

SCIENCE AND WATER



How many times did you use water today? There was water in your bath or shower. It made up the biggest part of the food you ate and the drinks you had. Even eggs, meat and fruit contain lots of water.

Water is the most common compound on the surface of the Earth. It is everywhere. Think of the huge quantities of water in the oceans, in clouds, in the Polar ice caps, in dams, rivers, lakes, in the ground, and in every living thing.

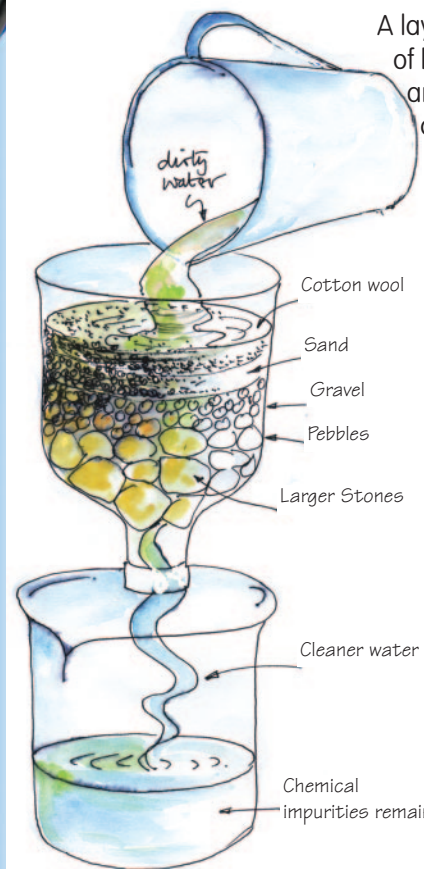
Although there is so much water all around us, not all of it is suitable for us humans to use.

Water is a scarce resource in South Africa. Our average rainfall of about 500 mm per year is only about 60% of the world average rainfall per country per year. Scientists predict that fresh water will get even scarcer in some parts of the world because of the effects of climate change.

Water is a most amazing substance and we need to carefully look extremely after our resources. Let's do some experiments with water to get to know its properties better.

Model of a natural filter

Experiment 1



A layer of cotton wool on top of layers of sand, gravel and pebbles in a 2 litre cold drink bottle makes an excellent filter for any solid particles. Can you guess why the larger pebbles must be at the bottom and the smaller ones above them? A method often used by thirsty hikers who desperately need water, is to dig a hole in a river bed. It soon begins to fill up as the water filters through the sand on the sides.

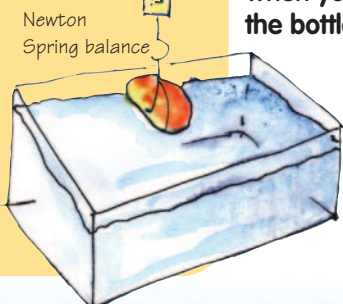
Question: What would happen if the large pebbles were on top?

Archimedes Principle

Experiment 2

Use a Newton spring balance to weigh a stone in the air just above a tank of water. Take the reading, then let the stone hang in water. It suddenly feels much lighter and (apparently) weighs much less!

Question: How does this work?



Cloud in a bottle

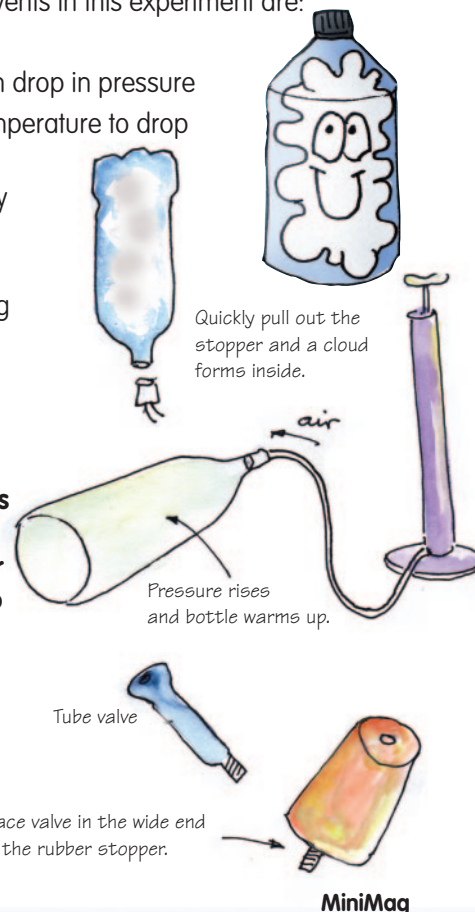
Experiment 3

Have you ever wondered how clouds are formed? Or why wet air is less dense than dry air?

Place a little water in a 2 litre plastic bottle. Now pump up the bottle, using a car pump and a one-hole rubber stopper that has been fitted with a trimmed car valve. When the bottle is quite stiff, you will notice, quite interestingly, that it is also a little warmer. Suddenly pull out the stopper. It will eject with a loud pop and immediately a cloud will form in the bottle. Repeat with a little smoke or chalk dust in the bottle and the cloud will be much denser and much whiter. Why would this be? The sequence of events in this experiment are:

1. high pressure
2. followed by a sudden drop in pressure
3. which causes the temperature to drop
4. which means the atmosphere suddenly cools down like a refrigerator
5. condensation causing billions of tiny liquid droplets to form
6. and bingo we have a cloud!

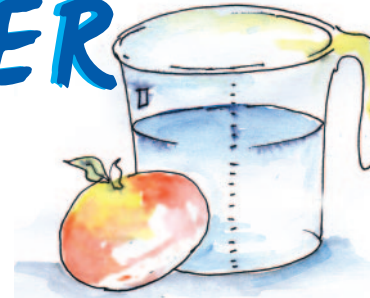
Question: Why do clouds form in the bottle? Why can you see them better when you add smoke to the bottle?



MATHS AND WATER

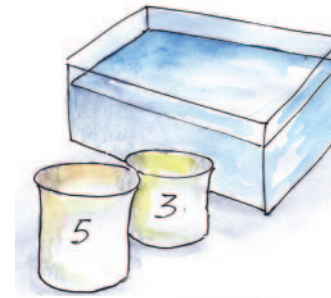
Experiment 4

Question: If you only had a measuring jug such as a milk jug with divisions on the side, how could you find the mass of an apple?



Experiment 5

You have the two containers shown on the right which have no markings. The containers can measure exactly three volumes and five volumes of water.



Question: How can you measure exactly four volumes of water? Remember, the containers have no marks on them!

Experiment 6

Question: Why does the container on the left seem to hold less liquid than the one on the right, even if they both hold 200 ml?



Experiment 7

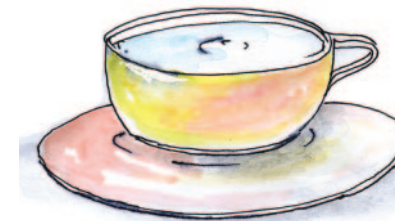
You have a milk jug with divisions on the side and you want to find out what capacity a tea kettle has.



Question: Think of two ways you can do it with the equipment you have.

Experiment 8

How many times do you imagine can one fill a saucer with water from its full cup?



Experiment 9

A dripping tap does not register on a water meter and is the cause of an enormous wastage of water. How can you determine the rate in litres/hour that the tap is wasting water?

Question: If 20 drops of water have a total volume of 4 ml, and the tap made 20 drops per minute, how many litres of water could be lost in one day? The answer will surprise you!



Answers for the experiments:

Answer 1:

With large pebbles at the top of our filter and smaller gravel and sand below, we get a model of a swamp where the water stays at the top and eventually becomes foul and undrinkable.

Answer 2:

When any object enters water, it pushes the water aside. The water pushes back and it is this upward thrust of the water that makes the object feel lighter. The size of the upward force will always equal the weight of the displaced water, in other words, the more water that is displaced, the bigger the upthrust will be. If such an upward force is bigger than the weight of the object, the object will float! Place an apple in a tank of water and it floats. Place a potato in the water and it sinks. Why does this happen? The water that the apple displaces, is heavier than the apple. (This is because the apple is less dense than the water.) The potato is heavier than the water it displaces. Swimming is relatively easy because your body pushes almost enough water aside to help you float. However, you still have to keep paddling otherwise you will definitely sink.

Answer 3:

The basic principle in this experiment is that when the pressure of a gas rises, its temperature also rises, and to the same extent. Conversely, when the pressure drops, the temperature also drops. In science this is known as the pressure temperature relationship.

The water vapour condenses more easily if there are solid particles in the air. Condensation takes place on the surface of the particles. That is why dust storms actually promote the formation of clouds and eventually showers of rain.

Answer 4:

Half fill the jug with water. Take the reading. Insert the apple and take the second reading. The difference in the readings in millilitres is equal to the mass of the apple in grams. This is because every millilitre of water has a mass of one gram.

Answer 5:

Fill the '5' beaker and use it to fill the '3' beaker. Empty the '3' beaker and pour the remaining 2 into it. Fill the '5' again and use it to top up the '3' beaker. You are now left with 4 in the '5' beaker.

Answer 6:

This is an optical illusion. Taller containers always seem to have a greater capacity.

Answer 7:

Fill the kettle and pour all its contents into the jug. Take the reading/s. Alternatively, fill the jug to the 1 litre mark and then pour the contents into the kettle. Refill if necessary.

Answer 8:

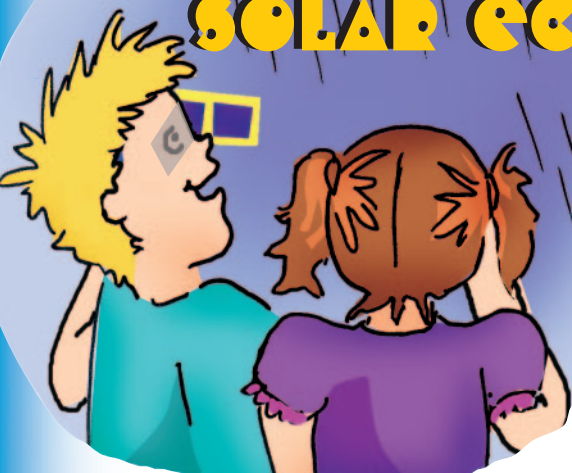
Only once. The cup appears to hold much more liquid because it is taller.

Answer 9:

Per minute 20 drops/min = 4 ml.
Per hour this equals 60 x 4 ml = 240 ml
Per day this is 24 x 240 ml = 5760 ml or 5.76 litres!

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. Visit the website: www.saasta.ac.za for more information.

WATCH THE PARTIAL SOLAR ECLIPSE!



All of South Africa will experience a partial eclipse of the Sun on Monday, 26 Jan 2009, from about 7:15 to 9:30 am. In South Africa, the International Year of Astronomy 2009 will be officially launched with this partial eclipse.

This eclipse is definitely worth watching – and it's our last decent national eclipse at a reasonable time of day until 2016.

WHAT IS A SOLAR ECLIPSE?

A solar eclipse occurs when the Moon passes between the Earth and the Sun, blocking the Sun's rays from reaching the Earth. The shadow of the Moon follows a different path across the Earth at each eclipse. The umbra is the region where a total eclipse is seen, and the penumbra is the area where a partial eclipse of the Sun is seen.

During a total solar eclipse, the whole of the Sun is hidden behind the Moon. At this time you can see bright stars and some animals might go to sleep! During a partial eclipse, only a portion of the Sun is hidden behind the Moon and it will be only slightly darker than usual at that time of day. The Sun and Moon are not exactly in line during this type of eclipse.

WHERE CAN IT BE SEEN?

Anywhere in South Africa – in town, at school, at home. The event will be best seen at Cape Town, where the magnitude of the partial eclipse will be 65%. In Johannesburg, the magnitude will be 35%.

The Sun will be over in the east when the eclipse starts. Make sure your view won't be blocked by buildings or trees. If you are on the street, make sure that no-one is in danger from cars. If you have a tree nearby, you can watch pinhole projections of the eclipsed Sun on the ground. Find a place with passers-by, share your eclipse viewers with them – it's very rewarding!

WHEN?

The partial eclipse will start about 7:15 am and will end around 9:30 am on Monday, 26 January 2009

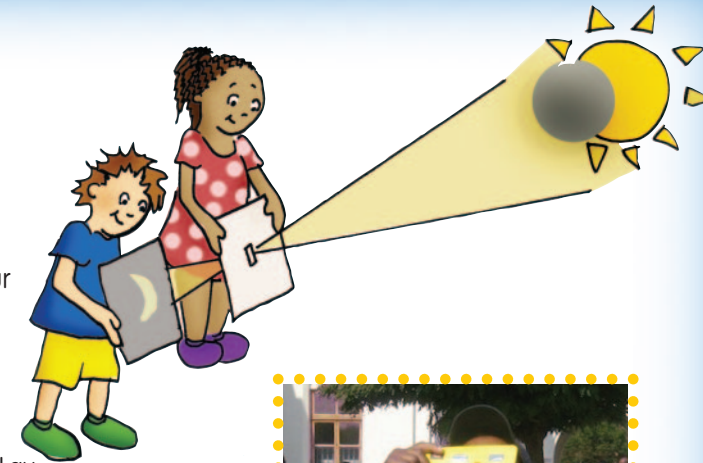
WHAT DO YOU NEED?

You will need eclipse viewers to protect your eyes! Contact the Jhb Planetarium for eclipse viewers: www.planetarium.co.za www.planetarium.co.za/cell

- Eclipse viewers - to protect your eyes. These can be shared - people will watch for just a few seconds at a time.
- A pinhole projector (see next page).

MAKE YOUR OWN PINHOLE PROJECTOR

- You will need two sheets of white paper or card and a pencil.
- Make a small hole in one sheet of paper with the pencil. This is your 'projector'.
- Hold the other sheet of paper as shown in the diagram. This is your 'screen'. Look for the image of the Sun on the screen.
- Try making a rectangular hole, to prove that the image is the shape of the Sun on the screen.
- Move the projector further from the screen to get better image.



The gaps between the leaves of a tree are natural pinhole projectors. Lay a piece of white paper on the ground under a tree, and look for images of the Sun on the paper. Try this during the eclipse and see how the shape of the Sun changes on the paper! You can also try to do pinhole artwork.

Visit www.planetarium.co.za for ideas.



The Earth goes around the Sun and the Moon goes around the Earth. When the Moon moves in between the Earth and the Sun, it is called a solar eclipse.

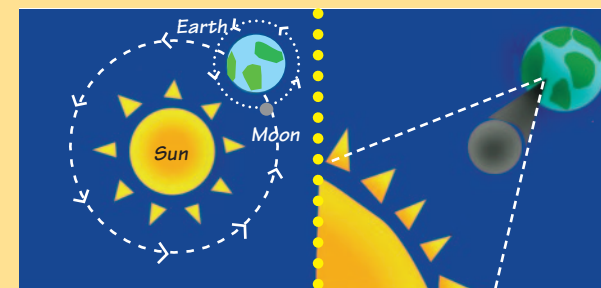
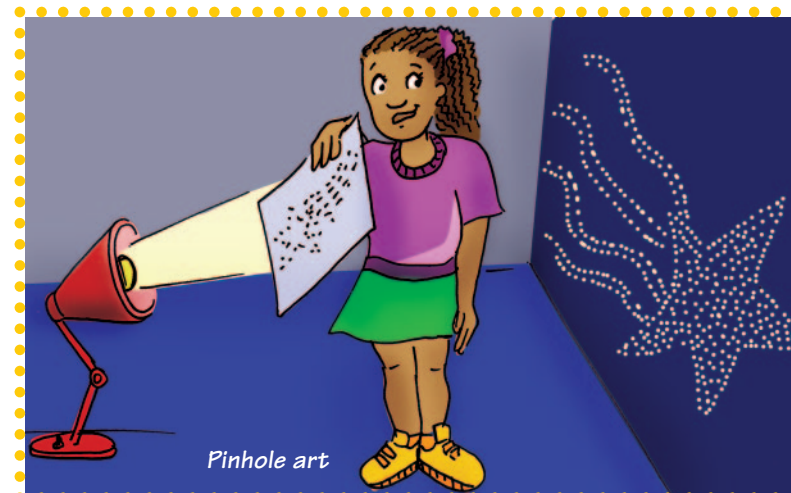


Photo: HartRAO



Pinhole art

ECLIPSE EYE SAFETY

Looking at the Sun at any time - during an eclipse or on any other day - is bad for your eyes. The bright light damages the delicate sensors in your eye, and the invisible heat (infrared) will 'cook' them. The best eye protection is properly-constructed eclipse viewers fitted with filter material that blocks light, heat and ultraviolet.

NB! Do not use:

- Binoculars or a telescope. These magnify the harmful effects of the sunlight and can cause instant blindness.
- A telescope fitted with a cheap 'eyepiece' solar filter. Large (expensive) filters should be fitted by an expert to the objective end of the telescope.
- Ordinary sunglasses. These do not block heat.
- Film negative, sweet or chip packets or x-ray film.

For more information, visit the eclipse info page on the website: www.planetarium.co.za



www.astronomy2009.org.za