# About Water

**Students’ Sheet**

**Introduction**

**Water covers 70% of Earth’s surface. Without it there would be no life on our planet. In plants, water:**

* dissolves nutrients from the soil and carries them around the plant
* is one of the reactants in photosynthesis (the other is carbon dioxide)
* keeps stems, leaves and shoots rigid (plants wilt if they have insufficient water)
* evaporates from leaves, which also cools the leaves

**Activities**

**Activity 1: Structure of water**

There are three states of matter for water: solid, liquid and gas. The smallest water particles in all of these states are water molecules. The only difference between the states if how the water molecules are arranged and move.

*When a substance melts or boils, the size of its particles do not change.*

*Its particles are the same in all three states of matter: solid, liquid and gas.*

Density of ice and water at different temperatures

State Temperature / oC Density / g/cm3

Solid (ice) 0 0.917

*When most substances change from a solid state to a liquid state their volume does not change much.*

*When a liquid changes into a gas, the spacing between the particles increases by a factor of about ten.*

Liquid (water) 1 1.000

Liquid (water) 4 1.000

Liquid (water) 20 0.998

Liquid (water) 40 0.992

Liquid (water) 60 0.983

Liquid 80 0.972

Gas (water vapour) 100 0.0006

Before answering these questions make sure you know how the simple particle model can be used to explain the differences between solids, liquids and gases.

**Questions**

1. A water molecule has the formula H2O.

(a) Atoms of which elements are needed to make a water molecule?

(b) How many of each are needed?

2. Compare the data for ice and water.

(a) Which has the largest volume, 1.000 g of ice or 1 g of water?

(b) What does this tell you about the arrangement of water molecules in ice compared to water?

3. Plot a graph of the density of water against temperature.

(a) Describe the shape of the graph.

(b) What does the graph tell you about how the distance between water molecules changes as the temperature rises?

(c) Try to explain why the distance between water molecules in water changes as the temperature rises.

Volume of cube, *V* = *x*3

*x*

*x*

*x*

4. Look at the data for water and water vapour.

(a) Calculate the volume of water vapour produced from 1 cm3 of water.

(b) The relative distance, *d*, between water molecules in water and in water vapour can be estimated by comparing the sizes of a cube of water and a cube of water vapour.

*d* = 3√(volume of water vapour / volume of water)

Use this equation to estimate the relative distance between water molecules in the two states of matter.

5. Bring the ideas together by sketching diagrams of the arrangement of water molecules in ice, water and water vapour. Beneath each diagram describe the movement of the molecules.

**Activity 2: Changes of state**

*When* ***bonds are broken*** *energy is transferred from the surroundings, which cool down. This is an* ***endothermic*** *change.*

*When* ***bonds are formed*** *energy is transferred to the surroundings, which heat up down. This is an* ***exothermic*** *change.*

Ice melts to produce water. Water evaporates to produce water vapour.

Both melting and evaporation are endothermic changes. Energy is transferred from the surroundings.

You feel much colder on a windy day if you are wet than you do if you are dry. This is an example of the cooling effect of evaporation.

Try this experiment to investigate the temperature change when water evaporates.

**Instructions**

1. Soak a paper towel in water.

|  |  |
| --- | --- |
| **Results** | |
| Time / min | Temperature / oC |
| 0 |  |
| 3 |  |
| 6 |  |
| 9 |  |
| 12 |  |
| 15 |  |

1. Take it out of the water and when it stops dripping, wrap the wet paper loosely around the sensor of a digital thermometer. Use an elastic band to hold the wet paper in place and clamp the thermometer vertically.
2. Monitor the temperature and when it is steady blow air over the wet paper. You could use a fan or a hair dryer (but not with the heat on).
3. Record the temperature every 3 minutes for 15 minutes. If you have time you could monitor the temperature for longer.
4. Complete the results table.

**Questions**

1. Did your results support the idea that evaporation is endothermic?

2. Use the particle model to explain what happened when water evaporates.

3. Why does transpiration help to cool the leaves of a plant?

**Activity 3: Solvent properties**

Water is solvent. Many substances dissolve in it. It is this property that explains the role of water in getting nutrients into a plant and in moving substances around in a plant. It doesn’t dissolve all substances though.

Try this experiment to investigate show how water can dissolve nutrients from soil.

**Instructions**

1. Put a handful of earth and teaspoon of sodium hydrogen carbonate into a beaker. Half-fill the beaker with water and a few drops of blue food colouring.
2. Stand the beaker on a wooden block next to another beaker which is on the benchtop.
3. Now take a sheet of paper towel and roll it up tightly.

water

earth

paper towel

1. Arrange the rolled up sheet so that one end is in the mixture and the other is in the empty beaker.
2. Watch what happens and record your observations after 5, 10 and 15 minutes.
3. Leave the experiment overnight.
4. The following day
5. Record any changes.
6. Add a few drops of dilute hydrochloric acid to any liquid that is in the lower beaker. Record your observations.

*When dilute hydrochloric acid is add to sodium hydrogen carbonate a* ***chemical reaction*** *happens:*

*hydrochloric acid + sodium hydrogen carbonate 🡪 sodium chloride + carbon dioxide + water*

*The reaction mixture effervesces (fizzes) because carbon dioxide is a gas and escapes from that mixture.*

**Interpret and conclude**

You set up a very simple ‘model’ experiment to mimic a plant growing in soil.

* the rolled up a sheet of absorbent kitchen towel was the plant
* the mixture of earth and sodium hydrogen carbonate (representing nutrients) was the ‘soil’
* the water containing food colouring (there to make it easier to see the movement of water) was ‘soil water’ (water that collect in soil when it rains).

From the results of your model experiment, describe how the solvent properties of water extract nutrients from the soil and carry them into a plant.