Department Energy and Water Supply

Water is special

year 6 Science

For the Australian Curriculum

Water: Learn it for life!

waterwise Queensland

Great state. Great opportunity.

Queensland Government

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Contents

Water is special

Introduction

Water is fundamental to life on Earth and should play a key role in our curriculum. The water cycle is a popular topic for teaching a range of science concepts. However, giving students a deeper understanding of some of the underlying concepts can be challenging.

In this lesson sequence, students explore what water is and how it behaves as it changes from ice to liquid water to water vapour. Some students struggle with even the most basic ideas, such as what a cloud is made of. They can hold a range of alternative conceptions about molecules and how water molecules behave, and seem to find the processes of evaporation and condensation particularly challenging to understand. Some students may believe that when water evaporates, it ceases to exist. In the case of condensation, some students believe that:

- water comes through the glass
- coldness comes through the glass
- the cold surface and dry air (oxygen and hydrogen) react to form water
- water in the air sticks to the glass.

The purpose of this lesson sequence is to give primary students a clear mental picture of water molecules. Learning about how these molecules behave when water is heated and cooled can help them to understand how the water cycle works. These mental pictures will be a useful foundation for further learning in chemistry.

Australian Curriculum links

Science—Year 6

» Science Understanding

Chemical sciences

- Changes to materials can be reversible, such as melting, freezing and evaporating_ or irreversible, such as burning and rusting (ACSSU095).

» Science as a Human Endeavour

Use and influence of science

- Scientific understandings, discoveries and inventions are used to solve problems that directly affect peoples' lives (ACSHE100).
- Scientific knowledge is used to inform personal and community decisions (ACSHE220).

» Science Inquiry Skills

Questioning and predicting

- With guidance, pose questions to clarify practical problems or inform a scientific investigation, and predict what the findings of an investigation might be (ACSIS232).

Planning and conducting

- With guidance, plan appropriate investigation methods to answer questions or solve problems (ACSIS103).
- Use equipment and materials safely, identifying potential risks (ACSIS105).

Processing and analysing data and information

- Compare data with predictions and use as evidence in developing explanations (ACSIS221).

Unit overview

» How is water recycled

Engage

Where does rain come from?

Pre-test: Concept cartoon head talk

Why does the mirror in the bathroom fog up when you are having a shower?

Why is Whizzy a waterdrop?

Read Whizzy's Incredible Journeys

Explore

How many drops of water can you fit on a five cent coin?

Predict—Observe—Report

Explain

What is water made of?

Why is water sticky?

What happens to the water molecules when water changes state?

Matter and evaporation learning object

Molecular drawings

Elaborate

Making a solar still

Revisit the water cycle—link to water cycle in our local area

Reflection and assessment

Pre-test: Concept cartoon head talk

Why does the mirror in the bathroom fog up when you are having a shower? Using scientific terminology

Teaching and learning sequence

Focus question	Lesson steps	Time (minutes)	Resources
Why do mirrors fog up?	**Engage** 1. Use the 'foggy mirror' concept cartoon (Resource 1) to identify students' prior knowledge about condensation. The same concept cartoon will be used at the end of the unit to assess student learning over the unit. In their water journal, students identify the responses they think are correct and explain their choice. If students have an alternative idea, they record that idea and explain it. (Resource 1a can be used for this.)	15	'Foggy mirror' concept cartoon (Resource 1) » Student water journal
How are clouds formed?	2. Display the concept cartoon 'Where does rain come from?' (Resource 2). Ask students to share their ideas with the class. This cartoon is one of a range of Indigenous concept cartoons developed as part of the *Conversations about Science* curriculum resource. These cartoons draw on a range of themes, contexts, cultural references and language familiar to Indigenous and refugee students, to improve the accessibility of science concepts and enhance student engagement.	5	'Where does rain come from?' concept cartoon (Resource 2)
	3. Read the river journey in *Whizzy's Incredible Journeys*. Discuss how the clouds are formed in this story. Ask students how the illustrator explained how clouds are formed. They should make a judgement about how accurately the illustrator has drawn this process. Ask students to write their ideas in their water journal using the sentence starter: 'I think that the illustrator ……'.	20	*Whizzy's Incredible Journeys* in hard copy or from the CD-ROM with a digital projector or interactive whiteboard Student water journal
Why is Whizzy a water drop?	4. In the story *Whizzy's Incredible Journeys*, Whizzy is a water drop. Using a 'noisy round robin' brainstorming strategy, students work in groups to record their initial ideas about why water forms droplets.	10	A4 sheets of paper with the question 'Why does water form droplets?' and space for groups to complete their answers.
How many drops of water can you fit on a five cent coin?	**Explore** 5. Display the Word splash and ask students to discuss the meaning of these terms and to predict what they think the activity will involve. 6. Students investigate what happens when liquid water forms a water drop by answering the question 'How many drops of water can you fit on a five cent coin?'. Hand out the equipment for this activity. Using a Predict-Observe-Explain approach, first ask the students to predict how many drops of water they think will fit on a five cent coin and what they think the water drops will look like on the coin. Record their predictions in their work sheet (Resource 4). Then ask students to predict what they will see when they drop the water drops on the coin.	20	Word splash (Resource 3) » Five cent coin » Plastic pipette or dropper » Paper towel » Small cup of water Student worksheet—Predict-Observe-Explain (Resource 4)

Focus question	Lesson steps	Time (minutes)	Resources
How many drops of water can you fit on a five cent coin? (continued)	7. In groups of three, students observe what happens when they add the drops to the coin. They need to record the total number of drops, their observations and any questions that occur to them while they are doing the activity. What shape did the water drops take? The student-initiated questions could include 'Does the side of the coin make a difference?', 'Does the height that the dropper is held above the coin make a difference?' or 'Does the placement of the drops make a difference?'. Student groups can investigate these questions at the end of this lesson sequence.		Student worksheet—Predict-Observe-Explain (Resource 4)
What is water made of?	**Explain**		
	8. In the Explain phase of this activity, discuss the results, observations and questions raised. *Note that the questions raised could form the basis for further independent student inquiry in the Elaborate phase of the unit. Students could design a 'fair test' to investigate a question of their choice.* Ask students to speculate about why we would describe water as 'sticky'. Students might express surprise that the water droplet formed a tall dome and bulged out over the sides of the coin.	20	Diagram of a water molecule (Resource 5)
	9. Ask students what they think water is made of. Explain that it took scientists many hundreds of years to discover what the matter around us (including water) is made of. They concluded that water is made of molecules. Display a diagram of a water molecule. Explain that water is made of billions of tiny, tiny, tiny particles called molecules. We can't see water molecules directly even with powerful microscopes so scientists use models and diagrams, like the diagram in Resource 5, to understand what molecules look like. Ask students what aspects of the water molecule diagram might be like a real water molecule (such as, it is made up of two types of particles) and what aspects might be unlike a real water molecule (such as, it is much much, much, much smaller; it is not coloured like the diagram and probably doesn't have a hard shiny surface).		
	10. Students can make a model of a water molecule using plasticine or fuzzy balls with Blu-Tack. Ask students to evaluate their own model by identifying the aspects of the model that might be like a real water molecule and what aspects might be unlike a real water molecule. Students should keep their models on their desks for the next activity.		For each pair of students: » Two balls of plasticine – different colours or » Two larger fuzzy balls of the same colour and four smaller fuzzy balls of a different colour (can be sourced from the craft section of a discount shop) » Small piece of Blu-Tack

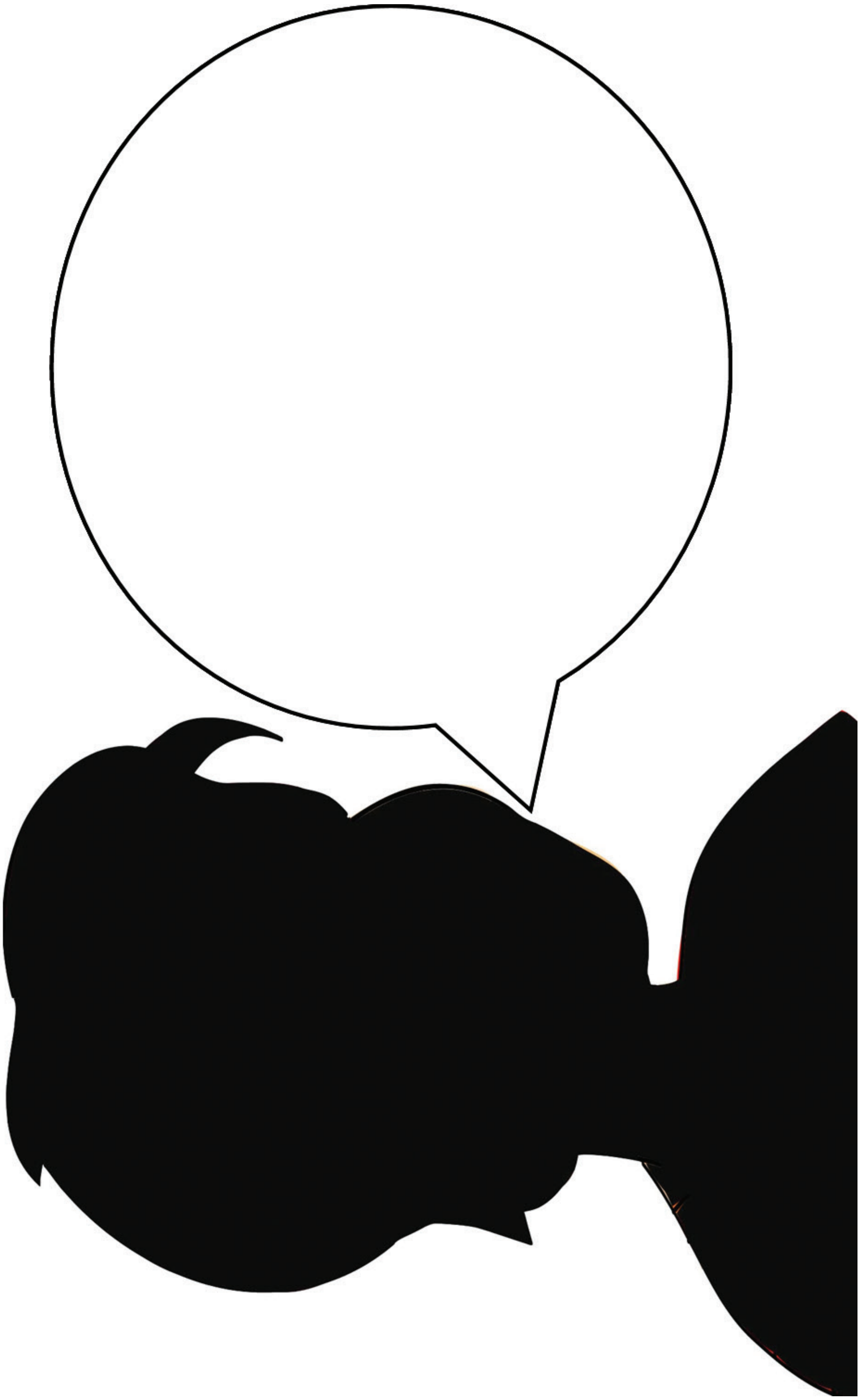
Focus question	Lesson steps	Time (minutes)	Resources
Why is water 'sticky'?	11. Explain that scientists also worked out why water is 'sticky' (see the note below). One end of the water molecule has a slight negative charge and the other end of the water molecule has a slight positive charge. Display the diagram of a water molecule showing the charges on the water molecule (Resource 6). 12. Working in pairs, ask students to use their models to predict how the charged water molecules might align when they are close to each other. Students should be able to predict that the negative end of one molecule will align with the positive end of the other molecule or vice versa. *Note: This explanation is dependent on the students' prior experience with the concepts of electrical charge. If the students are unsure about the basics of electrostatic charges, ask them to rub a balloon in their hair and hold it near a wall. Explain that rubbing the balloon on their hair caused a build up of negative charges and that holding the balloon against the wall causes a build up of positive charge on the surface of the wall. So the balloon sticks to the wall.*	10	Diagram of a water molecule with charges (Resource 6)
How are water molecules arranged in ice?	13. Ask students to speculate how water molecules might be arranged when frozen in ice. Students could work in groups of four to arrange their plasticine or fuzzy ball models. If you have time, students could make additional plasticine or fuzzy ball models.		Optional: additional materials for making model water molecules (See Step 9)
	14. As a class, watch Experiment 1 in the learning object 'Matter and evaporation'. This experiment simulates what happens when ice is heated from -10ºC to -1ºC. The simulation initially asks the students to predict if the ice will melt when heated to -1ºC. Play the simulation through a number of times to allow the students to watch the different elements on the screen. For instance, on first viewing you might focus student attention on the ice cube. Does it melt? On the next viewing, you might focus their attention on how the water molecules are arranged in the ice and then how the motion of the water molecules change as the ice is heated. Ask students to complete Part A of Resource 7.	20	Learning object 'Matter and evaporation' (The Learning Federation TLF 1490) » Digital projector or interactive whiteboard How are water molecules arranged in ice, liquid water and water vapour? (Resource 7)
What do the water molecules do when the ice melts?	15. Ask students what they think will happen if the ice cube is heated further. As a class, watch Experiment 2 of the 'Matter and evaporation' learning object. Students complete Part B of Resource 7.		

Focus question	Lesson steps	Time (minutes)	Resources
What happens to water molecules when liquid water evaporates to form water vapour?	16. Ask students to suggest what they think will happen if the liquid water is heated to higher and higher temperatures. As a class, watch Experiment 3 of the 'Matter and evaporation' learning object. Students complete Part C of Resource 7.		Learning object 'Matter and evaporation' (The Learning Federation TLF 1490) » Digital projector or interactive whiteboard How are water molecules arranged in ice, liquid water and water vapour? (Resource 7)
What happens to salty water in a solar still?	**Elaborate** Show students the equipment and materials to make a solar still (Resource 8). Ask students to predict what kind of liquid they will get in the small cup in the centre of the still. Students work in groups to complete the Predict-Observe-Explain activity in Resource 9 while they make and use a solar still.	60	Making a solar still – teacher resource (Resource 8) Making a solar still – student resource (Resource 9) For each group: » 2-litre plastic ice cream container » Small, shallow glass or cup or plastic shot cup (clean) » Cling film (wider than the bowl) » Rubber band » Pebble » Hot water » Food dye » Salt
	Evaluate Ask students to reflect on what they learned in this unit. Revisit the concept cartoon in Step 1 (Resource 1). Ask the students to demonstrate what they know by completing Resource 1a. Alternative assessment task: Read the river journey in *Whizzy's Incredible Journeys* to the students again. Ask the students to write a brief story about the journey of a water molecule that passes through a solar still.	20	'Foggy mirror' concept cartoon (Resources 1 and 1a)

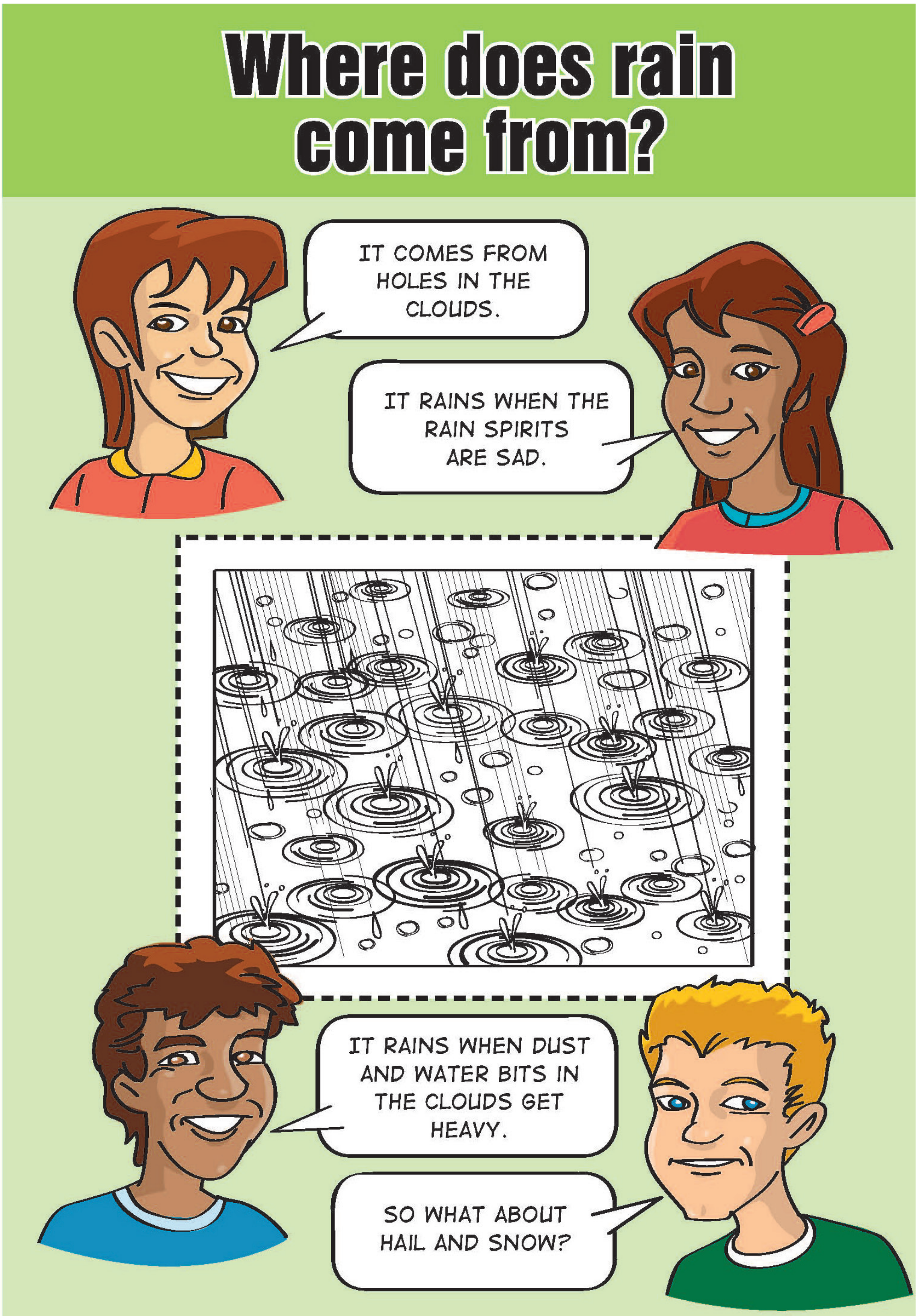
‘Why does the mirror fog up’ concept cartoon

Student worksheet

Why does the mirror fog up when you have a shower?



‘Where does rain come from?’ concept cartoon



Word splash

Word splash!

Water

gas

ice

molecule

condenses

sticky

liquid

evaporates

Resource 4

How many drops of water fit on a five cent coin?

» My predictions

I predict that ______ drops will fit on a five cent coin

I predict that that the coin and the water drop will look like this.

» My observations

a) The water on the coin was shaped like

____

____

b) I also observed ____

____

c) Some questions we asked while we did this activity were: ______________

____

____

____

My explanation

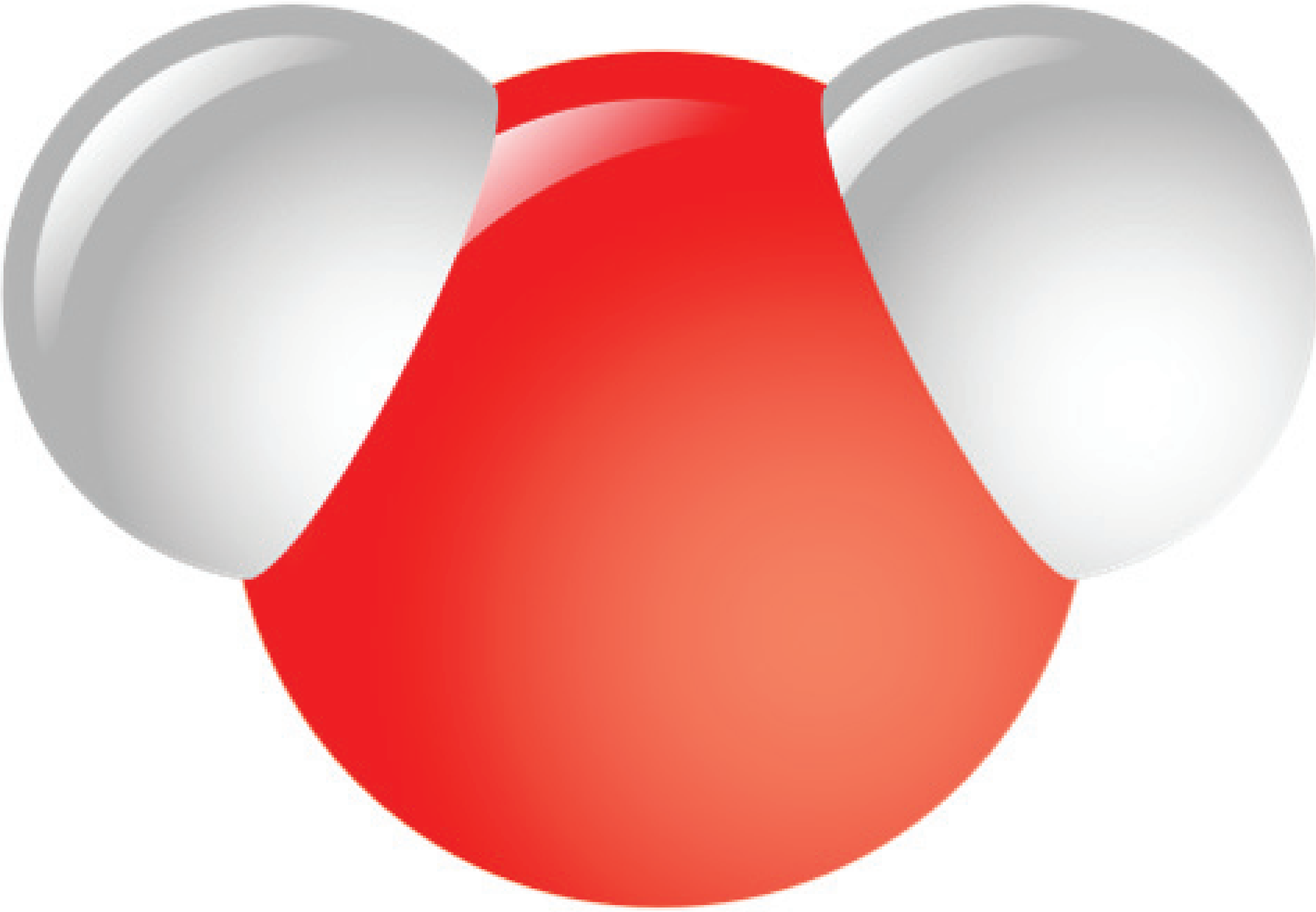
The water drop took this shape because ______________________

____

____

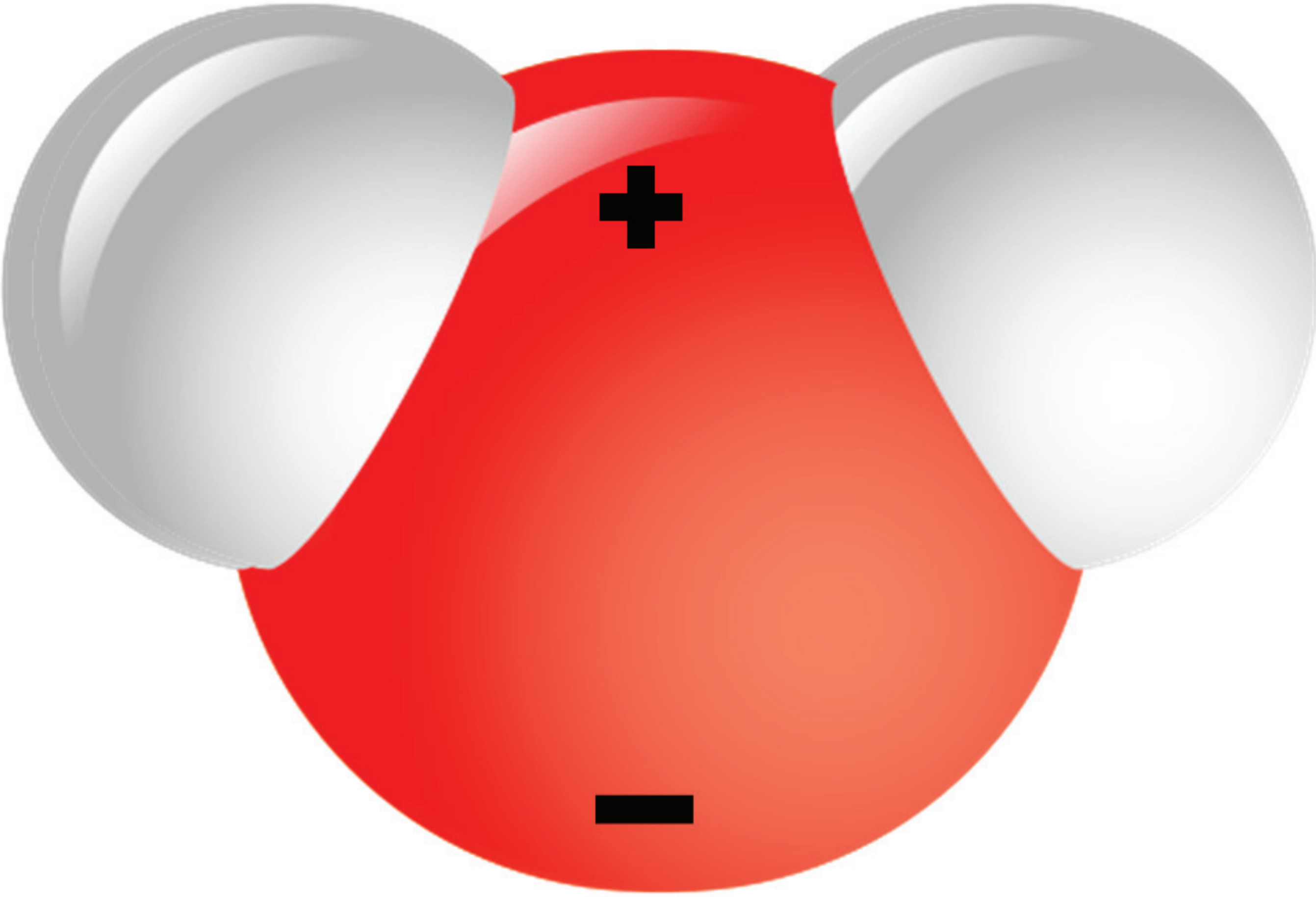
____

Water molecule diagram



Resource 6

Water molecule diagram with charges



Resource 7

How are water molecules arranged in ice, liquid water and water vapour?

Part A Experiment 1—Solid water (ice)	
Draw a labelled diagram to show how water molecules are arranged in ice.	Explain in your own words how water molecules are arranged in ice.
Part B Experiment 2—Liquid water	
Draw a labelled diagram to show how water molecules are arranged in liquid water.	Explain in your own words how water molecules behave when they are in a liquid form.
Part C Experiment 3—Water vapour	
Draw a labelled diagram to show how water molecules are arranged in water vapour.	Explain in your own words how water molecules behave when they are in a water vapour.

Your reflections:

Today, I think I learned ______________________________

____

____

The solar still activity (teacher resource)

Adapted from a resource developed by Dr Tony Wright (School of Education, University of Queensland)

This is a versatile activity that uses a solar still to purify water. Students will witness coloured salty water transformed into clear unsalted water. Different versions of a solar still can used to desalinate seawater, in desert survival kits and for home water purification. To find out more about how a modern desalination plant such as the Gold Coast Desalination Plant, go to the seqwater 'learning centre' and then 'interactive virtual tours' ‹www.seqwater.com.au›.

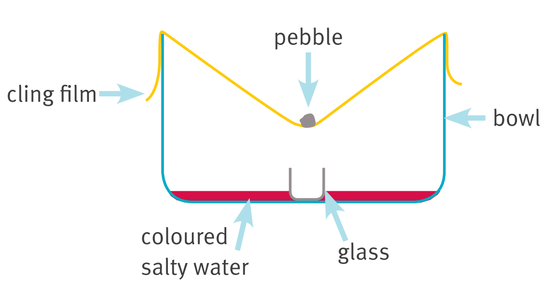
The aim of the activity is to provide students with the opportunity to extend their ideas about evaporation and condensation to a new context, to consolidate their learning about these concepts and to demonstrate their understanding. This activity can be used to assess student learning either formatively or summatively.

For this activity, the students complete the Predict–Observe–Explain worksheet (Resource 9). Explain the activity to the students and ask them to complete the Predict section of the worksheet before they begin the task.

Risk assessment: Complete an appropriate risk assessment for this task. The main hazard in this activity is that the water in the small cup in the solar still could be contaminated with pathogens. To minimise this risk, make sure that the small cups are either disposable or very clean. The students should be careful not to touch the inside of the small cup. Students can taste the water in the small cup using a disposable straw.

You will need a sunny day to do this activity!

The Solar Still



Equipment

For each group of three students:

- one 2-litre plastic ice cream container
- small, shallow plastic cup or shot cup (clean)
- Blu-Tack (or similar)
- cling film (wider than the bowl)
- pebble
- hot water
- food dye
- salt
- disposable drinking straws

Method

Mix up a plastic jug of hot water with the food colouring and a couple of tablespoons of salt in front of the class. Make enough solution to fill each ice cream container to a depth of about 1 cm.

Take all the equipment out to a sunny, level place.

Assign the students to groups of three to complete the activity. Warn the students that they will need to be very careful not to contaminate the inside of the small plastic cup with salty water.

Place a small piece of Blu-Tack on the bottom of the small cup so that it will stick to the bottom of the ice cream container.

Pour the coloured salty solution into each ice cream container (ensuring the water has cooled to become tepid) and carefully place the plastic cup in the middle of the container, making sure no water splashes into it.

Cover loosely with cling film so that the cling film sags slightly in the middle. Seal the film to the rim of the ice cream container with a large rubber band.

Place the pebble in the middle of the film (directly above the cup).

Leave the still for at least half an hour (the longer the better).

1. Remove the cling film and take out the cup without splashing any water into or out of the cup.
2. Ask the students to make observations about the water in the cup. Is it coloured? What does it taste like? Students can taste the water using a straw.

Examples of different levels of student explanations—How does the solar still work?

Students can explain this activity at a range of levels, from a basic description of the phenomenon to a detailed explanation at the ionic level. The following explanations provide examples of how students from mid-primary to upper secondary phases might answer this question.

Level A

The water in the big container is heated by the sun and goes through the air and collects in drops on the cling film. Then it runs down to where the pebble is and falls into the cup. The food colour stays in the big container.

This explanation correctly indicates the movement of water from the bowl to the cup and identifies the need for heat to make the water evaporate. However, no distinction has been made between the water mixture and purified water. Also no attempt has been made to use the appropriate language about the states—solids, liquids and gases—or the processes of evaporating and condensing.

Level B

The water mixture in the bowl is heated by the sun. It evaporates and forms water vapour which travels up to the cling film and condenses back to liquid water again. The droplets of water on the cling film collect together and run down to the pebble and then fall into the cup. The other compounds in the water mixture do not evaporate and so the water is purified and is safe to drink.

The explanation correctly indicates the changes of state occurring and goes on to point out that the salt and food dye do not evaporate and so components of the mixture are separated, purifying the water and changing its usefulness.

Level C

In the big container the water molecules (particles) evaporate forming a gas in which the molecules are moving around in the air. Then they condense on the plastic, forming droplets of liquid water with all the molecules packed together. These droplets collect together and run down into the cup. The other compounds don't evaporate so their molecules don't go into the air.

This explanation makes the first attempt to use particle theory to explain the processes involving water molecules (the particles that make up water). The explanation also correctly identifies that the particles of the other compounds do not evaporate, thereby enabling the separation.

Level D

In the big container the water molecules are moving around but remain touching each other. The sun provides the energy necessary for some of the water molecules to break away and move about in the air colliding with other air molecules but remaining separate. When they collide with the plastic cling film they lose some energy and form droplets with other water molecules. As the droplets get bigger they clump together and finally run down to the lowest point under the pebble and drop into the cup.

The molecules of food dye are much bigger because they contain lots more atoms and so the rate of evaporation is very slow. This means so few molecules evaporate that there is no visible dye in the cup. The salt particles don't evaporate either. This means pure water collects in the cup and is drinkable.

Level E

The salt particles don't evaporate because salt is made up of sodium (Na^+) ions and chloride (Cl^-) ions. These ions are surrounded by water molecules and don't get enough energy from the sun to break free from the solution and move as separate ions in the air.

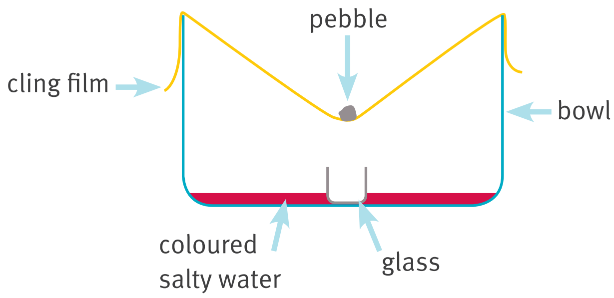
The solar still could be used to separate water from other ionic compounds, polymers and other non-molecular solids such as glass and other minerals. It couldn't be used to separate other volatile (molecular) compounds such as small hydrocarbon molecules, like alcohol (ethanol).

The solar still activity: Predict–Observe–Explain

The solar still is a device that that uses solar energy to purify water. Different versions of a still are used to desalinate seawater, in desert survival kits and for home water purification. It is very easy to splash salty water into the small cup in the middle of the solar still so be very careful!

Before you begin this activity, write your prediction below. What do you think will happen? What will you get in the small cup in the middle of the solar still?

The Solar Still



Method

1. Take all the equipment out to a sunny, level place.
2. The teacher will pour 1 cm of the coloured salty water into your ice cream container.
3. Place a small piece of Blu-Tack on the bottom of the small cup so that it will stick to the bottom of the ice cream container.
4. Carefully place the plastic cup in the middle of the ice cream container, making sure no salty water splashes into the small plastic cup.
5. Cover loosely with cling film so that it sags slightly in the middle. Seal the film to the rim of the ice cream container with a large rubber band.
6. Place the pebble in the middle of the film above the cup.
7. Leave the still for at least half an hour (the longer the better).
8. Remove the cling film and take out the cup without splashing any water into or out of the cup.
9. Record your observations about the water in the plastic cup on this worksheet. Is it coloured? What does it taste like? Students can taste the water using a straw.
10. Complete the worksheet by explaining your ideas about why you got your results.

Use the following words in your explanation:

- evaporate
- liquid
- vapour
- condense
- molecules

Predict

I think that ____

____

____

____

because____

____

____

____

Observe

Our group found that ____

____

____

____

____

____

Explain

I think that ____

____

____

____

____