COSMOS LESSONS

Earth and Space Sciences

Water Cycle: Where's the El Niño?

In May 2014 scientists warned South Americans to prepare for severe storms later in the year thanks to an impending El Niño. Water, perhaps our most precious resource, is always on the move.

In this lesson you will investigate:

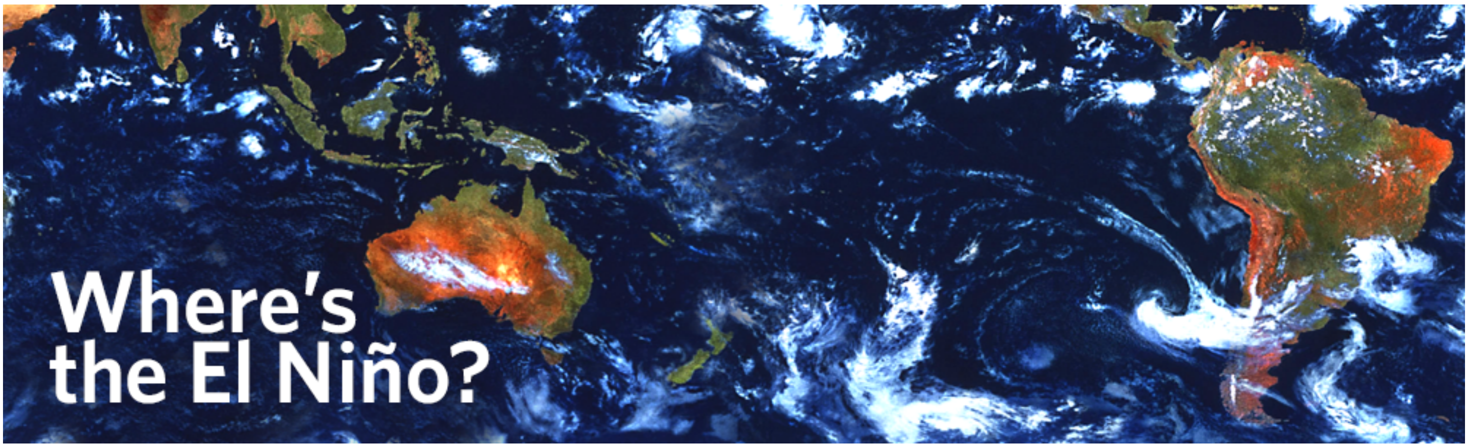
- What is the water cycle?
- How much of the Earth's water is drinkable?
- What is El Niño?
- How can you purify sea water?

So get ready to make a splash on your journey around the water cycle.

This is a print version of an interactive online lesson. To sign up for the real thing or for curriculum details about the lesson go to **www.cosmosforschools.com**

Introduction: Water cycle (P1)

COSMOS LIVE LEARNING



In May this year, scientists warned that wild weather was on the way for the year ahead thanks to an impending major El Niño event.

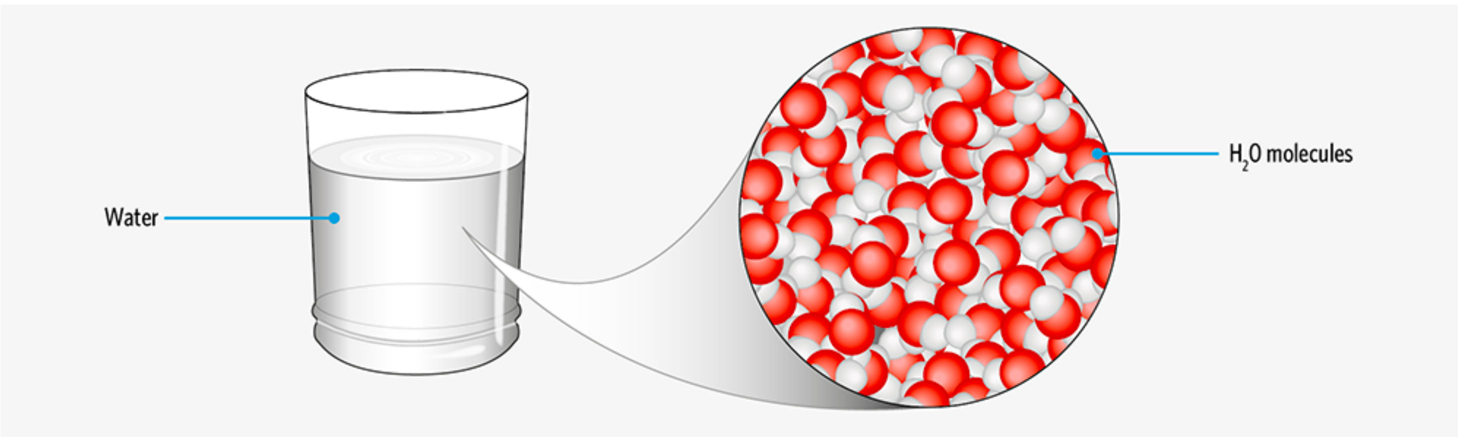
The weather pattern occurs when warm water spreads eastwards from Indonesia and rises to the surface of the Pacific Ocean, taking rain from Asia and Australia and dumping it on the Americas – droughts and wildfires for some in Southeast Asia and Australia, floods and landslides for others on the other side of the ocean. A big El Niño in 1997-98 killed 20,000 people and caused almost $97 billion of damage.

But so far, the scientists seem to be wrong. Nothing like a "super El Niño" has happened.

It shows just how hard it is to make models of complex systems like the weather. But scientists say there still might be an El Niño event. They say that we have been caught out before by dismissing the chances of one.

No one knows quite what will happen. Recent temperature changes have again made the chances of an El Niño slightly higher, but we'll have to keep watching to know for sure.

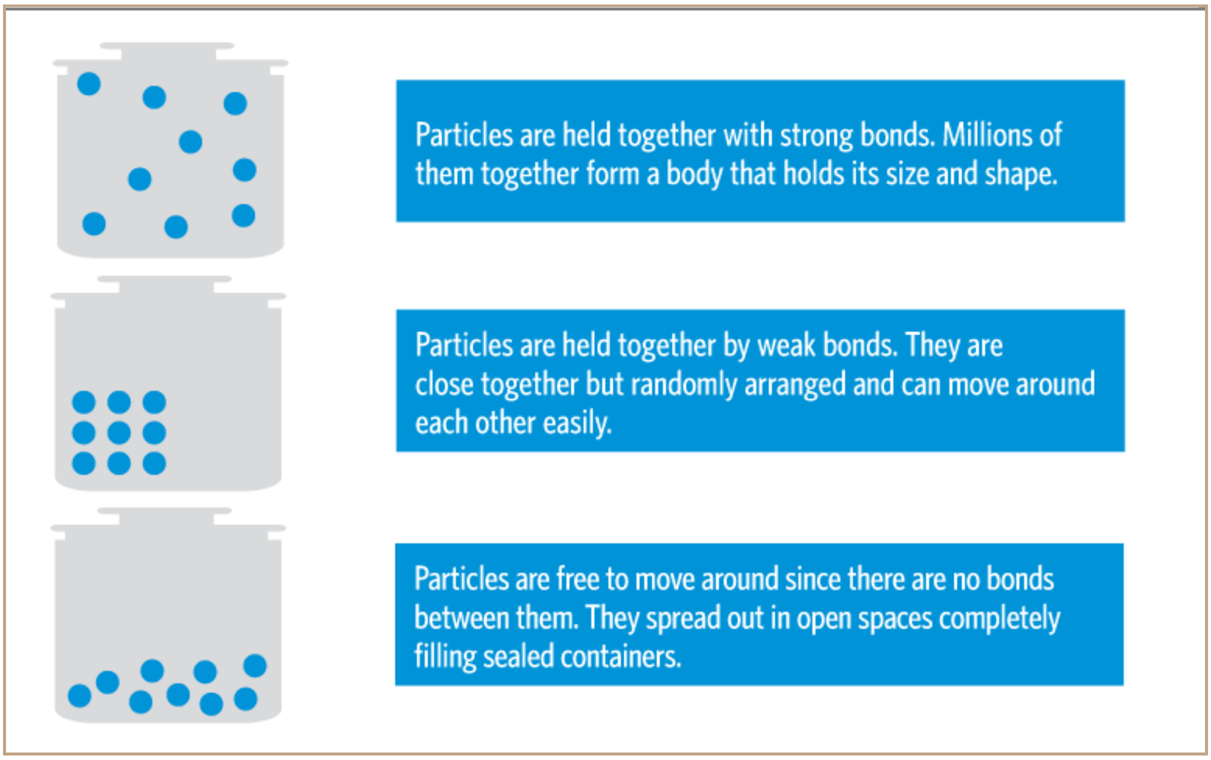
Read or listen to the full *Cosmos* magazine article here.



Question 1

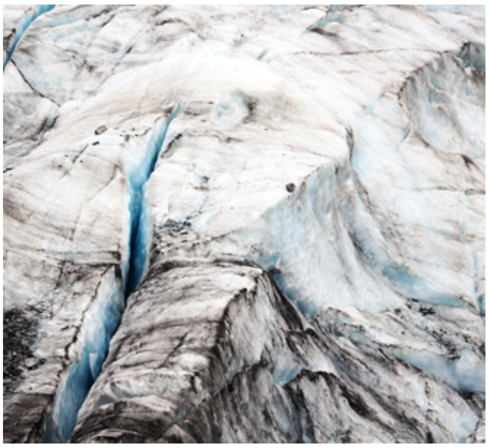
Review: Water is special not only because it covers more than 70% of the Earth's surface, but also because it is the only known substance that exists naturally on Earth in all three physical states of matter – gas, liquid, and solid. Previously you have learned that solids, liquids and gases have different observable properties and behave in different ways.

Label the following diagrams as **solid**, **liquid** or **gas** and draw a line to link each diagram to the correct description



Gather: Water cycle (P1)

COSMOS
LIVE LEARNING



Water on the move

Whether in solid, liquid or gaseous state, the chemical composition of each water molecule is always H_2O. The molecules themselves do not break apart or change in any other way as water changes state. What does change is the way the molecules are arranged and the speed at which they move.

Question 1

Describe: Fill in the table below to complete the following statement summarising the effect of heat on the movement and arrangement of water molecules:

The ____________ the temperature of the water, the ____________ the molecules move and the ____________ spread out they become.

Blank 1	Blank 2	Blank 3

Not only do the individual H_2O molecules continuously wiggle and jiggle but when millions of these molecules come together as liquid, they move along surfaces and seep between cracks. Water also moves through the air as a gas and a liquid and across the land and oceans as solid glaciers and icebergs.

Water is always on the move.

The water cycle is our planet's way of recycling water – it describes the continuous movement of water on, above and below the surface of the Earth, as well as the transition from one state of matter to another.

Question 2

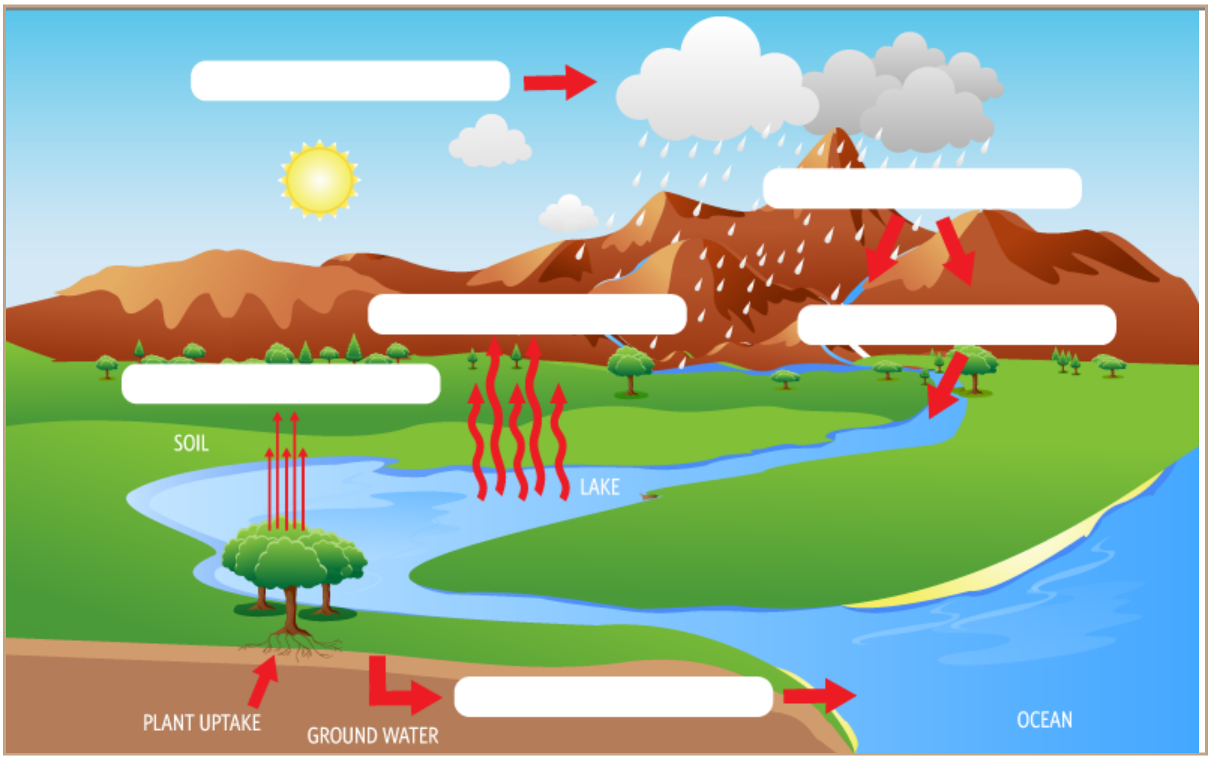
Define: There are six main processes that make up the water cycle. Match these processes with their descriptions in the table below:

condensation; evaporation; infiltration; precipitation; runoff; transpiration

Process	Description
	The process where a liquid, in this case water, changes from its liquid state to a gaseous state by absorbing heat energy.
	When the temperature and atmospheric pressure are just right, the small droplets of water in clouds form larger droplets, falling to Earth as raindrops, hail or snow.
	This process occurs when water evaporates through plant leaves. As plants absorb water from the soil the water moves from the roots through the stems to the leaves. Once the water reaches the leaves some of it evaporates, adding to the amount of water vapour in the air.
	The opposite of evaporation; this process occurs when a gas, in this case water vapour, changes from its gaseous state to its liquid state.
	Much of the water that returns to Earth as precipitation runs off the surface of the land and flows downhill into streams, rivers, ponds and lakes, eventually flowing out to the oceans.
	The process where rain water soaks into the ground, through the soil and underlying rock layers, with most of it eventually flowing out to the oceans.

Question 3

Label: Using the six processes you defined in Question 2, label the following diagram of the water cycle.



Question 4

Select: In which of the following events in the water cycle is solar energy being absorbed?

- [ ] Water vapour condensing to form clouds.
- [ ] Rain freezing as it falls towards the ground.
- [ ] Water evaporating from the surface of an ocean.
- [ ] Clouds releasing precipitation as snow over a mountain.

Question 5

Explain: Use your understanding of the behaviour of particles in the different states of matter to explain the following statement:

"***The atmosphere can transport water more quickly than the oceans.***"

Did you know?

We have the same amount of water we had millions of years ago, but the drinkable water on our planet is a limited resource.

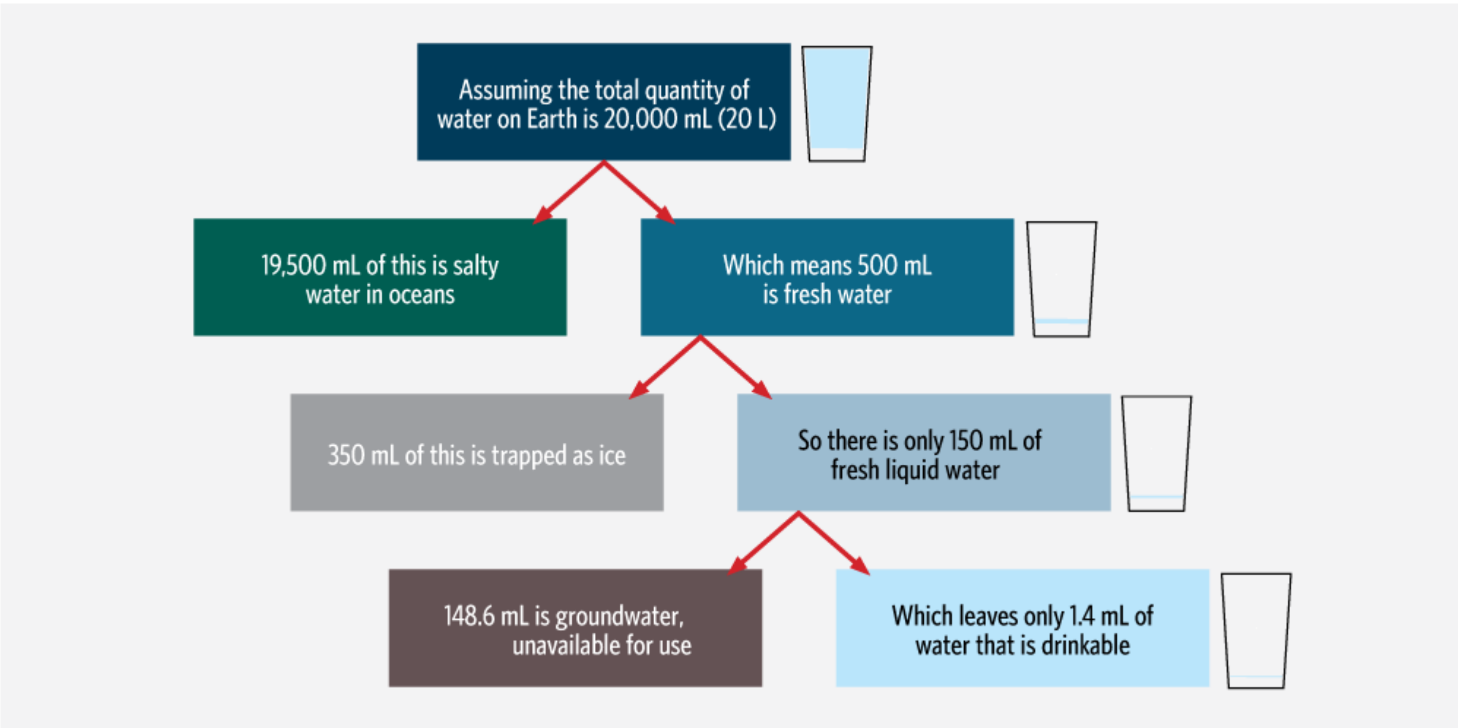
Poll 1

Predict: Before answering Question 6, predict the approximate percentage of Earth's total water that you think is drinkable.

- Less than 1%
- 5%
- 10%
- 15%
- More than 20%

Question 6

Calculate: Determine the percentage of Earth's total water that is drinkable based on the data in the following graphic.



Question 7

Reflect: Comment on whether you overestimated or underestimated the percentage of drinkable water and identify which of the details presented in the graphic surprises you the most, giving your reasons.

Did you know?

The actual quantity of water in, on and above the Earth is estimated to be closer to 1.368 x 10^{15} litres (1,368,000,000,000,000 litres)?

Process: Water cycle (P1)

COSMOS LIVE LEARNING

If you have ever been seasick, then you know that there is a lot of motion in the ocean's waters. Not unlike the circulatory system that carries blood around your body, the oceans carry massive amounts of thermal energy (that is, heat) and nutrients around the globe.

The *Cosmos* blog “So what happened to the super El Niño we were promised?” describes a weather phenomenon that occurs irregularly every two to seven years. El Niño is due to the warming of ocean surface waters in some geographical areas that leads to the disruption of normal global heat circulation patterns. This can result in droughts and wildfires for some countries and floods and landslides for others.

Question 1

Map: Use the information in the video to annotate the following map of the Pacific Ocean and surrounding land masses.

1. Draw a red circle around the areas affected by drought during the El Niño period.
2. Draw a blue box around the areas affected by torrential rain.
3. Add a white arrow to show the direction of movement of the warm ocean surface waters across the Pacific Ocean.

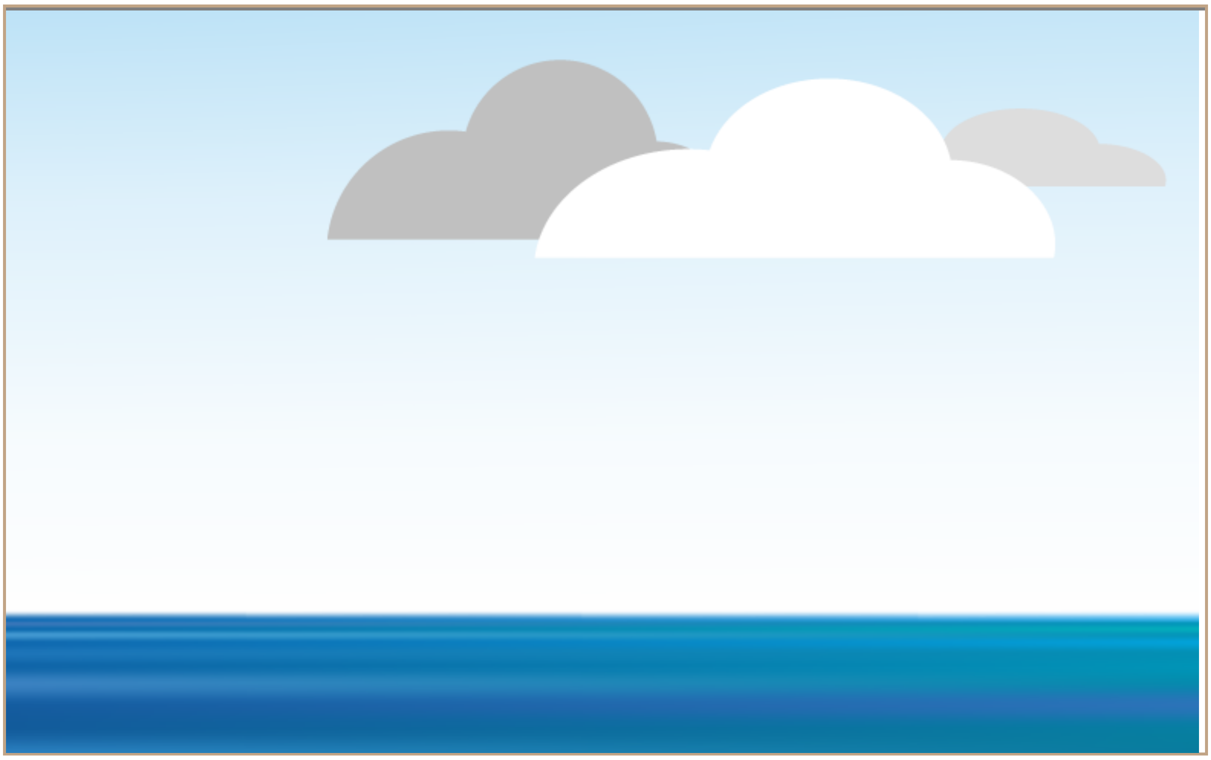
Question 2

Classify: The video above also describes a number of social, environmental and economic consequences of El Niño for both sides of the Pacific Ocean. Summarise these consequences in the table below, classifying them as affecting either Australia or South America.

Consequences affecting Australia	Consequences affecting South America

Question 3

Design: Draw and label a diagram of how you think water molecules might be arranged as they move through the water cycle. Download the image of a water molecule below then upload it into the sketchpad. Make multiple copies of the molecule and arrange them appropriately, then add arrows and labels to illustrate the cycle.



H2O.png

Question 4

Generalise: Explain why more rain clouds form when the ocean surface waters are warmer.

Question 5

Imagine: Watch the following animation about Drip the water droplet and, in your own words, describe the process of the water cycle in a creative way.

You may like to write a poem, a song or a short creative story about a typical day or week in the life of Drip the water droplet. The journey might begin in a puddle, on a farm, in a mountain lake, a stream, a cloud, or even a large ocean. You may also decide to set your story during a period of El Niño.

Try to include as many of the key words and concepts you have studied in this lesson as possible.

Apply: Water cycle (P2)

COSMOS LIVE LEARNING

Experiment: Building and testing a solar still

Background

You have learned that water covers most of the Earth, but almost all of it is in the oceans and is salty. Much of the water on land or in the ground is also salty or otherwise unsuitable for human use.

The *Cosmos* blog "So what happened to the super El Niño we were promised", highlights that even a moderate event can significantly affect Australia's rainfall. Without sufficient drinkable water supplies from rainfall, animals and plants will suffer. Finding ways to purify water is becoming more and more necessary as the human population increases and our dependence on fresh water for agriculture, farming livestock and industry grows.

The solar still is a device that that uses solar energy to purify water. The quantities of fresh water produced by solar stills are not sufficient to irrigate crops or feed livestock, but various versions of a solar still can be used to desalinate seawater for human survival in dry climates and for home water purification.

Aim

To build a solar still and simulate aspects of the water cycle as you purify fresh water from salty water.

Materials

- Large metal or plastic flat-bottomed bowl
- Small shallow glass or cup
- Measuring jug or measuring cylinder
- Cling film (wider than the bowl)
- Adhesive tape

- Small stone, pebble or marble
- Hot water
- Food dye and salt

Procedure

1. Add a measured volume of hot water (equivalent to about 1 cm depth) to the bowl.
2. Add some food colouring and about a teaspoonful of salt to the hot water in the bowl, stir to dissolve.
3. After considering the factors that influence where you should put your solar still, take all the equipment outside to a sunny, level place.
4. Place the glass or cup in the middle of the bowl making sure no water splashes into it.
5. Cover the bowl loosely with cling film and tightly seal the cling film to the rim of the bowl using the adhesive tape.
6. Place the stone/pebble/marble in the middle of the cling film above the cup and record the 'initial time' in your results table. Also note the colour of the salty water.
7. Leave the solar still for at least an hour (the longer the better) and then check that there is some water in the cup. Record the 'final time' in your results table.
8. Take the solar still back indoors, carefully remove the cling film and take out the cup without splashing any water into or out of the cup.
9. Measure the amount of purified water in the cup and note the colour of this water. Record these details in the results table.

Safety Information

Standard laboratory safety guidelines should be followed throughout this experiment.

Variables

Independent variable – design of your solar still.

Dependent variable – quantity of purified water collected in the solar still.

Results

Question 1

Collect: Use the project space below to present your results. You should construct a table of results and a labelled diagram of your solar still but you may also include photos, video or other representations.

Discussion

Question 2

Assess: Calculate the purification efficiency of the solar still you built using the equation below:

$$\% \text{ purification efficiency} = \frac{\text{volume of liquid collected}}{\text{volume of liquid added to still}} \times 100$$

Question 3

Justify: Explain why it was important to tightly seal the cling film to the rim of the bowl using adhesive tape.

Question 4

Apply: Using what you have learned about the water cycle in this lesson explain, in your own words, how the solar still works.

Question 5

List: Describe the factors you needed to consider when deciding where to put your solar still.

Question 6

Evaluate: Write down some ideas about how you might improve the design of your solar still and give reasons for your proposed improvements.

For example you might try using different coloured containers to find out which absorbs the sunlight most efficiently.

Question 7

Extend: Suggest how you might test whether the liquid you collected in the cup was actually fresh water.

Conclusion

Question 8

Conclude: Write a concluding statement that addresses the aims of the experiment.

Career: Water cycle (P2)

Brought to you by RiAUS

Question 1

Evaluate: The Gold Coast is the most populated non-capital city in Australia. It is famous for its surf, sun and sand. A number of activities occur near to the Gold Coast waters, including jet skiing, surfing, farming and V8 supercar racing. Imagine you are an environmental scientist, like Dr Kylie Catterall, involved in monitoring the water quality within the Gold Coast area. Describe how these activities might negatively impact on water quality. Rank them in order of lowest risk to highest risk of negative impact, giving reasons for your answer.

Cosmos Live Learning team

Lesson authors: Hayley Bridgwood and Samantha Webber
Editors: Bill Condie, Jim Rountree and James Whitmore
Art director: Robyn Adderly
Education director: Daniel Pikler

Image credits: Kate Patterson / MediPics / Prose, Getty images and iStock.
Video credits: Griffith Sciences, Ben Loran, Rob Nelson Films, Curious Videos, WizitArun and YouTube.