# Science

Queensland Comparable Assessment Tasks (QCATs) 2012

# Model behaviour

Student booklet

6

Given name: . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

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# Setting the scene

Weather is a “snapshot” of the atmosphere at a particular time.

Wind is a key feature of the weather.

## How does the wind affect us and our environment?

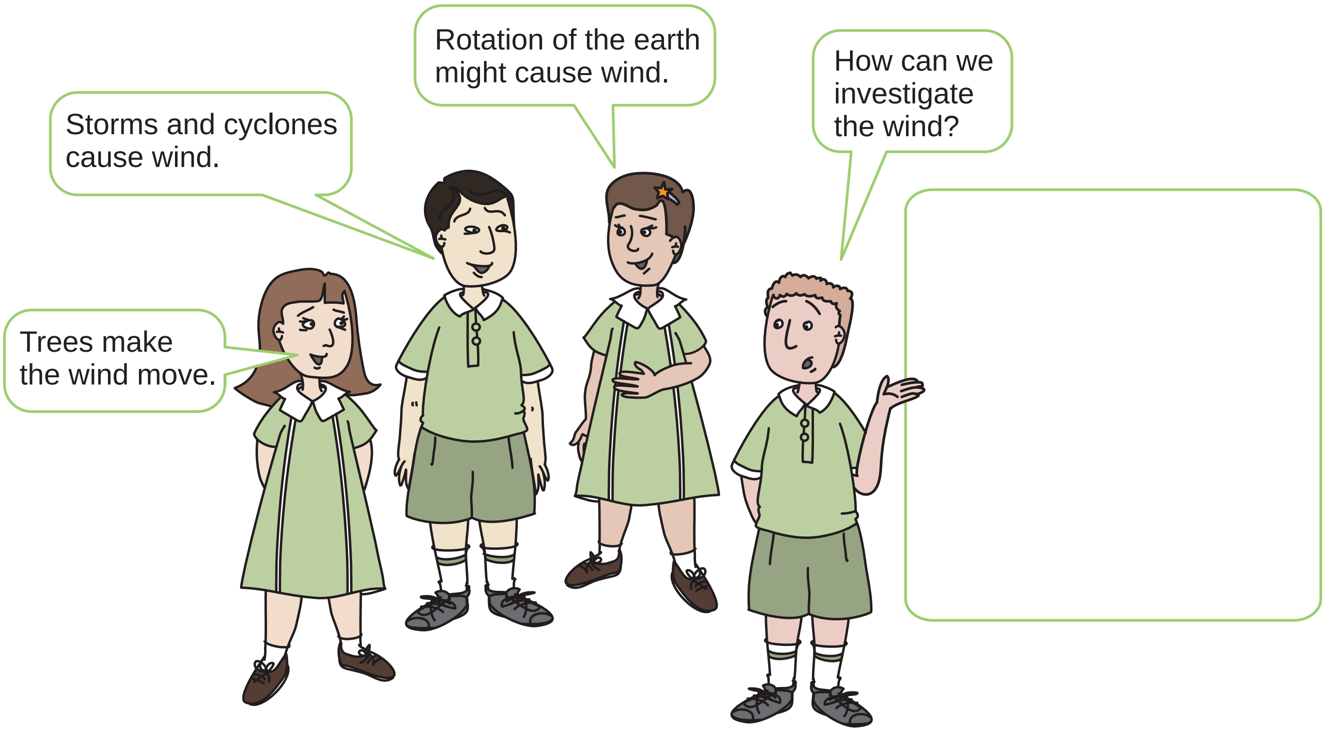
Use these images below to discuss how the wind affects us and our environment.

# What causes the wind to move?

Together read the ideas of the students below.

In the space provided write one of your ideas about the wind and what causes it to move.

Discuss your ideas with your class.



The wind is caused by processes we cannot see.

In Science we can **model** processes in nature to help explain the weather we observe, such as wind.

Discuss some models you have used in class to show features of weather or other phenomena such as electric currents, earthquakes, our solar system or erosion.

How were the models similar to and different from nature?

# In this assessment, you will:

- model two ways fluids move in nature
- explain wind patterns and wind speed in nature
- explain cyclone data and observations
- describe the effects of cyclones on the environment
- describe how new technology can reduce the impacts of cyclones.

Queensland Studies Authority PO Box 307 Spring Hill Qld 4004
Phone: (07) 3864 0299 Fax: (07) 3221 2533 Email: office@qsa.qld.edu.au Website: www.qsa.qld.edu.au

Images p. 2 Beach erosion: <www.123rf.com/photo_7637530_beach-erosion-a-dead-tree-on-the-beach.html>; Wind surfer: <www.123rf.com/photo_10577497_windsurfing-champion-playing-in-the-waves.html>; Wind farm: Drew Broadley, "Wind farm" <www.sxc.hu/browse.phtml?f=view&id=395675>; Wave: <www.123rf.com/photo_8647503_rough-windswept-waves-off-the-south-african-shore.html>; Cyclone from space: <www.123rf.com/photo_9396382_cyclone.html>; p. 6 Photo: <www.123rf.com/photo_3811402_engineer-at-wind-farm-portrait.html>; p. 13 Satellite image: Satellite image(s) originally processed by the Bureau of Meteorology from the geostationary meteorological satellite MTSAT-2 operated by the Japan Meteorological Agency; p. 15 Photo: www.123rf.com/photo_8026232_asian-business-woman-outdoors-in-thailand.html.
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# Modelling weather: Wind

## Investigation 1: Modelling how fluids move

A **fluid** is a substance that can flow, such as water (a liquid) and air (a gas).

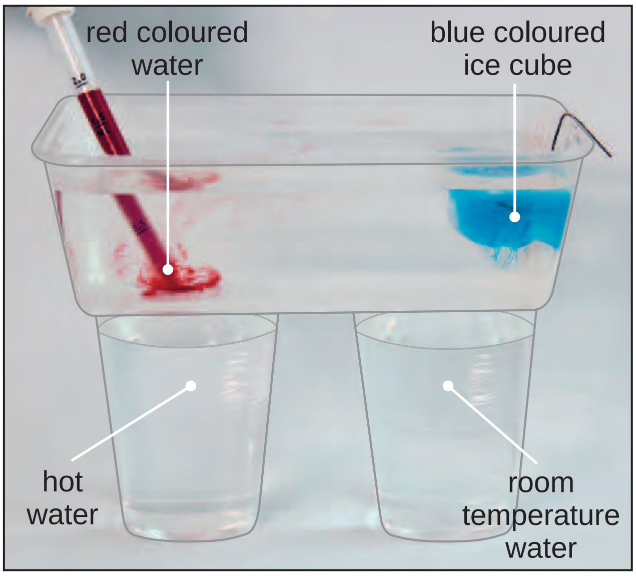
**Investigate:** How can we model one way fluids (water and air) move in nature?

**Materials:**

- transparent container
- dropper
- 2 cups
- 700 mL room temperature (tap water)
- 200 mL hot water
- 2 mL tap water (coloured red)
- ice cube frozen with paperclip (coloured blue)

**Procedure:** Follow your teacher's safety instructions and the steps below to set up a model in your group.

1. Fill the transparent container with tap water. **Keep the container and water still until there is no movement.**
2. Carefully fill one cup with hot water and the other cup with tap water.
3. Place the cups next to each other.
4. Slowly lift the plastic container onto the cups, keeping the water as still as possible.
5. Carefully hang the paperclip with ice over the edge of the container **above the room temperature cup**.
6. Use a dropper to gently squeeze the red water onto the bottom of the container **above the hot water cup**.



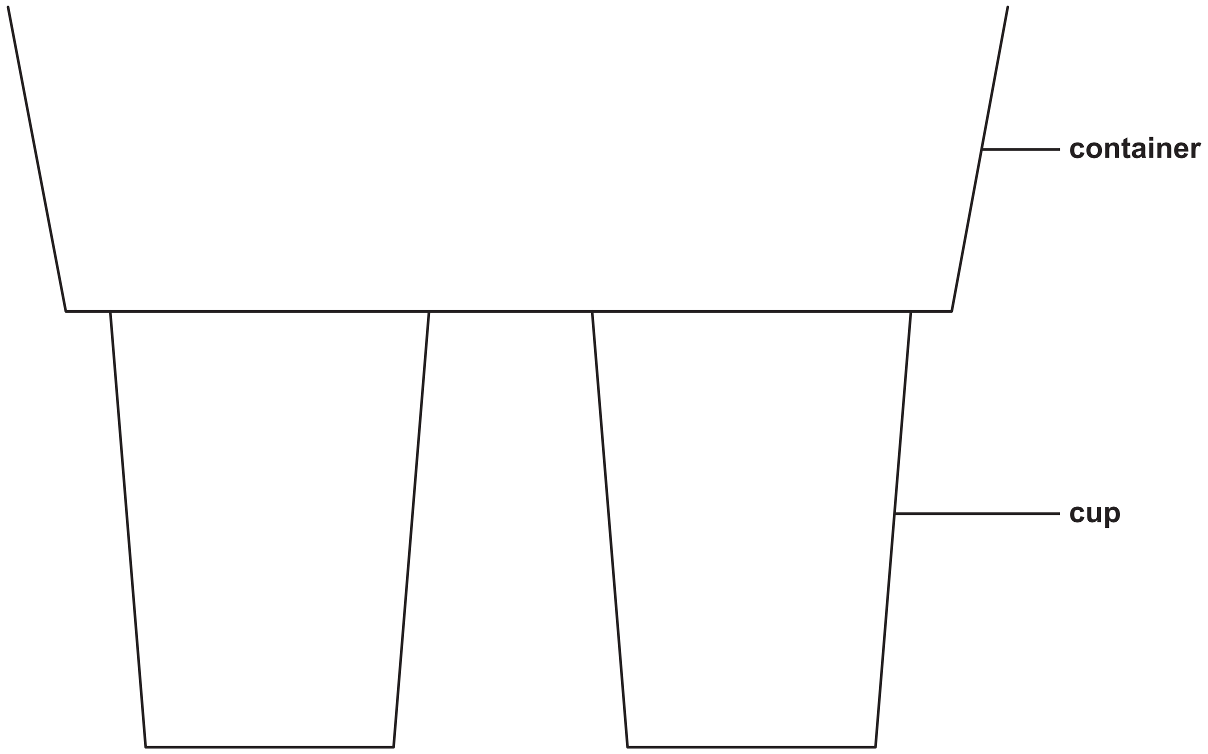
**Observe:** At eye level, observe the movement of the blue and red water for 2–3 minutes.

Recall that heat moves from one object to another.

In this model heat moves **from** the heat source (hot water) **to** the fluid above.

Work individually to answer the following questions.

1. Complete the **scientific diagram** below to record your observations of how the cool (blue) and warm (red) water moved in the container.



Hint: Use arrows to show movement of fluids.

2. Describe the pattern of each fluid's movement.

Warmer fluid . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

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Cooler fluid . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

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# Explaining wind patterns

## Group discussion

**Convection** is the movement of fluids caused by differences in temperature.

In nature, warm land and ocean warm the air above.

When air moves we call it **wind.**

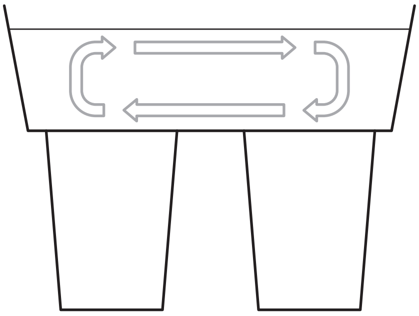
**Engineer, wind farm**

With your class compare convection in the model with convection in nature:

- Draw lines to label the diagrams below.

Hint: Each label may be joined to one or both diagrams.

**Convection in Model 1**



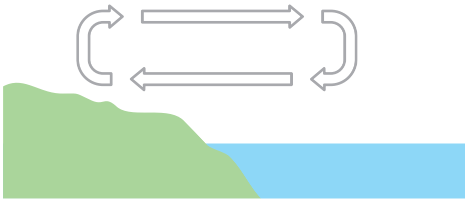
**Labels**

convection in water

convection in air

heat source

**Convection in nature**



- Complete these sentences using words from the box and the diagram above.

land ocean wind hot water fluid

In the **model**, the heat source is the . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

In **nature** the heat source can be the . . . . . . . . . . . . . . . . . . . . or the . . . . . . . . . . . . . . . . . . . . . .

In **both** the model and nature, heat moves **from** the heat source **to** the . . . . . . . . . . . . . . . . above and causes it to move. This movement of fluids is called **convection**.

Convection can cause different wind patterns during the daytime and night-time.

**3.** Show the daytime and night-time wind patterns below.

- Compare the land and ocean temperatures.
- Circle the words in the flow chart to complete the sentences correctly.
- Draw arrows on the diagram to show the wind movement in your choices for ii, iii and iv.

## Daytime wind pattern

Flow chart

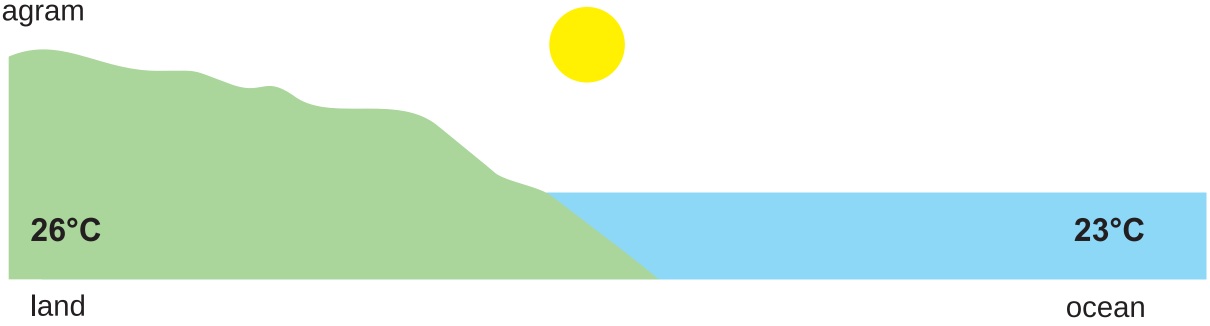
(i) The land is **warmer / cooler** than the ocean.

(ii) Air above the land will be **rising / falling.**

(iii) Air above the ocean will be **rising / falling.**

(iv) This will cause the wind to blow across the surface **from** the **land / ocean** **to** the **land / ocean.**

Diagram



## Night-time wind pattern

Flow chart

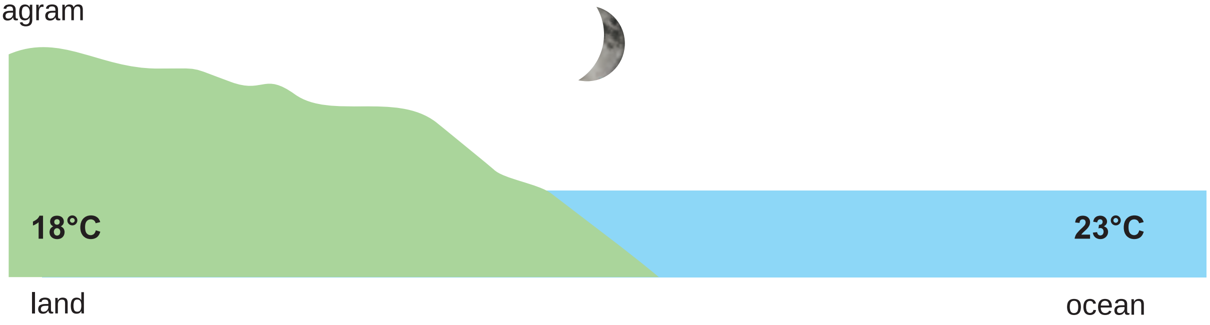
(i) The land is **warmer / cooler** than the ocean.

(ii) Air above the land will be **rising / falling.**

(iii) Air above the ocean will be **rising / falling.**

(iv) This will cause the wind to blow across the surface **from** the **land / ocean** **to** the **land / ocean.**

Diagram



# Explaining wind speed

## Teacher demonstration: Modelling speeds of convection

**Investigate:** When we change the temperature of the heat source, what happens to the speed of convection?

**Predict:** We predict that . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

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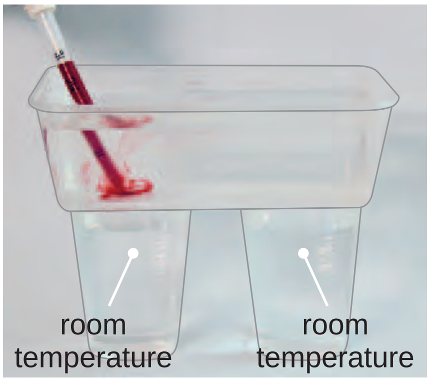
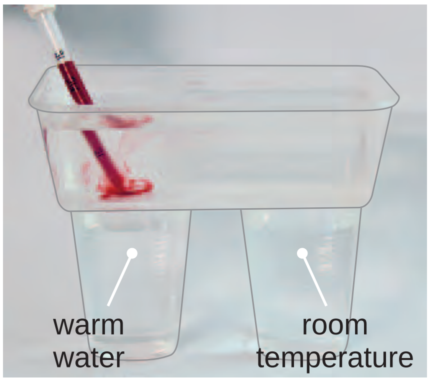
- Discuss the reasons for your prediction.

As your teacher sets up the materials, discuss the **variables** that need to be controlled.

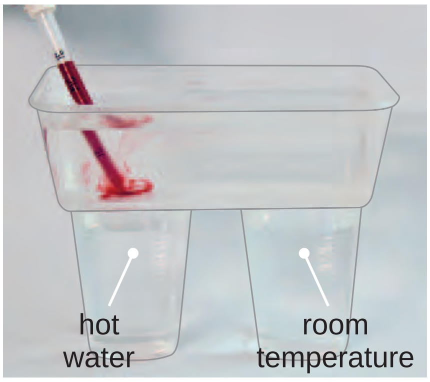
**Container 1**



**Container 2**



**Container 3**



**Observe:** Record how many seconds it takes for the red water to reach the surface in each container.

- Complete Table 1.

**Table 1**

| Container | Temperature *difference* between the cups | Time taken to reach the surface (seconds) |
|---|---|---|
| 1 | **[✓ none] / small / large** | |
| 2 | **none / small / large** | |
| 3 | **none / small / large** | |

**Explain:** Use your observations to describe the pattern and think about your prediction.

The **larger / smaller** the temperature difference,
the **faster / slower** the fluid above it moves.

- Discuss how well your observations match your predictions.

Work individually to answer the following questions.

Map 1 shows the ocean temperatures along the Queensland coast and the land temperature at three different Queensland towns.

**Map 1**

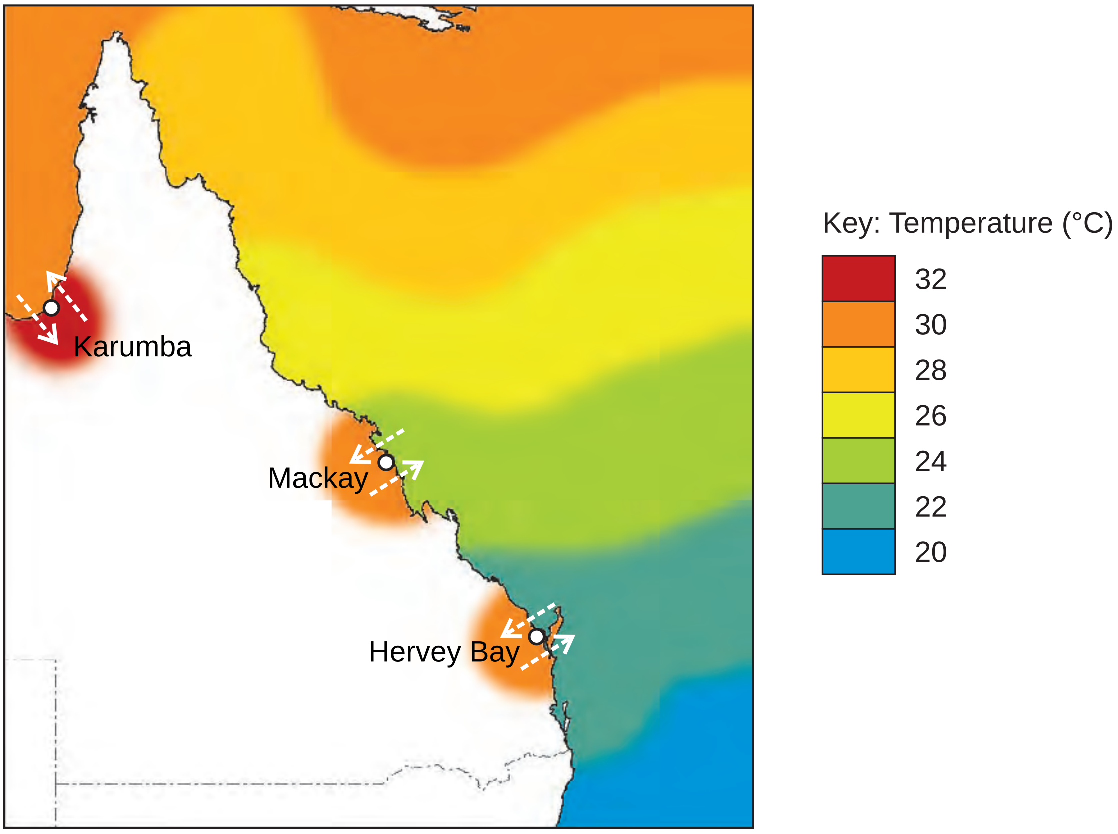


**Table 2**

| | Land temperature (°C) | Ocean temperature (°C) |
|---|---|---|
| Karumba | | |
| Mackay | | |
| Hervey Bay | | |

**4.** (a) Complete Table 2 to record and compare the temperatures of the land and ocean at the three towns.

(b) Predict the **direction** of wind at each town. Draw over an arrow to show the direction.

(c) The wind **speed** will be fastest at **Karumba / Mackay / Hervey Bay**. (circle one)

(d) Explain your choice of town.

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

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# Modelling extreme weather: Wind in a cyclone

## Group discussion

Fast winds are part of many extreme weather events, including cyclones.

Did you know? Cyclones are classified by their wind speed.

| | | |
|---|---|---|
| Category 5 | Greater than 280 kilometres per hour | Extremely destructive winds |
| Category 4 | 225–279 kilometres per hour | Very destructive winds |
| Category 3 | 165–224 kilometres per hour | Very destructive winds |
| Category 2 | 125–164 kilometres per hour | Destructive winds |
| Category 1 | Less than 125 kilometres per hour | Gales |

## The cyclone vortex

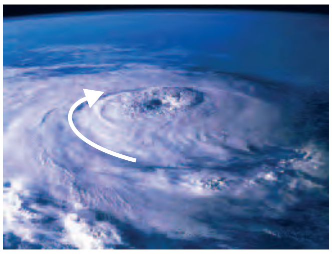
The word cyclone means “turning wind with one eye”.

When there is a storm over a warm ocean, weather scientists have noticed that it can start to spin into a cyclone if:

- the sea surface temperatures are above 26 °C
- wind speed reaches at least 63 km/h.

The spinning motion of a fluid (air or water) is called a **vortex**.

- Discuss how the vortex model might be similar to and different from the vortex in nature.
- Discuss situations where you have seen a vortex form.
- Move the bottles in different ways to try and create a vortex.



Nature

Model

## Investigation 2: Modelling how fluids move

**Investigate:** Which action helps fluids move the fastest?

**Predict:** We predict the action that will empty the bottle fastest will be **flip / pour / swirl**. (circle one)

This is because ..................................................................

..................................................................

Work individually to answer the following questions.

**Observe:** Use the given actions in Table 3 to empty the water from one bottle to the other.

- Record how many seconds it takes to empty the bottle for each action.
- Observe how the **air** and **water** move in each action.

**5.** Record times and observations for each action in Table 3.

**Table 3**

| Action | Forms a vortex (yes/no) | Time taken to empty the bottle (seconds) | Observations (how the water and air moved) |
|---|---|---|---|
| flip | | | |
| pour | | | |
| swirl | | | |

## Explain:

**6.** The action that emptied the bottle fastest was **flip / pour / swirl.** (circle one)

This is because . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Hint: Compare your prediction with your observations in Table 3.

## Group discussion

- Draw lines to label the following diagram:

slower water movement

faster water movement

the “eye”

direction of spinning fluid

- Move the vortex bottles to model how a cyclone might travel **across the ocean.**
- Move the vortex bottles to model how a cyclone might travel **across a town on the coast**.

# Explaining observations of a cyclone

Watch the video of satellite data showing the path of cyclone Ului in 2010.

As you watch, think about:

- how the fluid moved in the vortex model
- the direction of spinning cloud in the animation
- how the cyclone changes as it moves along its path.

# Eyewitness observations

Read the following eyewitness observations of Cyclone Ului crossing the Queensland coast.
The eyewitness was located at **A** on the satellite photo during the cyclone.

20–21 March, 2010

6:30 pm:

We could see the storm clouds of the cyclone getting closer and the wind was getting faster. The wind was coming from the south and pushing enormous waves about 10 metres high, right up onto the land.

1:00 am:

We were woken by the sound of destructive wind, trees crashing and windows smashing.

1:30 am:

Suddenly the wind stopped. For about an hour there was only very light rain and we could even see the stars!

2:30 am:

All of a sudden the destructive wind returned and the sky clouded over again.
The heavy rain started again but we were surprised that the wind was coming from the opposite direction.
After a few hours the wind speed slowed right down.

**7.** Use the vortex model and the video to explain some of the eyewitness observations.

(a) Why were there changes in wind speed? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

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(b) Why was there an hour of clear sky? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

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(c) Why were there changes in wind direction? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

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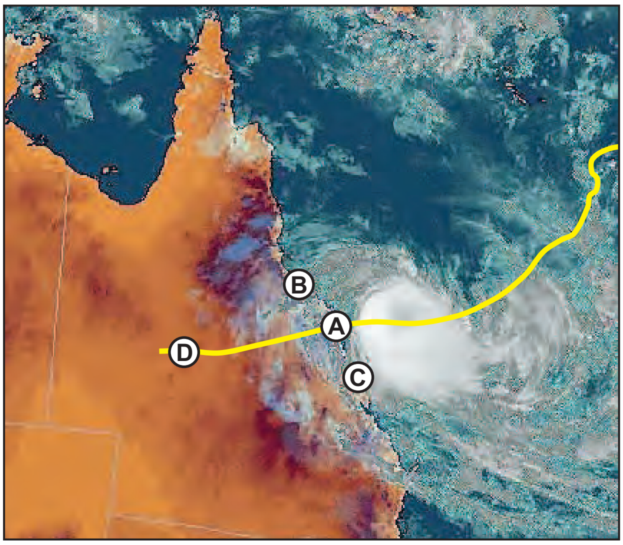
The satellite photo shows:

- the position of the cyclone when the eyewitness starts to make observations
- the path of the cyclone with a yellow line
- four locations **A**, **B**, **C and D.**



**Satellite photo**

**8.** Complete Table 4, using the video and satellite photo to:

- match the weather to a location
- explain your choice of location, giving reasons
- describe the different effects of cyclone weather on the environment.

**Table 4**

| Weather | Location on satellite photo | Effects on living and non-living environment |
|---|---|---|
| Heavy rainfall, strong destructive winds, large waves | **B / C / D (circle one)**<br>This is because | |
| Heavy rainfall, strong destructive winds | **B / C / D (circle one)**<br>This is because | |
| Light rainfall and flooding | **B / C / D (circle one)**<br>This is because | |

# Predicting cyclones

Read the case studies of two cyclones that have crossed the Queensland coast.

## Case study: Mackay cyclone 1918

### Warnings and predictions:

About 12 hours before cyclone crossed the coast
No record of warning or prediction

### Measurements:

Category: predicted to be 5
Wind speed: estimated 194 km/h
Maximum wave height: 7.6 m

(Most measurements and observations were made by local residents.)

### Impacts:

Widespread destruction to buildings
Loss of gas and water supplies
Loss of communication for five days
Trees uprooted

## Case study: Cyclone Ului 2010

### Warnings and predictions:

- Identified as Tropical cyclone: 12 March, Solomon Islands by satellite data
- Cyclone warning issued: 18 March, 10:00 am
  (2 days before crossing the Qld coast)
- Computer modelling predicted the cyclone to cross the coast: 1–2 am, 21 March
- Height of waves predicted by wave-monitoring sites
- Rainfall up to 200 mm, issued flood warnings inland

### Measurements:

Category: 3
Wind speed: 215 km/h (290 km/h gusts)
Maximum wave height: 9.4 m

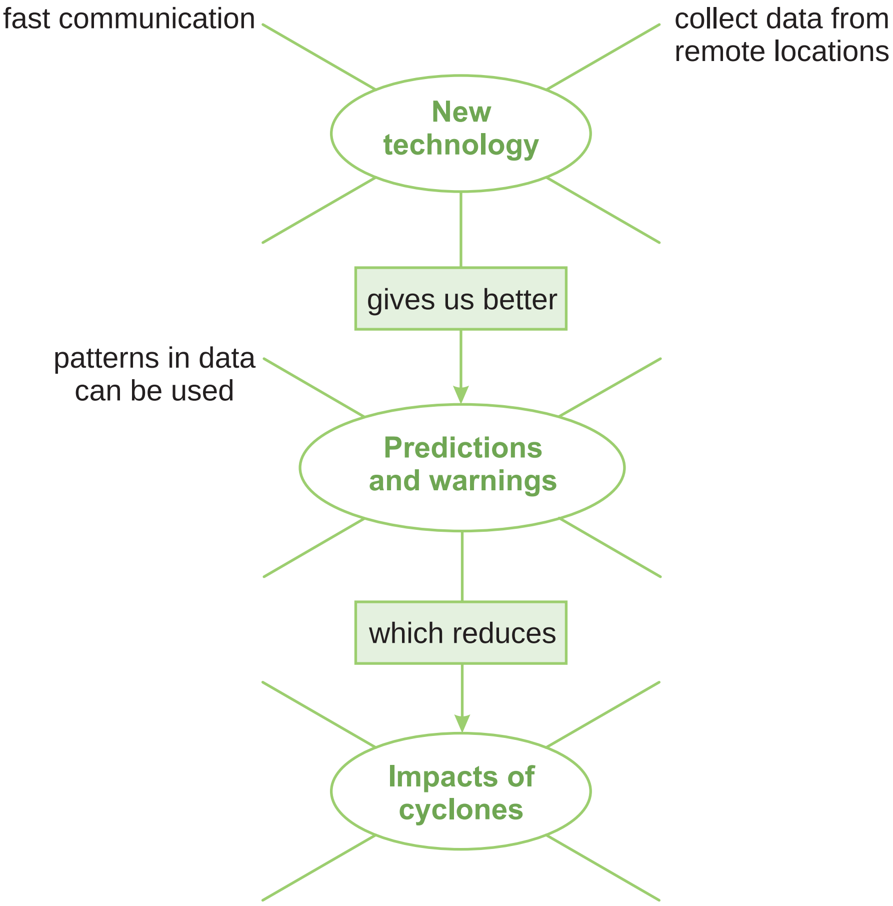
### Impacts:

Minor to moderate damage to buildings
Some loss of electricity
Sugar cane fields flattened
Forest trees stripped of foliage
No deaths

New technology has allowed scientists to understand cyclones and make better predictions and warnings. This can reduce the impacts of cyclones.

**Meteorologist**

**9.** (a) Annotate the flow chart below. Use your knowledge and the information in the Case studies on page 14.



(b) Draw lines between annotations to show links between ideas.

(c) **Explain** the links between ideas to show how the impacts of cyclones can be reduced.

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# Guide to making judgments — Year 6 Science

Student name . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

**Focus:** Model the behaviour of wind to make predictions and explain observations.

| Understanding | | Skills | | |
|---|---|---|---|---|
| **Science Understanding** | **Science as a Human Endeavour** | **Science Inquiry Skills** | | |
| **Earth and space sciences**<br>Describes the effects of a cyclone on the living and non-living environment.<br>Question 8 | **Nature and development of science**<br>**Use and influence of science**<br>Describes how new technology has been used by scientists to understand cyclones and improve predictions and reduce impacts.<br>Question 9 | **Processing & analysing data & information**<br>Uses observations and data to predict and explain wind patterns and the fastest way to empty a bottle.<br>Uses patterns, models and data to explain eyewitness observations.<br>Questions 3–7 | **Communicating**<br>Uses a labelled diagram and a description to communicate observations of convection.<br>Questions 1, 2 | |
| ◀ Gives scientific reasons for matching weather to locations. | ◀ Explains links between new technology, better predictions and warnings and reduced impacts of cyclones. | ◀ Applies the convection model to explain choice of fastest wind speed. Applies the vortex model to explain eyewitness observations of a cyclone. | ◀ Uses scientific conventions to show movement of warm and cool fluids. Describes the complete pattern of convection. | **A** |
| ◀ Correctly matches weather to locations. | ◀ Makes links between annotations. | ◀ Applies the convection model to predict wind direction and speed. Uses data and observations to explain the fastest way to empty a bottle. | | **B** |
| ◀ Describes effects of cyclones on both living and non-living aspects of the environment. | ◀ Annotates the flow chart to identify examples of new technology, better predictions and warnings and impacts of cyclones. | ◀ Explains an aspect of the eyewitness observation. Applies convection model by choosing words and drawing arrows to explain day and night wind patterns. | ◀ Uses scientific conventions to identify aspects of the convection model. Describes part of the pattern of convection. | **C** |
| ◀ Describes effects of cyclones on the environment. | | | | **D** |
| | ◀ Annotates the flow chart with relevant information. | ◀ Records data or observations from investigations. | ◀ Identifies aspects of the convection model in a diagram. | **E** |

Feedback: . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

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