible gas that results when water evaporates. We can "see" water vapour through the electromagnetic eyes of infrared-sensing instruments.
Reference: http://www.ucar.edu/learn/1_1_2_3t.htm

Images

Reference: http://www.ucar.edu/learn/1_1_2_3t.htm

Water literacy list

Atom: The smallest unit of an element that retains the chemical properties of the element. Atoms can exist alone or in combinations with other atoms forming molecules. http://visionlearning.org

Gas: One of the states of matter. It can fill a container of any size or shape as the molecules spread out to fill the whole space equally. It is invisible to us because of the vast separation of the individual gas particles. http://www.chem4kids.com

Molecule: A particle formed by the chemical bonding of two or more atoms. It is the smallest particle of a chemical compound that retains the chemical properties of the compound. http://visionlearning.org

Hydrogen: A chemical element with chemical symbol H and atomic number 1. It is the lightest element on the periodic table with an atomic weight of 1.00794 u. It was discovered by Henry Cavendish in 1766. http://www.webelements.com

Liquid: One of the states of matter. It has a definite volume but no fixed shape. It takes the shape of a container. A liquid is made up of tiny vibrating atoms, held together by intermolecular bonds. Water is by far the most common liquid on Earth. http://www.webelements.com

Oxygen: a chemical element with symbol O and atomic number 8. About two thirds of the human body and nine tenths of water is oxygen. The gas is colourless, odourless, and tasteless. Discovered by Joseph Priestley & Carl Scheele at 1774 in England, Sweden. http://www.webelements.com

Solid: One of the states of matter. It is structural rigid (hard, holds its shape and doesn't flow). The molecules in solids are packed together and can't move very much. http://www.chem4kids.com

Surface tension: Caused by the fact that molecules at the surface of liquid water are not surrounded by molecules on all sides and consequently they interact more strongly with those directly adjacent to them on the surface. http://visionlearning.org

Teacher reference

A beginner's guide to the chemistry of water. Teaching Australian Curriculum: Science Chemical Science for primary and middle years. Mary Rolland Aqius Education, 2013. Link to pdf

Information and animated videos showing the states of matter.

- http://www.kentchemistry.com/links/Matter/phases.html
- http://www.chem.purdue.edu/gchelp/liquids/character.html
- http://www.harcourtschool.com/activity/states_of_matter/index.html

The story of drinking water - American Water Works Association. An easy sequence to follow that helps gain basic knowledge about water. However gallons are used and an older style treatment process than our local one. http://www.pvwc.com/story_of_water/html/story.htm

Maths and Science Activity Centre – basic water molecule information with animated diagrams. http://www.edinformatics.com/math_science/water_ice.htm

Water: Properties and Behaviour Anthony Carpi, Ph.D. – reading, quiz and resources. http://visionlearning.org/en/library/Chemistry/1/Water/57/reading

Video – why does ice float, clear visual explanation of why it floats and why it is important it floats. http://www.youtube.com/watch?v=UukRgqzk-KE

An experiment to explore surface tension and liquid dynamics. http://www.tryscience.org/experiments/experiments_surfacetension_athome.html

An experiment to create a closed system to observe the water cycle. http://www.tryscience.org/experiments/experiments_watercycle_athome.html

Link to our local water supply and sustainable water use

Our region's existing water sources can comfortably meet demand for water in the short to medium term. However, it is essential and responsible to plan for our region's longer term needs. To maintain a sustainable water supply for the region, Rous Water has developed the Future Water Strategy. The Strategy will guide long-term water planning and provide certainty about water needs and infrastructure development over the coming decades. Over the next 50 years, changes to climate and rainfall patterns are expected to reduce the reliability of rainfall for the region. At the same time, water use is forecast to increase as population grows. Based on these predictions, by around 2024, demand for water will match what current sources can reliably supply. Rous Water's Future Water Strategy has three key actions. Understanding the states of water and the water cycle helps to develop knowledge and awareness of our impact and role in the water cycle. Together we can make a difference for water efficiency and conservation.

- Key action 1—Maximise water efficiency through demand management and conservation.
- Key action 2—Investigate increased use of groundwater as a new water source.
- Key action 3—Investigate the suitability of water re-use as an additional new water source.

For more information visit the Rous Water website, Future Water Strategy Section:
http://www.rouswater.nsw.gov.au/cp_themes/default/page.asp?p=DOC-BYN-38-23-04

Kids section

Learn about the changing states of water as you experiment with different temperatures in this interactive activity.
http://www.sciencekids.co.nz/gamesactivities/statematerials.html

Science scenarios - Research and design an experiment that will show each statement to be correct:

- Liquid water has a 'skin' on the top called surface tension.
- Water expands as it changes from a liquid to a solid.
- Ice is less dense than water.
- Water passes through the leaves of plants and is released back into the air.
- Water evaporates from seas, lakes, rivers and other wet surfaces on land.

Experiment

What do water molecules do in a liquid and in a gas?

You will need: Balloon, Plastic bottle, 2 bowls, hot water and cold water.
What you do:

1. Put a balloon over the top of a plastic bottle and stand it in a bowl of hot water.
2. Then put the plastic bottle in a bowl of cold water.

PREDICT, OBSERVE & EXPLAIN.

What's happening? The balloon expands and shrinks because the water molecules in heated water move further apart and in the cold water move closer together. If you think about water vapour as a gas, it doesn't take any particular shape. The water molecules just spread out in all directions. So the water vapour expands to fill its container. http://sciencenetlinks.com/lessons/temperature-changes-everything