STUDENT BOOKLET

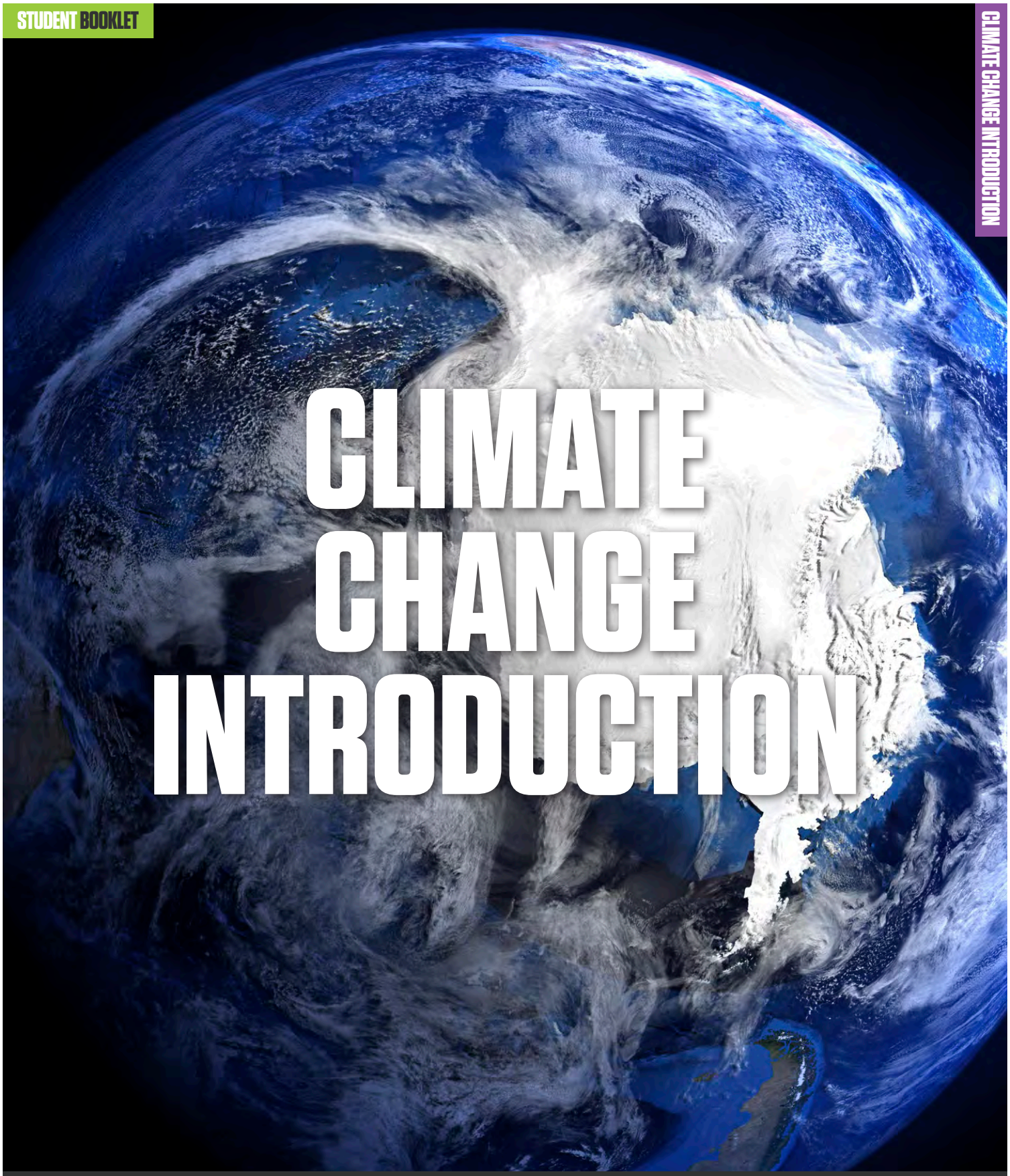
STELR

CLIMATE CHANGE AND OCEANS

NAME

CLASS

CONTENTS



CLIMATE CHANGE INTRODUCTION

BACKGROUND INFORMATION

Climate change is a frequently talked about topic in the media today. What are your opinions about climate change? How do your opinions compare with the rest of the class?

FOCUS QUESTIONS

1. What is climate change?
2. What causes it?
3. How will climate change affect you?
4. How will it affect people in other countries?
5. Is there anything we can do about it?

GROUP ACTIVITY

YOUR ATTITUDES TO CLIMATE CHANGE

Your first task in this topic is to complete this survey, which is designed to find out what you currently know about climate change.

Is our climate changing?

A. No.
B. Yes.

What best describes your thoughts about climate change?

A. I don't think the climate is changing.
B. I have no idea whether climate change is happening or not.
C. I think that climate change is happening, but it is just a natural fluctuation in the Earth's temperatures.
D. I think that climate change is happening, and I think that humans are largely causing it.

How worried are you about climate change?

1 = Not Worried, 5 = Very Worried

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

How much do you think climate change will harm you personally?

1 = Not a Lot, 5 = A Great Deal

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

How much have you personally experienced the effects of climate change?

1 = Not a Lot, 5 = A Great Deal

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

How important is climate change to you?

1 = Not Important, 5 = Very Important

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

The government of your country is...

A. doing enough about climate change.
B. doing too much about climate change.
C. not doing enough about climate change.
D. doing the wrong thing about climate change.

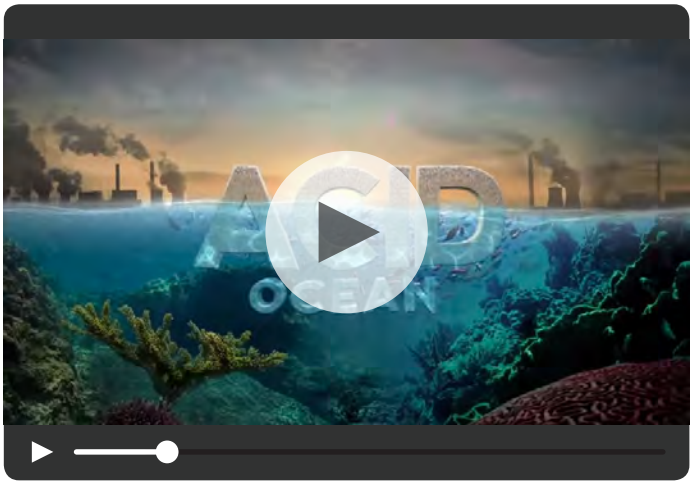
WORKSHEET 1

CLIMATE CHANGE CONCEPT MAP

Climate change is an issue that is frequently the subject of discussion and debate in the world today. In this worksheet you will explore what you and your classmates already know about this topic.

Watch this video to get you thinking about how global warming is affecting our oceans: www.youtube.com/watch?v=yQuTjRh18-8

This is a trailer for a documentary called *Acid Ocean*.



Have a class discussion about each of the Key Ideas for this lesson:

- What is climate change?
- What causes it?
- How will climate change affect you?
- How will it affect people in other countries?
- Is there anything we can do about it?

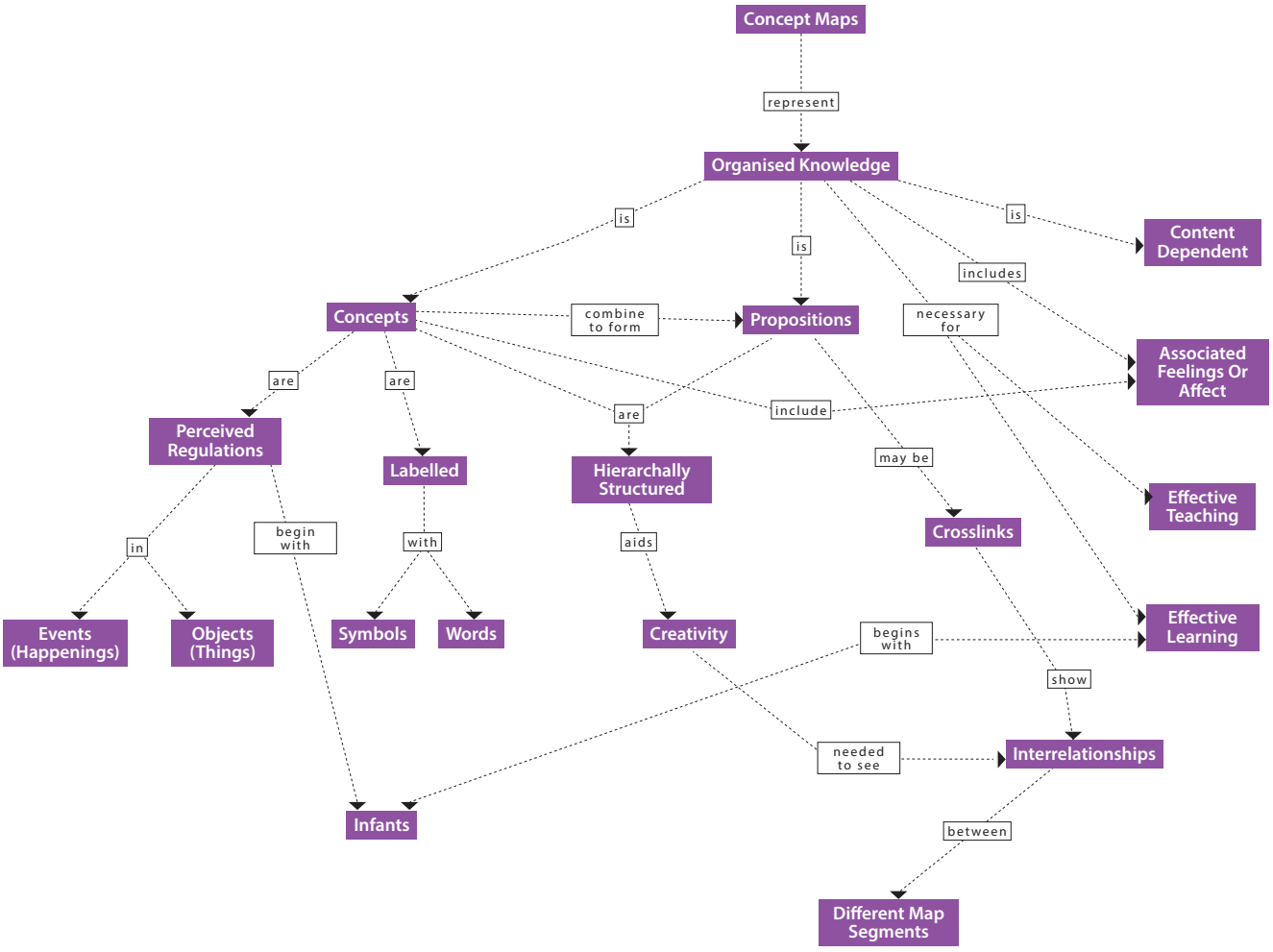
WORKSHEET 1 CLIMATE CHANGE CONCEPT MAP continued

QUESTION 1

Use your own knowledge and what you have learned from the class discussion to design a concept map that shows how various aspects of climate change are related to each other. Incorporate the following key words, as well as any others you can think of, into your concept map.

- Global warming
- Energy from the Sun
- Methane
- Ice cores
- Greenhouse gases
- The greenhouse effect
- The enhanced greenhouse effect
- The atmosphere
- Extreme weather events
- Refugees
- Rising sea levels
- Flooding
- Carbon dioxide
- Balance
- Temperature
- Ocean acidification

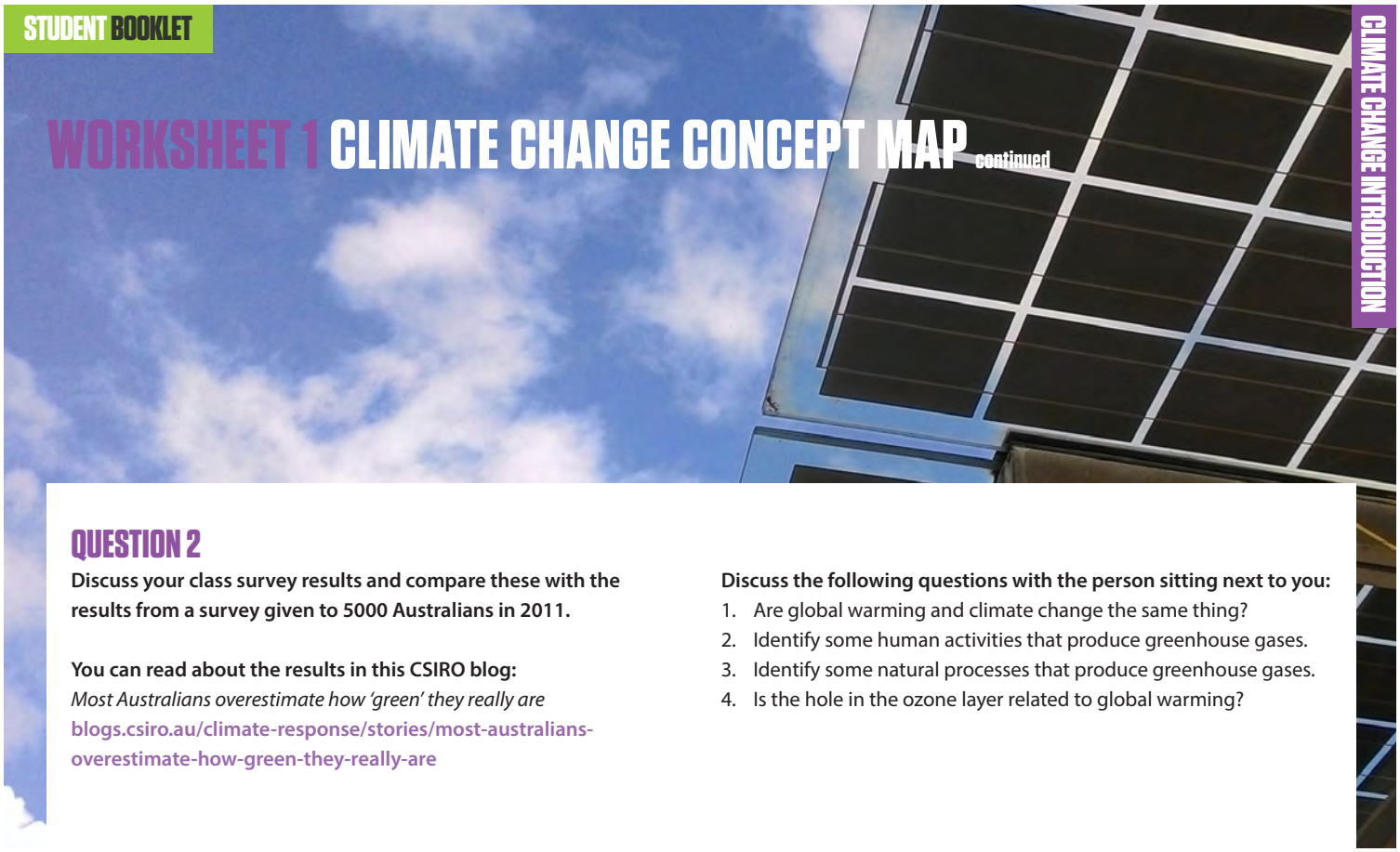
Figure 1: Example Concept Map



Credit: By English Wikipedia user Vicwood40, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=36966471

WORKSHEET 1 CLIMATE CHANGE CONCEPT MAP continued

Draw your concept map here.



WORKSHEET 1 CLIMATE CHANGE CONCEPT MAP continued

QUESTION 2

Discuss your class survey results and compare these with the results from a survey given to 5000 Australians in 2011.

You can read about the results in this CSIRO blog:
Most Australians overestimate how 'green' they really are
blogs.csiro.au/climate-response/stories/most-australians-overestimate-how-green-they-really-are

Discuss the following questions with the person sitting next to you:

1. Are global warming and climate change the same thing?
2. Identify some human activities that produce greenhouse gases.
3. Identify some natural processes that produce greenhouse gases.
4. Is the hole in the ozone layer related to global warming?

QUESTION 3

Write any questions you may have about global warming.

QUESTION 4

Where could you find information to answer your questions?

WORKSHEET 2

GLOBAL WARMING BACKGROUND

Now it's time to find out more about global warming.

Watch the video titled *Global Warming: Cold Facts Hot Science*
www.youtube.com/watch?v=CKzxdly7DpY

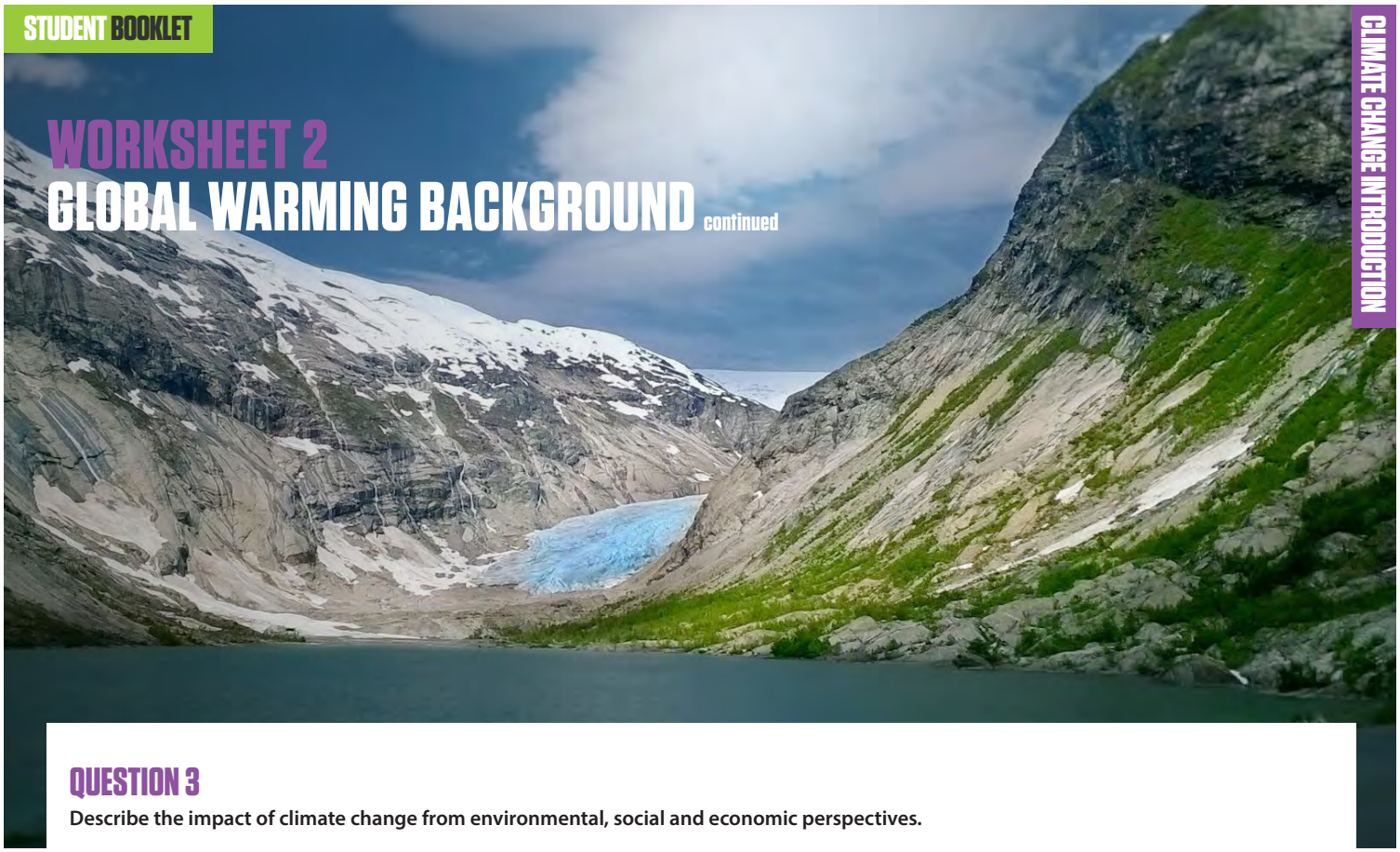
Then answer the questions below.

QUESTION 1

Describe greenhouse gases and their effect on weather and climate.

QUESTION 2

Explain how greenhouse gases contribute to climate change.



WORKSHEET 2
GLOBAL WARMING BACKGROUND continued

QUESTION 3
Describe the impact of climate change from environmental, social and economic perspectives.

QUESTION 4
How do you gather evidence for climate change?

QUESTION 5
Explain some of the solutions to reduce greenhouse gas emissions.

QUESTION 6
Who produced this video and who is the intended audience? How would you improve its message?

WORKSHEET 2
GLOBAL WARMING BACKGROUND continued

PROFILE

Read the following career profile and research other careers relevant to climate change science that you can find on the web.

Name: Kirsten Benkendorff

Job title: Marine researcher, Southern Cross University

Kirsten Benkendorff, a marine researcher at Southern Cross University (SCU) in NSW is keeping an eye on how global warming is affecting the oceans, and she has a special soft spot for marine molluscs – an animal group that includes snails, slugs, octopus, mussels and oysters

Kirsten's job is to see how marine molluscs are reacting to this stressful change in their environment, and find out what can be done to help them. "My work involves investigating the value of marine molluscs in nutrition and medicine, and I've been actively investigating the impacts of ocean climate change on molluscs," she says. "I love discovering through research, and sharing scientific knowledge and research skills with others."

QUESTION 7

What are some of the careers looking at solutions for climate change?

QUESTION 8

What skills might you need to work in a job focusing on understanding and addressing the consequences of climate change?

QUESTION 9

Write down any questions you still have about global warming.

CLIMATE CHANGE AND SMALL ISLAND NATIONS

FOCUS QUESTIONS

Focus questions are those questions that clearly define an issue. Write down your focus questions here.

1. _____

_____

2. _____

_____

3. _____

_____

INQUIRY QUESTIONS

What will happen to island nations if sea levels rise? What other effects will climate change cause?

CASE STUDIES

There are three case studies to choose from:

1. **Solomon Islands**
2. **Tuvalu**
3. **Maldives**

Read one of the case studies and complete the questions.

CASE STUDY 1 : SOLOMON ISLANDS

THE VANISHING ISLAND

The 16-seater shudders on the breeze. Below, a small grid of unsealed roads runs through a village of fibro buildings ringed by palm and jungle trees. A contracting grass airstrip dips at each end into the blue of the Pacific.

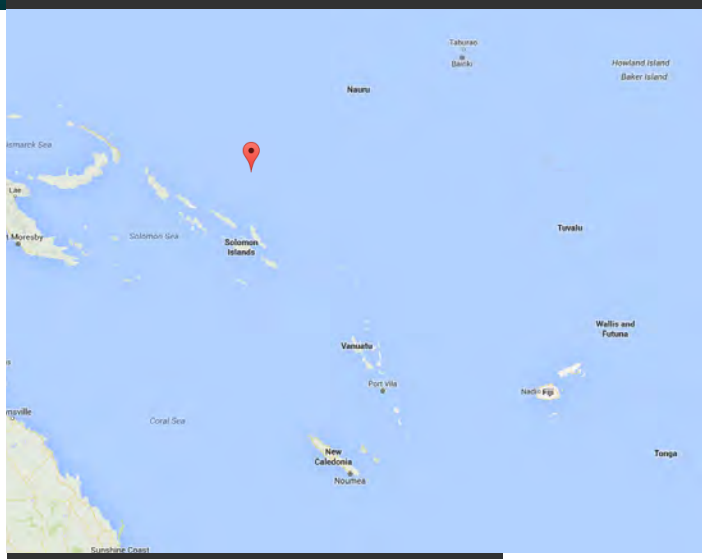
It could be the setting for a film about the end of the world. And for the people who live here – and will be forced to leave – it is.

Taro Island: a sometimes picturesque coral atoll adrift in the ocean at the north-western tip of the Solomon Islands.

Barely a kilometre long and less across and almost none of it more than 2 m above sea level, it is barely a smudge on a map. Yet this smudge – with its nearly 600 permanent residents, its hospital, churches (four), school, police station and courthouse – is set to take an unwanted place in history. Though tiny, it is the capital of the province of Choiseul. Soon it may be the first provincial capital in the world to be abandoned due to climate change.

This is the introduction to an article on the Solomon Islands published by Fairfax Media on 20 Sept 2015. Read the full article at www.theage.com.au/interactive/2015/the-vanishing-island

> "Choiseul may be the first provincial capital in the world to be abandoned due to climate change."



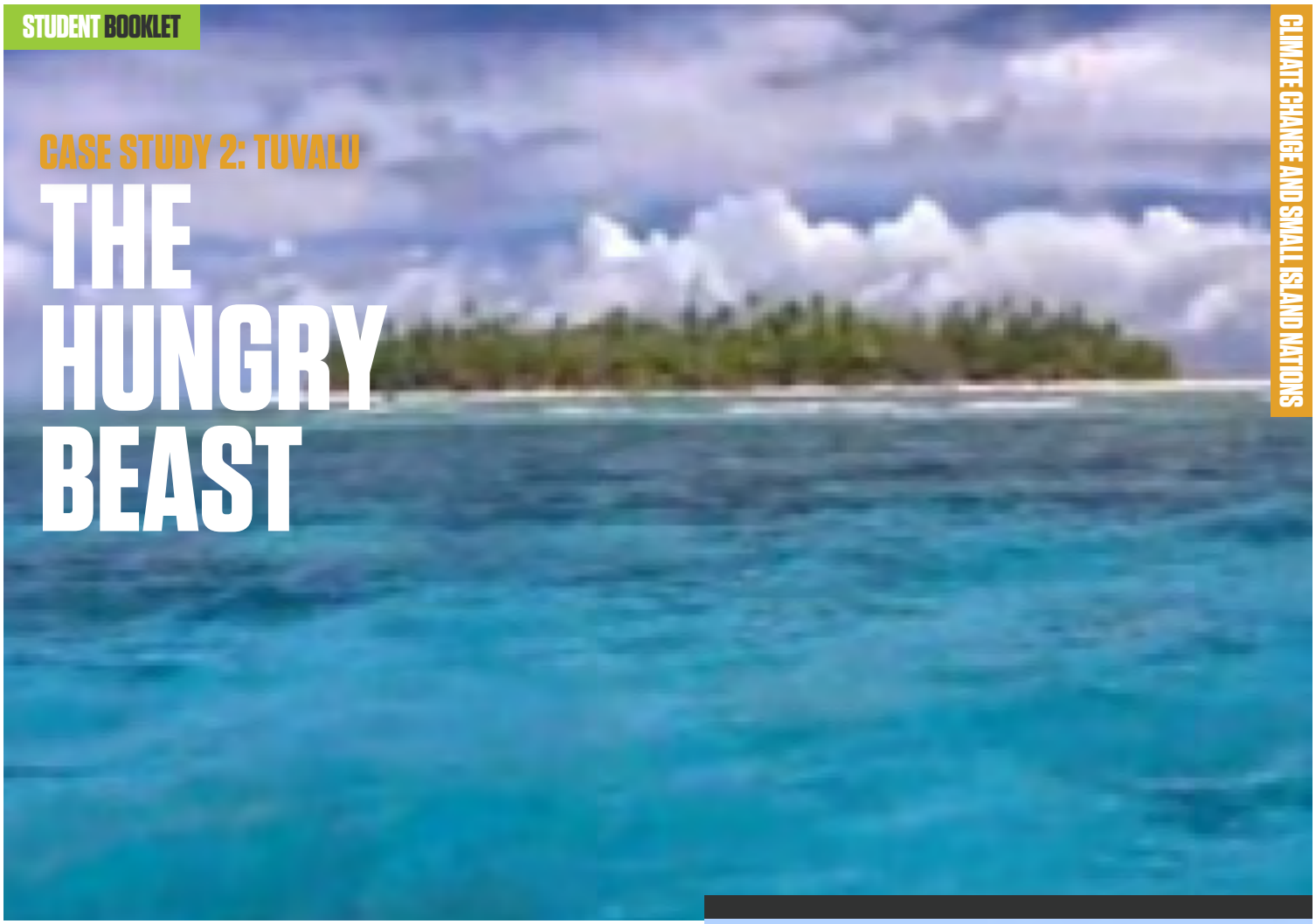
SOLOMON ISLANDS

Population: 515,870 (2009)

Geography: A scattered archipelago of about 1000 mountainous islands and low-lying coral atolls, the Solomon Islands lie east of Papua New Guinea and northeast of Australia in the South Pacific. The islands include Guadalcanal, Malaita, Santa Isabel, Makira, Choiseul, New Georgia and the Santa Cruz group.

Land area: 27,539 sq km

Economy: Fishing, gold mining



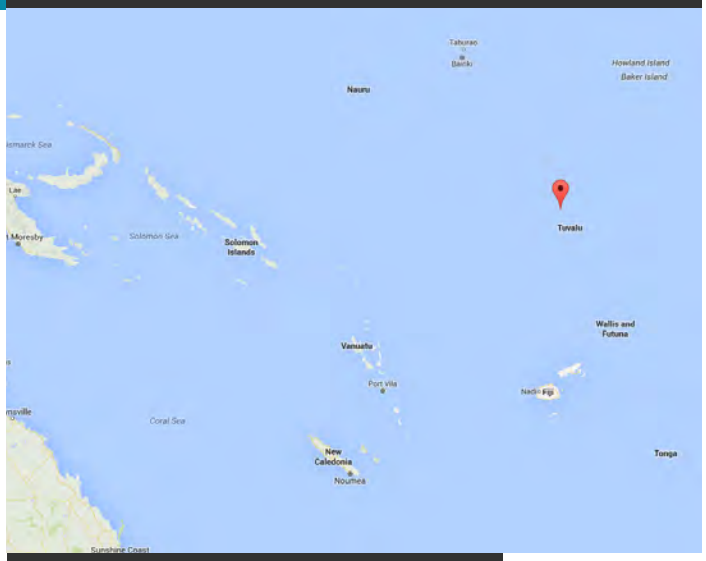
CASE STUDY 2: TUVALU

THE HUNGRY BEAST

The effects of rising sea levels due to global warming seem a long way off for most of us, but for the people of the small Pacific island nation of Tuvalu, the threat is more imminent.

Watch this video titled *Tuvalu (Hungry Beast)*
www.youtube.com/watch?v=DSmN8Eq4qEg

Then answer the questions on page 16.



TUVALU

Population: About 11,000

Geography: Consists of five low-lying coral atolls, four islands and more than 100 islets.

Land area: 26 sq km

Economy: Tuvalu is almost entirely dependent on external aid as well as highly variable revenue from fishing licences, surpluses from the country's overseas trust fund, and rent of its 'dot tv' internet extension.

CASE STUDY 3: MALDIVES

THE MALDIVES TEST CASE FOR CLIMATE CHANGE ACTION

MALDIVES IS PORTRAYED BY TRAVEL COMPANIES as a tropical paradise.

Like rays of burning sunlight concentrated through a magnifying glass, almost all the world's environmental problems come into sharp focus in the Maldives. The 1000km-long archipelago is the extreme test case.

The lowest lying country in the world is not even built on sand, but on the planet's most endangered ecosystem, coral reefs, the smashed fragments of which comprise every stunning white beach. And not only is the tide of sea level lapping at the shallow islands, but sea temperatures are rising as is the acidity of the ocean: both kill the corals.

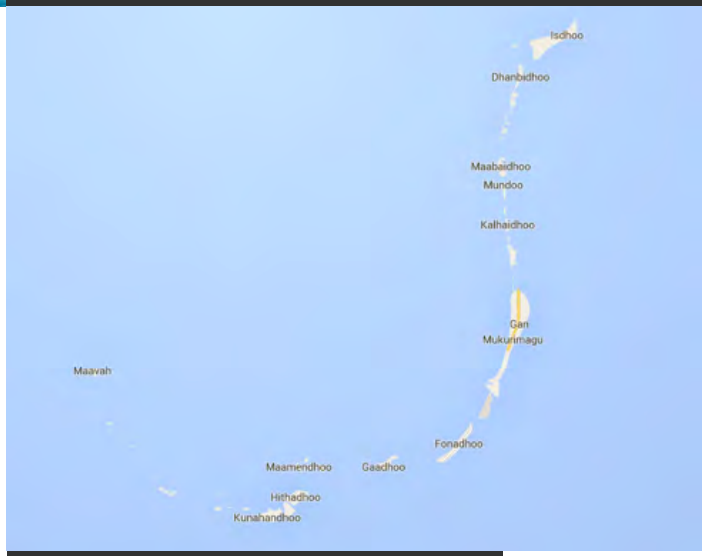
The beating sunlight in the Maldives should at least deliver plentiful solar power. But in a grim irony, the 400,000 islanders, whose overall contribution to planet-warming carbon emissions is negligible, are entirely hooked on diesel for the generators that keep their lights on. The nation, which is close to broke, spends over a quarter of its GDP on the fuel and pays colossal subsidies to keep energy bills affordable.

Despite the doubts about whether the Maldives will keep its head above water and the $1.5m per room cost of developing luxury resorts, the existing 110 resort islands are set to be joined by 50–60 more, each posing dangers to the fragile coral environment.

"That is too many if they are not implemented well, and they are not," says Armando Kraenzlin, regional vice president for the Four Seasons resorts in the Maldives, which spends hundreds of thousands of dollars a year on marine scientists in an attempt to protect its own natural coral and sealife assets.

Read the rest of the article here: http://bit.ly/2aj6Z19

By Damian Carrington. Published on 27 September 2013.



MALDIVES

Population: About 345,000

Geography: Consists of approximately 1190 coral islands grouped in a chain of 26 atolls

Economy: Mixed economy based on tourism, fishing and shipping. Tourism is the largest industry, accounting for 28% of GDP.

CASE STUDY QUESTIONS

QUESTION 1

Name the island nation. Where is it located? What is the size of the population?

QUESTION 2

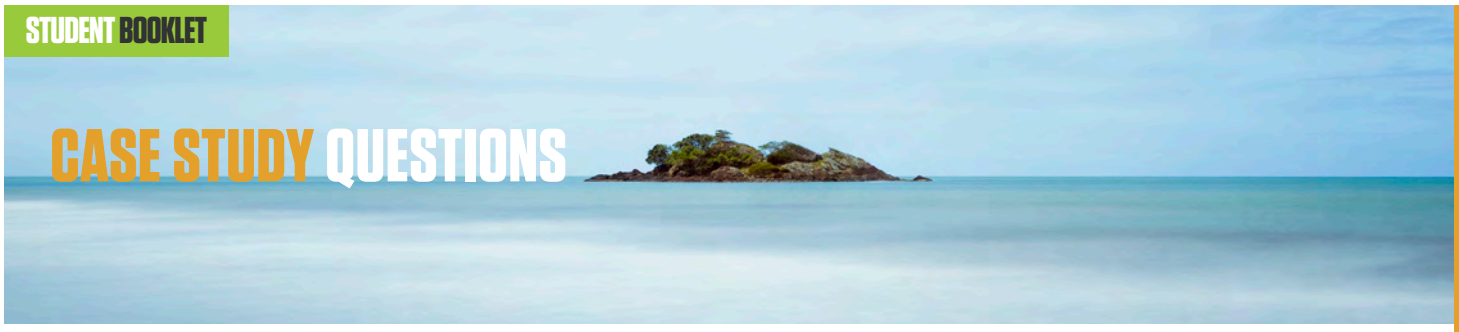
What is the nation's economy based on?

QUESTION 3

List the impacts of climate change for the elements listed in the table below.

Table 1: Impacts of Climate Change on Small Island Nations

Element	Effects	Causes
Tides		
Climate		
Coral Reefs		
Fishing Industry		
Homelands (Island Lands)		



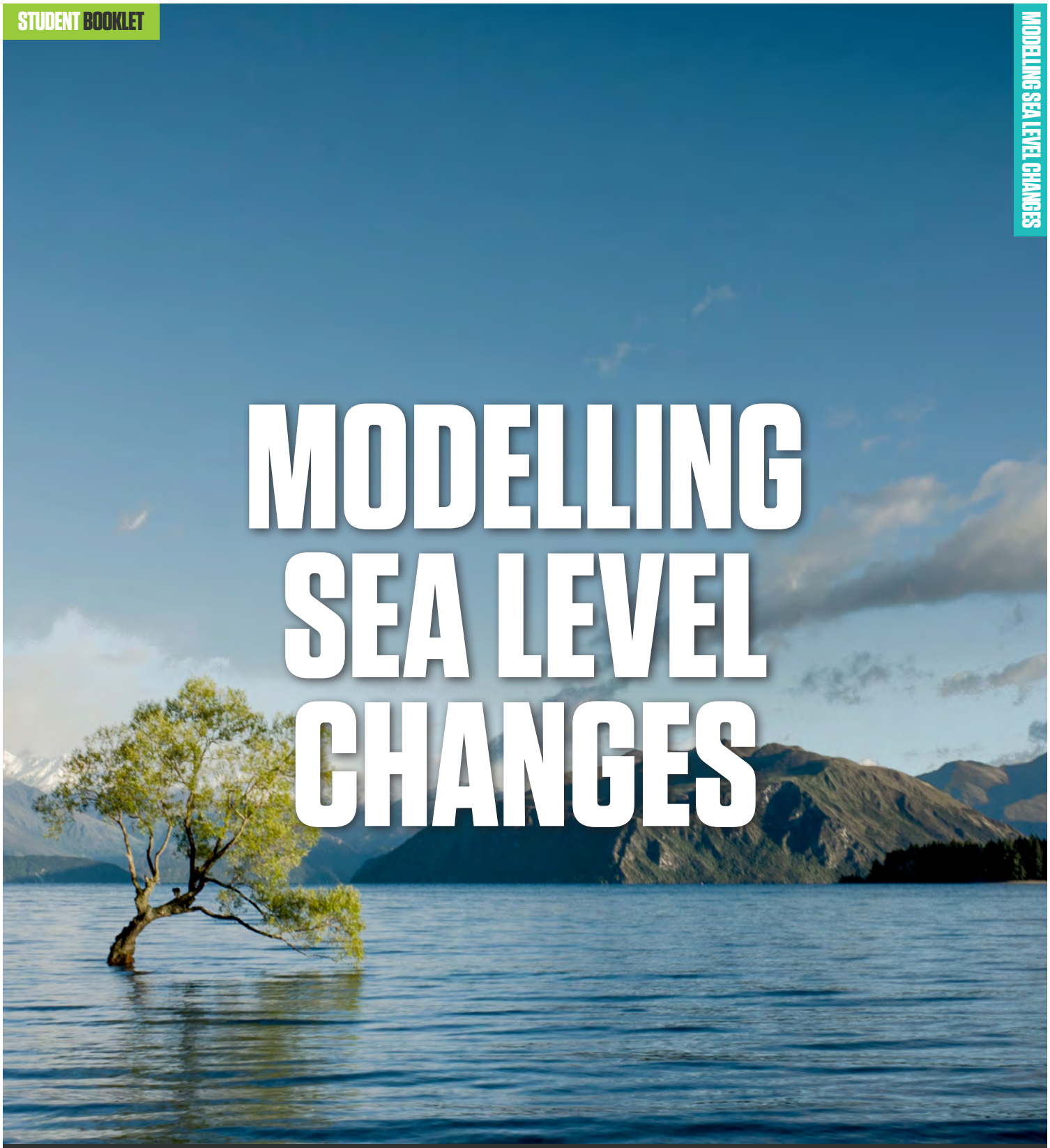
CASE STUDY QUESTIONS

QUESTION 4

Construct a mind map that summarises the effects of global warming on the nation.

QUESTION 5

List some solutions to the problems faced by the nation.



MODELLING SEA LEVEL CHANGES

BACKGROUND INFORMATION

Over the past 20 years, sea level rise has accelerated due to climate change. This rise in sea levels has affected vulnerable populations in small island nations. Scientists around the world have used techniques such as satellite tracking to measure changes in the oceans – and they have found that the global average of sea level rise per year is 4 mm.

Researchers believe humans are to blame for this rise in sea levels. Industrial activities have generated pollution and carbon dioxide (CO2) – a colourless and odourless gas that is produced by burning carbon and other organic compounds. CO2 is considered a greenhouse gas (climatekids.nasa.gov/greenhouse-effect), which means it absorbs heat, working almost like a blanket that keeps the planet toastier than it should be.

The excess heat caused by greenhouse gases is melting polar ice sheets and glaciers. It is also heating the water in the oceans, causing it to expand. These effects result in rising water levels in the world's oceans. Global warming also causes more extreme weather events like cyclones and hurricanes which, when combined with rising sea levels, result in floods. The strong winds of the storms can drive sea water far inland.

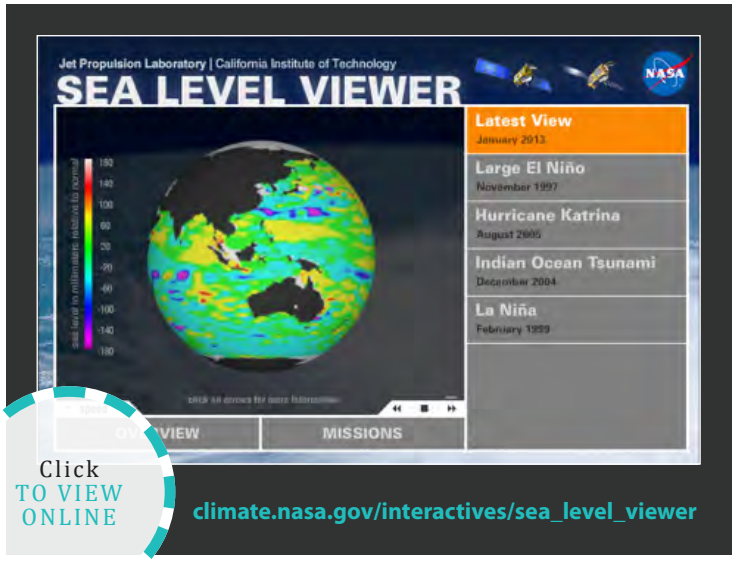
The world's 52 small island developing states (SIDS), including the Pacific states of Tuvalu and Kiribati, and the Maldives in the Indian Ocean, are the most affected by rising sea levels, experiencing increases of up to 10 mm per year. More than 50% of the people who call these islands home live near the coast, and every time the sea water rises, their livelihoods are threatened by floods.

Floods pose a threat to the islands' economic growth and agriculture.

When salt water combines with fresh water it pollutes useable water resources with salts and minerals. This process, called saltwater intrusion, makes fresh water unfit for human consumption. According to Professor José Benavente Herrera from the University of Granada in Spain, "Fresh water contaminated by 5% of sea water can no longer be used for common purposes, such as human use, agriculture or farming."

Using fresh water contaminated with salt water for agriculture may cause leaf burn and defoliation of plants. According to the United Nations Food and Agriculture Organisation (FAO), fruit crops are especially sensitive to high levels of sodium and chloride. In Tuvalu, for example, breadfruit, banana and cabbage crops have been affected. Tuvaluans are now trying to find crops that are resistant to the new conditions.

Global warming also means the water is getting warmer, and fish and corals aren't adapting quickly enough. The economies of these islands rely on ocean activities such as fishing, so if the sea level rises and the waters get warmer their citizens will have a hard time getting fresh produce to eat and sell.



> "Fresh water contaminated by 5% of sea water can no longer be used for common purposes, such as human use, agriculture or farming."

The 62 million people who live on these islands emit less than 1% of global greenhouse gases, but are the ones who suffer most from climate change. Something needs to be done.

Now scientists and government officials are trying to come up with solutions to help these islands. They have found that developing an eco-friendly economy that relies on renewable energy could help them thrive.

Some islands, like the Maldives, are already looking for more land, and Tuvaluans are building high walls to stop the floods. What do you think can be done to lessen the impact of the flooding?

PRACTICAL ACTIVITY 1

ICE SHEETS ON LAND MASSES

INQUIRY QUESTION

What will happen to sea levels if glaciers or the ice over the continent of Antarctica melt?

The continent of Antarctica is covered by an ice cap and surrounded by ice shelves.

MODELLING THE MELTING OF ICE SHEETS ON LAND MASSES

- The ice cap at the South Pole covers a very large continent called Antarctica.
- The continent of Antarctica is 1.8 times bigger than Australia.
- The ice cap that covers Antarctica is more than 2100 m thick in places.
- Antarctica has 70% of all the world's fresh water frozen as ice – and 90% of all the world's ice.
- The total volume of ice (on the continent and the ice shelves) is 25.4 million cubic kilometres.
- Large volumes of ice are also found in glaciers and other ice sheets such as over Greenland.

WHAT YOU NEED

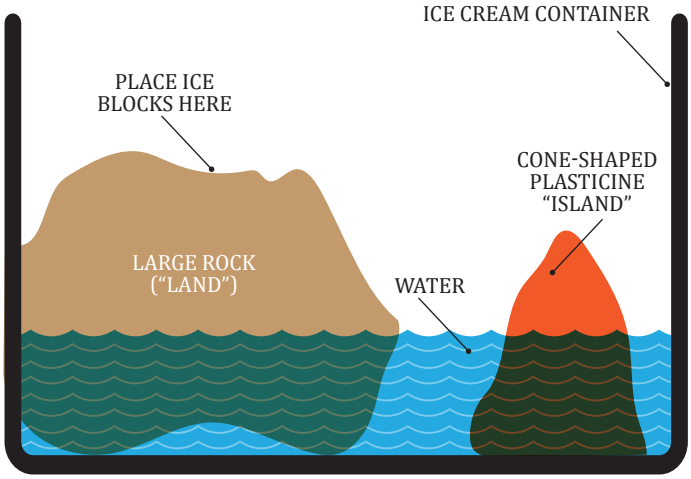
- Ice-cream container
- Rock
- Plasticine
- Thermometer or STELR IR thermometer (optional)
- Ice
- Lamp (to provide heat)

WHAT TO DO

1. Set up a shallow ice-cream container with the contents shown in the diagram.
2. The plasticine 'island' should be cone-shaped.
3. Add about 10 ice blocks to the 'land'.
4. Mark the 'sea level' on the side of the container.
5. Shine a lamp onto the ice and water.
6. Observe what happens to the ice and the 'sea level'.

PRACTICAL ACTIVITY 1
ICE SHEETS ON LAND MASSES continued

FOX GLACIER in New Zealand



QUESTION 1

What happened to the ice and the 'sea level'?

QUESTION 2

What implications does this have for island nations? Why were they so vocal at the UN Climate Change Conference in Copenhagen in 2009?

QUESTION 3

What will happen to sea levels if glaciers or the ice over the continent of Antarctica melts?

PRACTICAL ACTIVITY 2

ICE SHEETS ON OCEANS

INQUIRY QUESTION

What happens to sea levels as the ice at the North Pole melts?

MODELLING THE MELTING OF ICE SHEETS ON OCEANS

- The ice cap at the North Pole is over the ocean.
- The ice cap changes in size throughout the year.
- Watch the NASA animation below to see how the ice cap changed in size over about four months in 2013.

This animation shows daily Arctic sea ice extent and seasonal land cover change from 16 May through to 12 September 2013, the day before the sea ice reached its minimum area of coverage for the year. The data was provided by the Japan Aerospace Exploration Agency (JAXA) from its AMSR2 instrument aboard the GCOM-W1 satellite.
www.youtube.com/watch?v=ktEAUO_Vpos

WHAT YOU NEED

- Beaker
- Ice
- Lamp (to provide heat)

WHAT TO DO

1. Place ice cubes in the beaker.
2. Add water until the beaker is full to the brim.
   Note: The ice should protrude above the top of the beaker.
3. Shine a lamp onto the ice and water.
4. Observe what happens to the ice and the 'sea level'.

PRACTICAL ACTIVITY 2
ICE SHEETS ON OCEANS continued

QUESTION 1

Predict what will happen to the 'sea level'. Will the beaker overflow when the ice melts?

QUESTION 2

What happened to the 'sea level'? Talk about what happened with a partner. Explain why this happened.

QUESTION 3

What happens to the sea level in the Earth's oceans when the ice cap at the North Pole melts? Explain your answer.

PRACTICAL ACTIVITY 3

HEATING OCEANS

INQUIRY QUESTION

What will happen to sea levels if the oceans heat up?

MODELLING THE HEATING OF THE OCEANS

Global warming means that both the atmosphere and the oceans are heating. Matter is made of particles. When matter heats up the particles vibrate more or move faster, causing the matter to expand.

WHAT YOU NEED

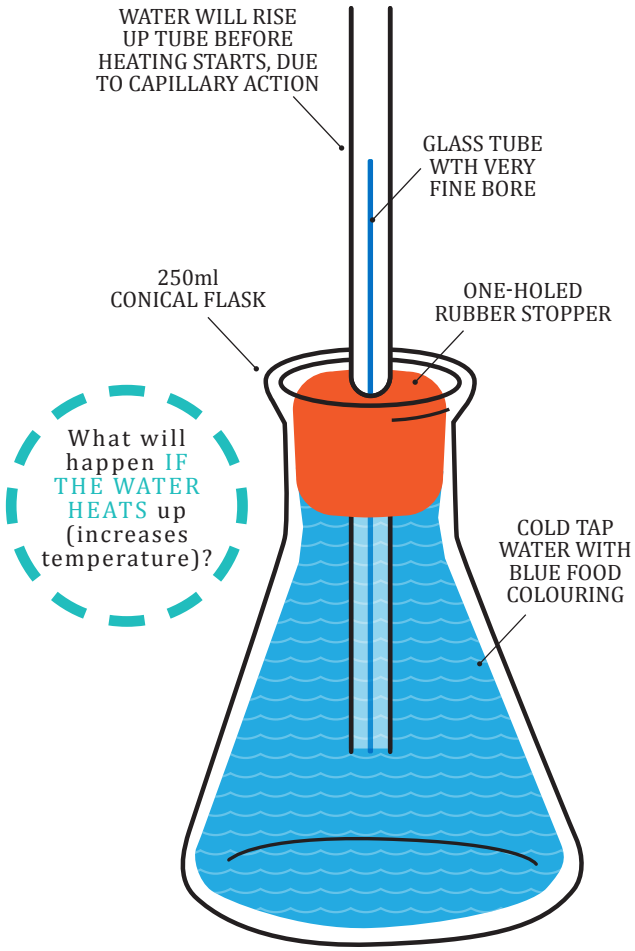
- Conical flask
- One-hole rubber stopper
- Glass tube
- Water
- Food dye
- Lamp (to provide heat)

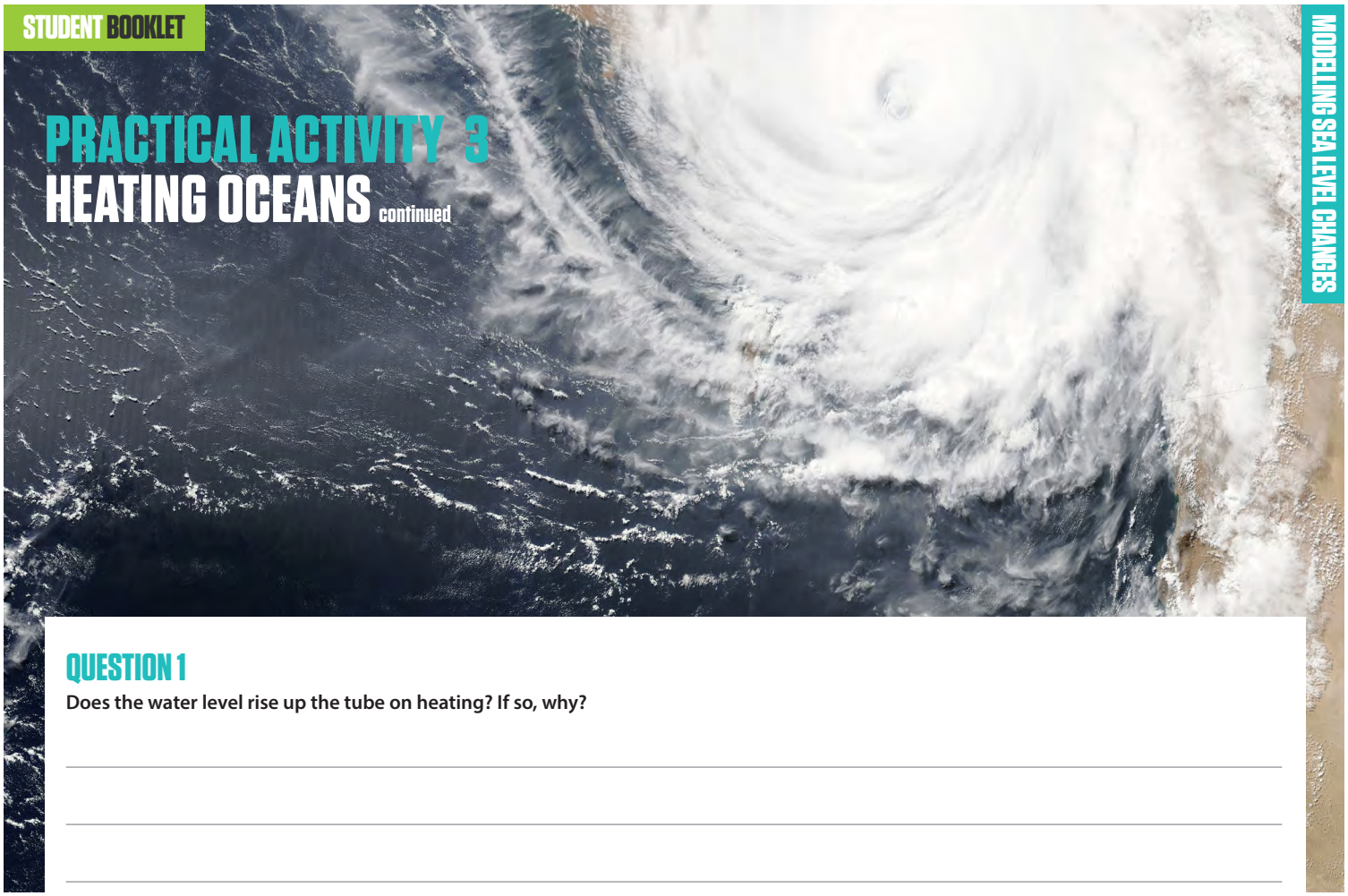
WHAT TO DO

Set up the apparatus shown in the diagram. The cold tap water should have dark blue food colouring mixed with it so that it can be readily seen moving up the bore. The flask should be completely filled with the coloured tap water. The glass tube inserted through the rubber stopper should have a very fine bore.

Wait until the level of water in the tube stabilises, then shine a lamp onto the water in the flask to heat it.

You could use the STELR IR thermometer to measure the temperature of the water before the lamp is turned on and just after it is turned off.





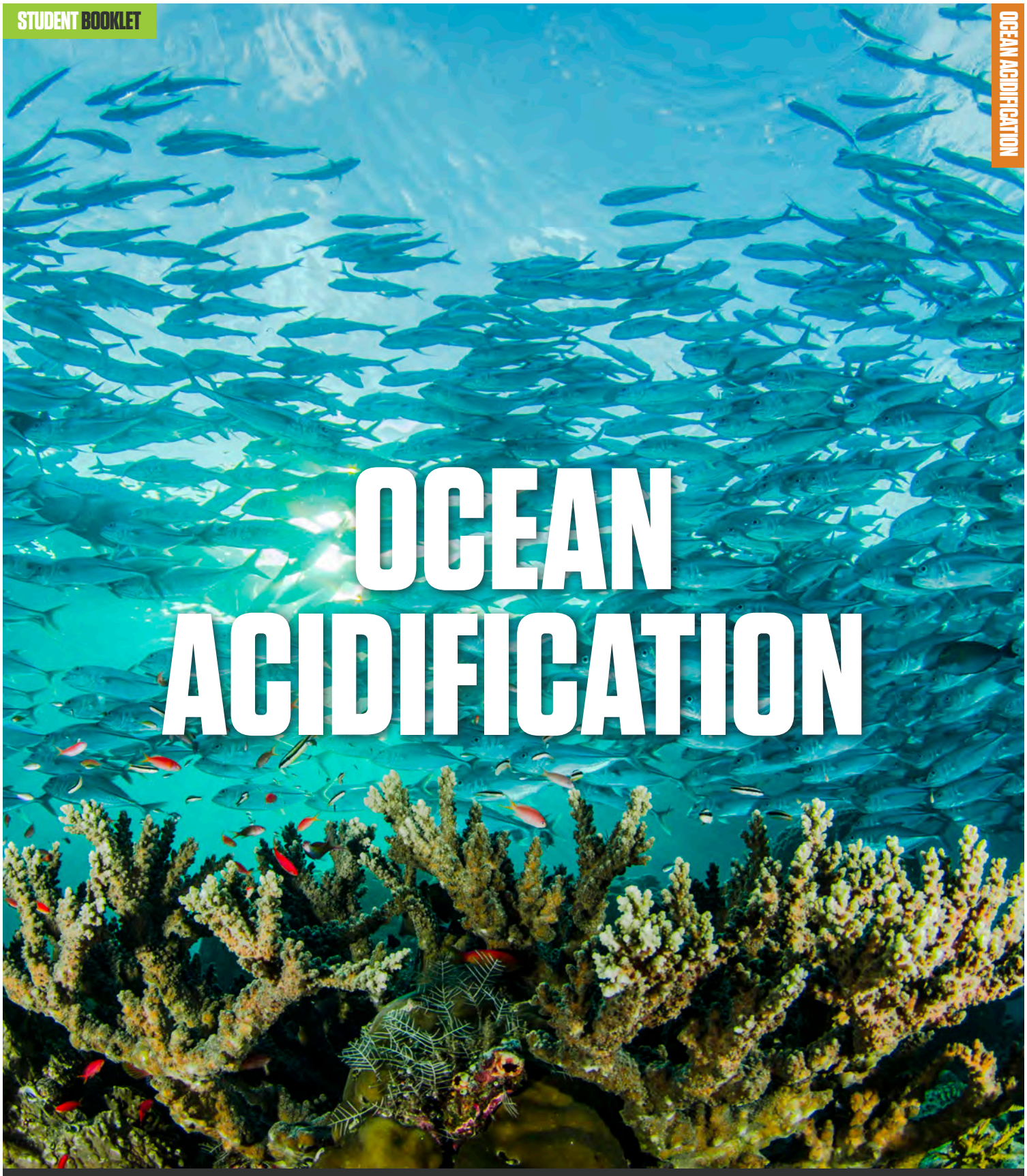
PRACTICAL ACTIVITY 3
HEATING OCEANS continued

QUESTION 1
Does the water level rise up the tube on heating? If so, why?

QUESTION 2
Why was this apparatus used for the simulation rather than simply heating the flask over a Bunsen burner?

QUESTION 3
Do other materials also expand when their temperature is raised? Give some examples.

QUESTION 4
What will happen to sea levels if the oceans heat up? Explain your answer.

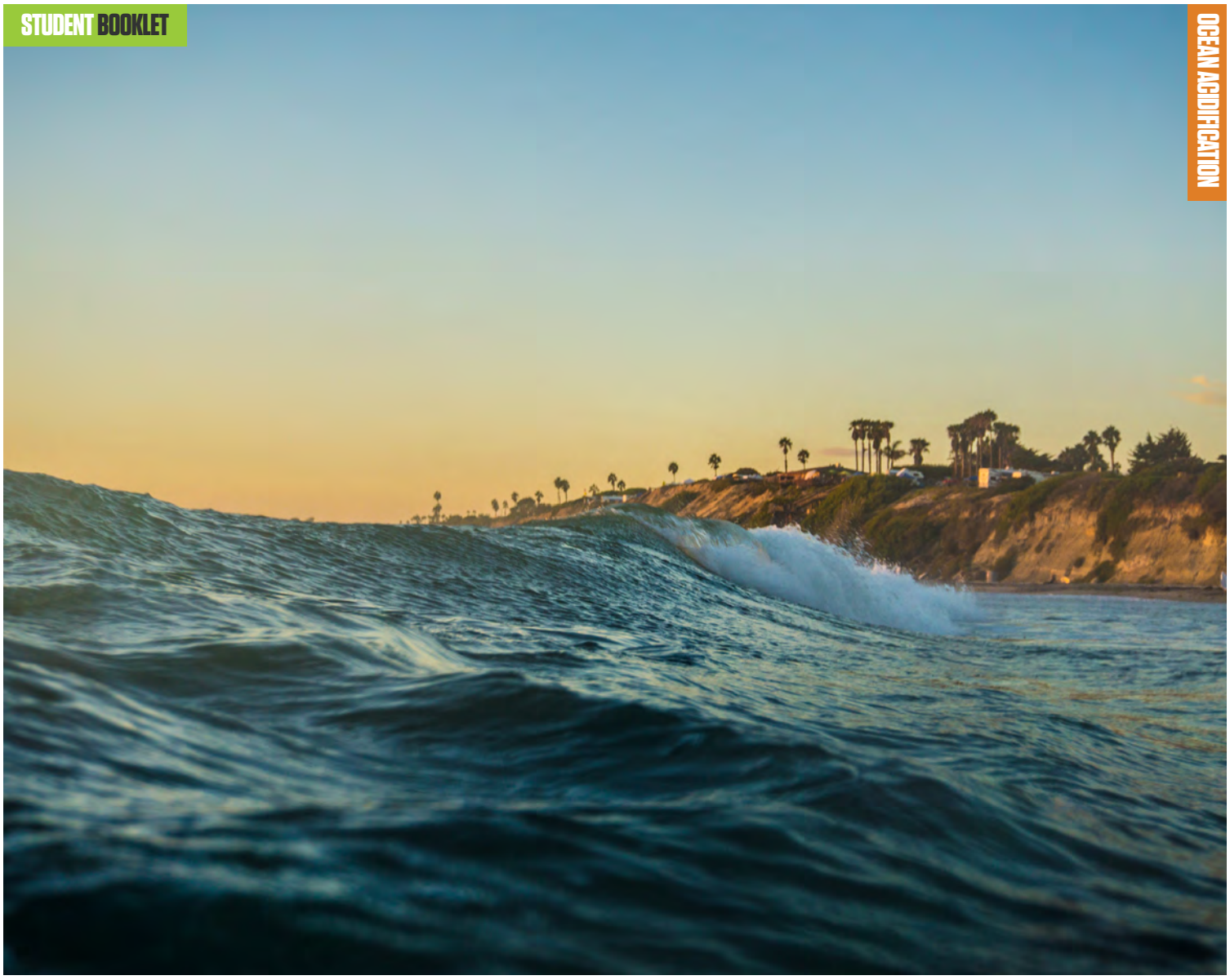


OCEAN ACIDIFICATION

BACKGROUND INFORMATION

There is evidence that our oceans are becoming more acidic, particularly in some regions. There is some evidence to suggest that one cause of this may be the build-up of greater amounts of carbon dioxide in the atmosphere in the past century or so, due to human activity.

You will be investigating this next. But first you need to know about acids and bases and pH



WHAT ARE ACIDS AND BASES?

Acids are substances that will corrode metals and also react with substances such as calcium carbonate, which is the main material present in shells and coral, the shells of bird eggs, limestone and marble, stalactites and stalagmites. Vinegar contains an acid. Its common name is acetic acid but its proper chemical name is ethanoic acid. Lemons, oranges and other citrus fruits contain another acid, which is commonly known as citric acid.
Bases are substances other than metals that react with acids. Calcium carbonate is an example of a base. It does not dissolve in water but it will dissolve in acids as it reacts with them. Bases that are soluble in water are also known as alkalis. An example of an alkali is sodium hydroxide.

Neutral substances are neither acidic nor basic. Pure water is an example of a neutral substance.

WHAT KIND OF SOLUTION IS IT?

Solutions can be classified as acidic, basic or neutral using substances known as acid-base indicators. These substances change colour depending on whether they are added to an acidic or a basic solution. Many plants such as purple cabbage contain substances that change colour like this.

UNIVERSAL INDICATOR

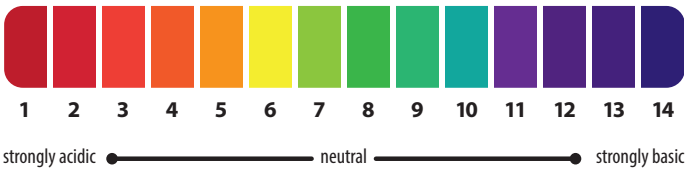
Universal indicator is a very handy acid-base indicator. A mixture of several indicators, it can turn through a range of colours to show if a solution is strongly or weakly acidic, strongly or weakly basic, or neutral. It even indicates the approximate pH of the solution! The indicator scale below shows the colour range for one brand of universal indicator solution.

pH

pH of a solution is a measure of the molar concentration of hydrogen ions in the solution and as such is a measure of how acidic/basic the solution is. The range goes from 0–14, with 7 being neutral.

> “The pH of a solution is a measurement of how acidic it is.”

INDICATOR SCALE



- The *lower* the pH, the *more acidic* it is!
- Acidic solutions are solutions that contain one or more acids and have a pH below 7.
- Basic solutions are solutions that contain one or more bases and have a pH above 7.
- Neutral solutions and pure water are neither acidic nor basic and have a pH of 7.
- When exactly the right amount of an acidic solution is mixed with a certain basic solution, the acids and bases present will react with each other and a neutral solution will be produced. This called a *neutralisation reaction*.

WARNING!

Although many foods are acidic or basic, and are safe to handle and eat, there are many acids and bases used in industry or in the laboratory that are very dangerous. These include sulphuric acid and sodium hydroxide. They can severely burn your skin and eyes. They must be handled with very great care

DID YOU KNOW?

Most aquatic organisms can only survive in water within a pH range of 7 to 8.2. These include the organisms that build our coral reefs, known as coral polyps.

Which one or more of these statements about acids are correct?

A. Acids have a pH higher than 7.
B. Acids can 'eat' into metals.
C. All acids should not be swallowed.
D. Acids can neutralise bases.

QUESTION 2

Which one or more of these statements about bases are correct?

A. Corals are made from a base.
B. All bases are called alkalis.
C. Bases have a higher pH than acids.
D. Bases can dissolve in acids.

QUESTION 3

Which one or more of these statements about acid-base indicators are correct?

A. All acid-base indicators have a range of colours.
B. Acid-base indicators can be made from certain plants.
C. Universal indicator is a mixture of indicators.
D. Universal indicator turns green in pure water.

WORKSHEET 3

WHAT'S HAPPENING IN OUR OCEANS?

INQUIRY QUESTIONS

1. **What everyday substances are acidic, basic or neutral?**
2. **What happens to the pH of sea water if extra carbon dioxide dissolves in it?**
3. **What might be the impact on the shells of shellfish if extra carbon dioxide dissolves in the oceans?**
4. **What might be the impact on the shells of shellfish if oceans become more acidic?**

INTRODUCTION

In the following activities, you will test the acidity of a range of foods and soaps and detergents as well as sea water and carbon dioxide solution. You will then see what happens to the pH of sea water when you blow air from your lungs into it.

Finally you will discover what happens to seashells or other forms of calcium carbonate when they are placed in different solutions. One of these solutions is soda water, which contains a little salt, but not nearly as much as sea water. Carbon dioxide has been bubbled into this under pressure. This means that soda water in a bottle that is sealed tight contains far more carbon dioxide than is dissolved in our oceans. When you open a new bottle of soda water, however, a lot of this carbon dioxide bubbles back out.

NOTE | It is important to use the colour chart that accompanies the universal indicator solution you use! It is also important to use sea water mix from an aquarium or pet shop, rather than water from the sea.

WHAT YOU NEED FOR ALL THE ACTIVITIES

- Small dropper bottle of universal indicator and chart
- Small samples of foods, and soaps and detergents
- Large dropper bottle of sea water
- Small jar of broken or crushed seashells or shell grit
- Small-scale testing equipment, as supplied
- Small spatula
- Droppers and small plastic teaspoons
- Small beaker of tap water
- 5 x 100 mL conical flasks
- 1 x drinking straw
- A4 sheet of white paper (or large white tiles)
- Paper towel
- Labelling system for testing, as supplied

PRACTICAL ACTIVITY 4

ACID, BASE OR NEUTRAL

INTRODUCTION

In this activity, you will test the acidity of a range of foods and soaps and detergents as well as sea water and carbon dioxide solution.

WHAT TO DO

1. Set up the testing equipment and labelling system your teacher has supplied.
2. You will be testing foods and soaps and detergents, plus tap water and sea water, as demonstrated by your teacher.
3. Draw up a results table to record all the foods you tested, the colour of the indicator, and the approximate pH of the solution.
4. In the case of the solutions you are testing, place a few drops of each solution in the appropriate well or other container, according to your labelling system. In the case of substances that have a thicker consistency, such as yoghurt, use a small teaspoon to add the substance to its well or other container.
5. If your samples are not sitting over a white background, then place them over white paper (or white tiles) so you can clearly see the colour changes that will occur when you add universal indicator solution to them.
6. Drop 2 or more drops of universal indicator solution onto each substance until the colour of the indicator can be seen (without it being too bright).
7. Do not get any of the substances onto the dropper from the bottle of universal indicator, or the dropper will become contaminated!
8. If you also have been provided with slices of fresh fruit and vegetables, place each slice over a piece of paper towel then place 1-2 drops of universal indicator solution onto the centre of the fruit. Let it soak into the fruit.
9. Record the substances you tested, the indicator colours, and the approximate pH from the pH colour chart, in Table 3, and hence classify the substance as acidic or basic or neutral.
10. Place the washable testing equipment in the tub of cold water provided.
11. Wrap the fruit and vegetable slices in the paper towel and place them in the bin provided.

RESULTS

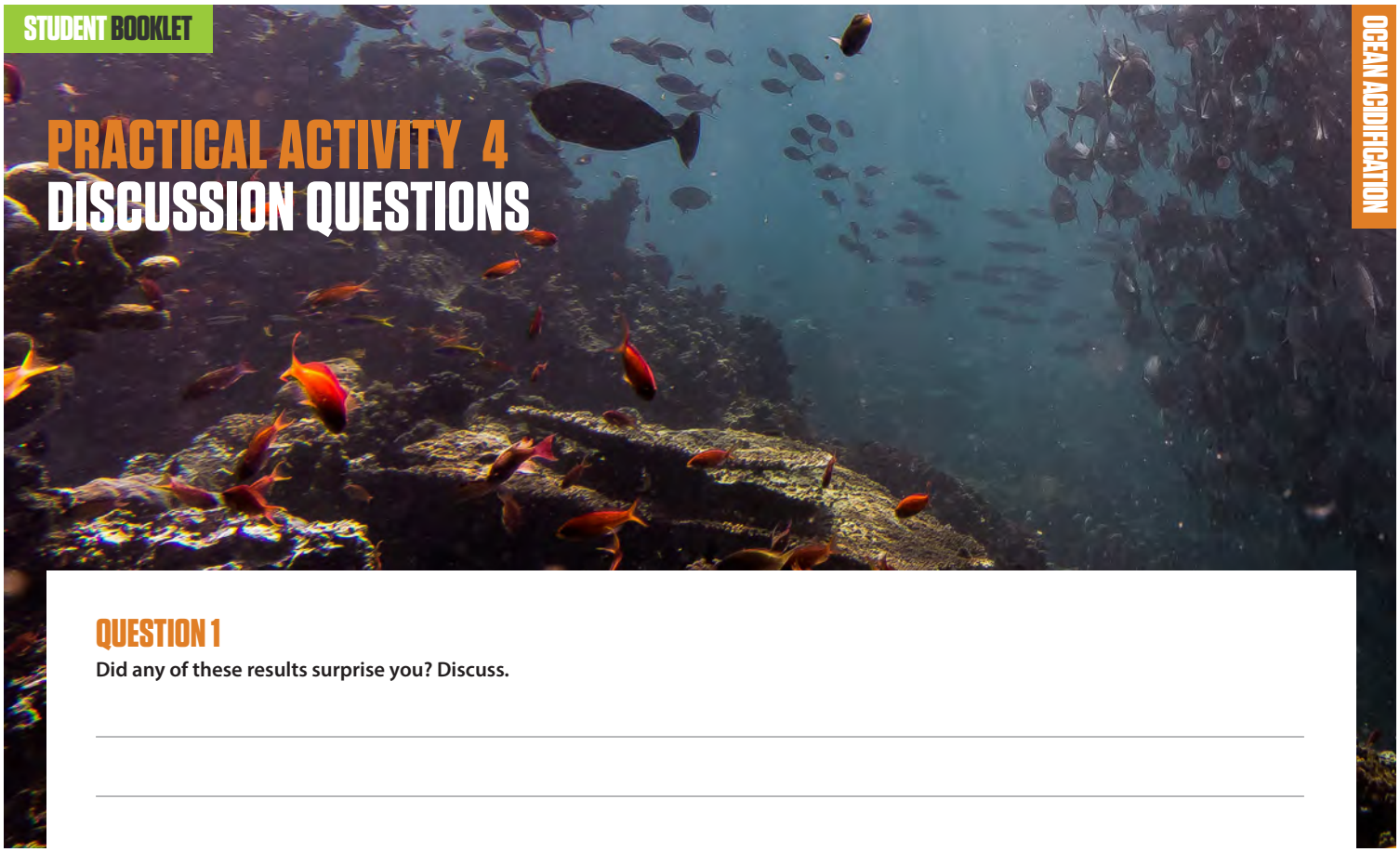
Use this table to record your results.

Table 2: pH Testing Results

Sample	Indicator Colour	Ph

SAFETY WARNING!

Don't eat the fruit. Remember universal indicator is poisonous and food should NEVER be eaten in a laboratory!



PRACTICAL ACTIVITY 4
DISCUSSION QUESTIONS

QUESTION 1

Did any of these results surprise you? Discuss.

QUESTION 2

An acidic solution with a pH of about 5 or 6 is classified as weakly acidic. In the table above, highlight or underline those substances that would be classified as weakly acidic.

QUESTION 3

A solution with a pH of about 8 or 9 is classified as weakly basic. In the table above, highlight or underline those substances that would be classified as weakly basic.

QUESTION 4

Long ago, some scientists used to identify substances that were acids or bases by tasting them. They said acids were substances that tasted sour and bases were substances that tasted bitter. What was wrong with this kind of testing?

PRACTICAL ACTIVITY 5

CO_2 AND SEA WATER pH

INQUIRY QUESTION

What happens to the pH of sea water if extra carbon dioxide dissolves in it?

INTRODUCTION

Carbon dioxide is produced in every cell in your body through a process called cellular respiration. This reaction provides cells with the energy they need to carry out their work.

CELLULAR RESPIRATION

GLUCOSE + OXYGEN → CARBON DIOXIDE + WATER + ENERGY

When too much carbon dioxide is dissolved in your blood, you become very ill. Your body constantly removes excess carbon dioxide through your lungs. You breathe out more carbon dioxide than you breathe in.

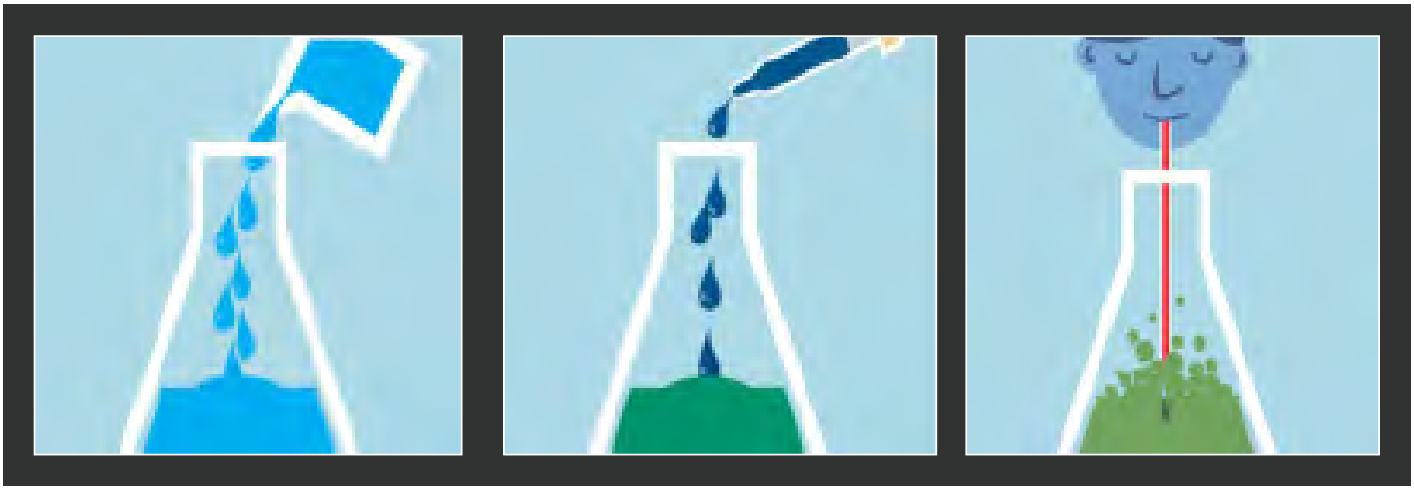
Sea water already contains some dissolved carbon dioxide. When you blow into sea water, you dissolve extra carbon dioxide in it.

WHAT TO DO

1. Add sea water to one of the conical flasks until it is about a quarter full.
2. Place the flask over white paper or a white tile.
3. Add enough drops of universal indicator solution to the water to make its colour obvious, but not too bright.
4. Record the indicator colour and approximate pH in Table 6.
5. Choose a group member to blow into the sea water.
6. Place the drinking straw into the water well below its surface, then blow bubbles into the water for about 1-2 minutes.
7. Record what happens to the indicator colour and the pH of the solution in Table 6.
8. Label the flask to show it contains sea water with carbon dioxide blown in, and keep it aside for Part C.
9. Place the used straw in the bin.

SAFETY WARNING!

Take care that you only blow into the straw. Do not suck any liquid back up into the straw! Universal indicator is poisonous!



PRACTICAL ACTIVITY 5
CO_2 AND SEA WATER pH continued

Table 3: Results of pH Testing of Sea Water

Time	What colour is the universal indicator solution?	What is the approximate pH of the solution?
Before blowing carbon dioxide into the sea water		
Before blowing carbon dioxide into the sea water		

RESULTS

What else did you observe?

CONCLUSION

What happens to the pH of sea water if extra carbon dioxide dissolves in it?

DISCUSSION

Our oceans absorb a lot of carbon dioxide from the atmosphere. From your results, what might happen to the pH of sea water if more and more carbon dioxide were to dissolve in it? Discuss.

WORKSHEET 4

EFFECTS OF SEA WATER pH

Watch this video titled *Ocean Acidification* and answer the questions.
https://www.youtube.com/watch?v=dbMomQgI3Fk

Science Today: Ocean Acidification, California Academy of Sciences

QUESTION 1

What happens when carbon dioxide dissolves in ocean water?

QUESTION 2

What happens when carbon dioxide dissolves in ocean water?

WORKSHEET 4
EFFECTS OF SEA WATER pH continued

Coral bleacing is caused by warming ocean temperatures and ocean acidification

QUESTION 3

What animals are most sensitive to an increase in acid in ocean water?

QUESTION 4

Name three organisms that build skeletons from calcium carbonate.

QUESTION 5

What can we do to fight ocean acidification?

QUESTION 6

This video was produced by the California Academy of Science. Why do you think they made the video? Can they be trusted?

PRACTICAL ACTIVITY 6

OCEAN ACID AND SHELLS

INQUIRY QUESTIONS

1. **What might be the impact on shellfish if extra carbon dioxide dissolves in the oceans?**
2. **What might be the impact on shellfish if acidic substances move into the sea from our land and waterways.**

WHAT TO DO

1. Place your flask of sea water and extra carbon dioxide from the previous experiment and four empty conical flasks over a sheet of white paper.
2. Label the four empty flasks to show whether they will contain tap water, sea water, vinegar or soda water.
3. Add the solutions to each of the four empty conical flasks, according to your labels, until each flask is about a quarter full. Make sure each flask is filled to the same depth.
4. Add a few drops of universal indicator solution to each of the four colourless solutions. Ensure you put the same number of drops of indicator in each flask.
5. Your set of solutions should now look like those in the figure below, but with labels.
6. Record the indicator colour and approximate pH of the solution in each flask in the table below.
7. Add a spatula-full of broken shells or shell grit to each of the flasks. Make sure you put the same amount into each flask!
8. Gently swirl the flasks and observe what happens.
9. Record your observations in the third and last column of the table.
10. Observe any changes to the solutions and shells over a period of 3 days, and record your results in the table.
11. Pack up according to your teacher's directions.

WHAT'S IN THE BEAKER?

PRACTICAL ACTIVITY 6
OCEAN ACID AND SHELLS continued

Table 4: Recording pH of Water with Dissolved Calcium Carbonate

Solutions to which the seashells were added	Before the seashells were added	About 30 minutes later	After 3 days	What changes happened to the seashells/ shell grit?
	Colour/Approx pH	Colour/Approx pH	Colour/Approx pH	
Tap water				
Sea water				
Vinegar				
Soda water				
Water from previous activity				

QUESTION 1

Print and attach a photo of your flasks after three days.

PRACTICAL ACTIVITY 6
OCEAN ACID AND SHELLS continued

QUESTION 2

Suggest explanations for the changes in pH of the solutions and changes to the shells observed in Part C.

QUESTION 3

Can you suggest why:

a) You were instructed to put the same amount of liquid, the same amount of shell and the same amount of indicator into each flask.

b) You tested the shells in tap water and sea water as well as the vinegar, soda water and sea water into which carbon dioxide had been bubbled.

c) The flasks were not sealed tight with rubber stoppers.

QUESTION 4

Use your results to answer the inquiry question: What might be the impact on shellfish if extra carbon dioxide dissolves in the oceans?

PRACTICAL ACTIVITY 6
OCEAN ACID AND SHELLS continued

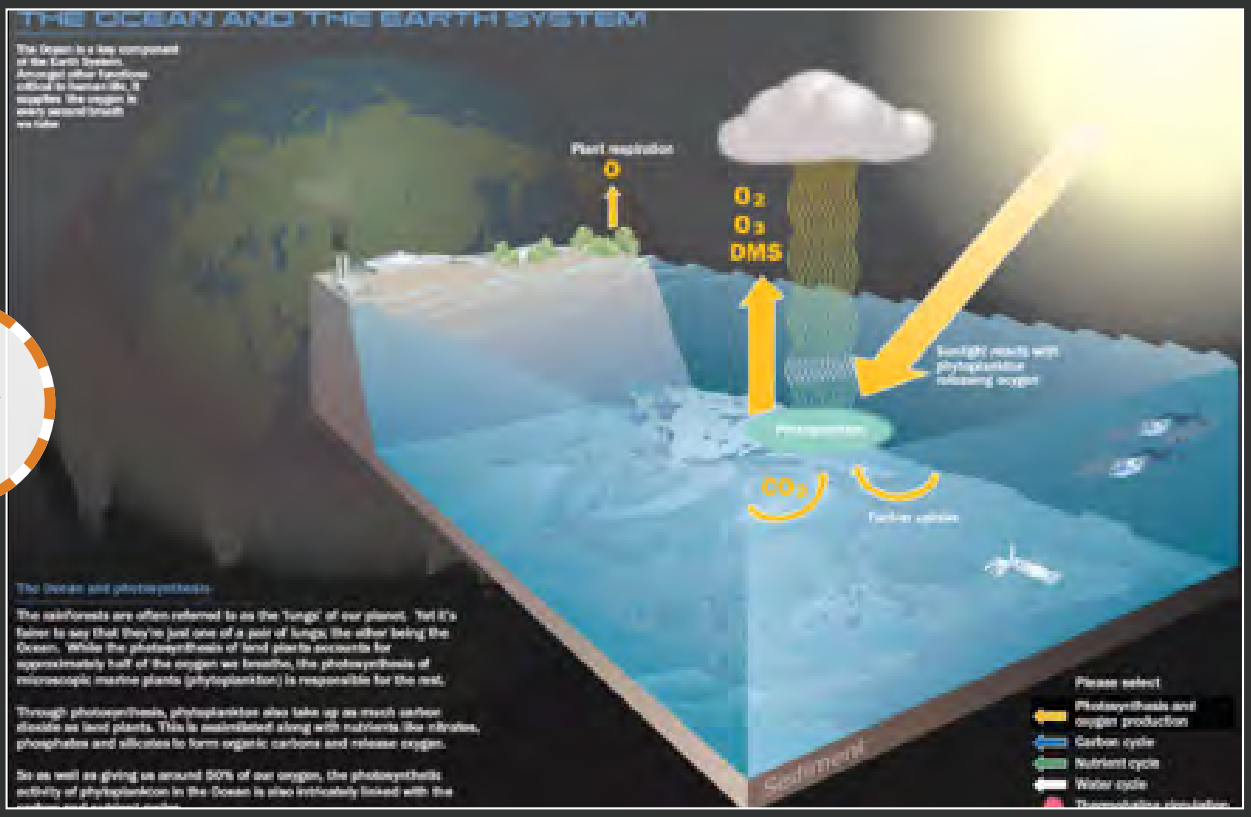
Watch this video about ocean acidification and shells and answer the questions.
www.youtube.com/watch?v=kxPwbhFeZSw

QUESTION 5

Use your results to answer the inquiry question:
What might be the impact on shellfish if extra carbon dioxide dissolves in the oceans?

PRACTICAL ACTIVITY 7

THE OCEAN AND THE EARTH SYSTEM



Click TO VIEW ONLINE

www.stateoftheocean.org/flash/system

BACKGROUND INFORMATION

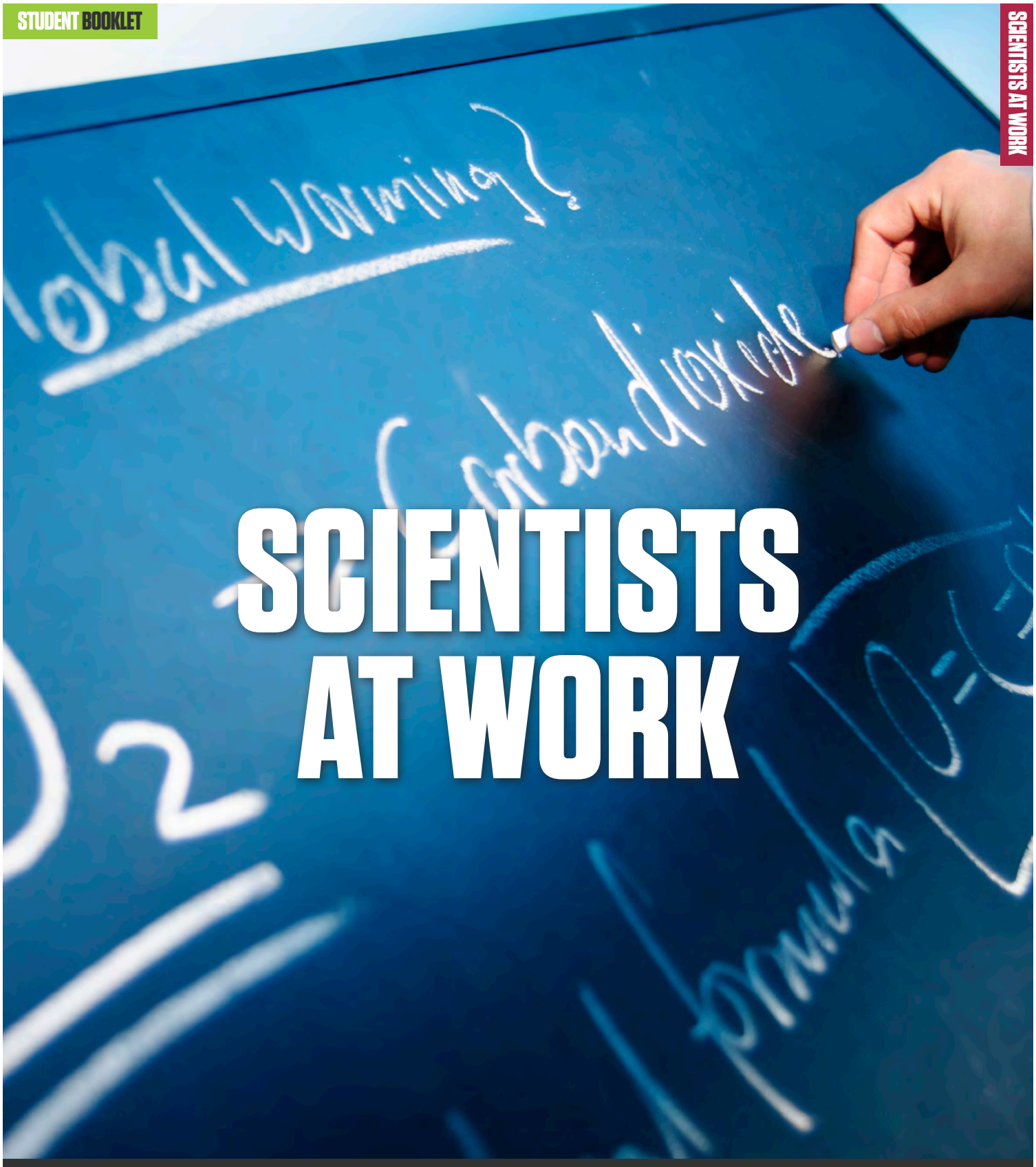
The **International** Programme on the State of the Ocean (IPSO) was established to enable a greater scientific understanding of the role of the ocean at an Earth system level and to consider the consequences of the multiple stressors exerted upon it for life on Earth.

IPSO works with the world's leading marine scientists to consider the cumulative impact of anthropogenic stressors from climate change through to the harvesting of marine species and what the consequences of these are for the ability of the ocean to function as part of the planet's life support system and to provide food and other ecosystem services to humankind.

The IPSO scientists develop an ecosystemic (holistic) understanding of how the ocean functions at the Earth system level by synthesising existing science, developing new scientific models and approaches, and enabling new scientific research and work to be undertaken.

IPSO has developed an infographic that covers the topics:

- Photosynthesis and oxygen production
- The carbon cycle
- The nutrient cycle
- The water cycle
- Thermohaline circulation



SCIENTISTS AT WORK

INTRODUCTION

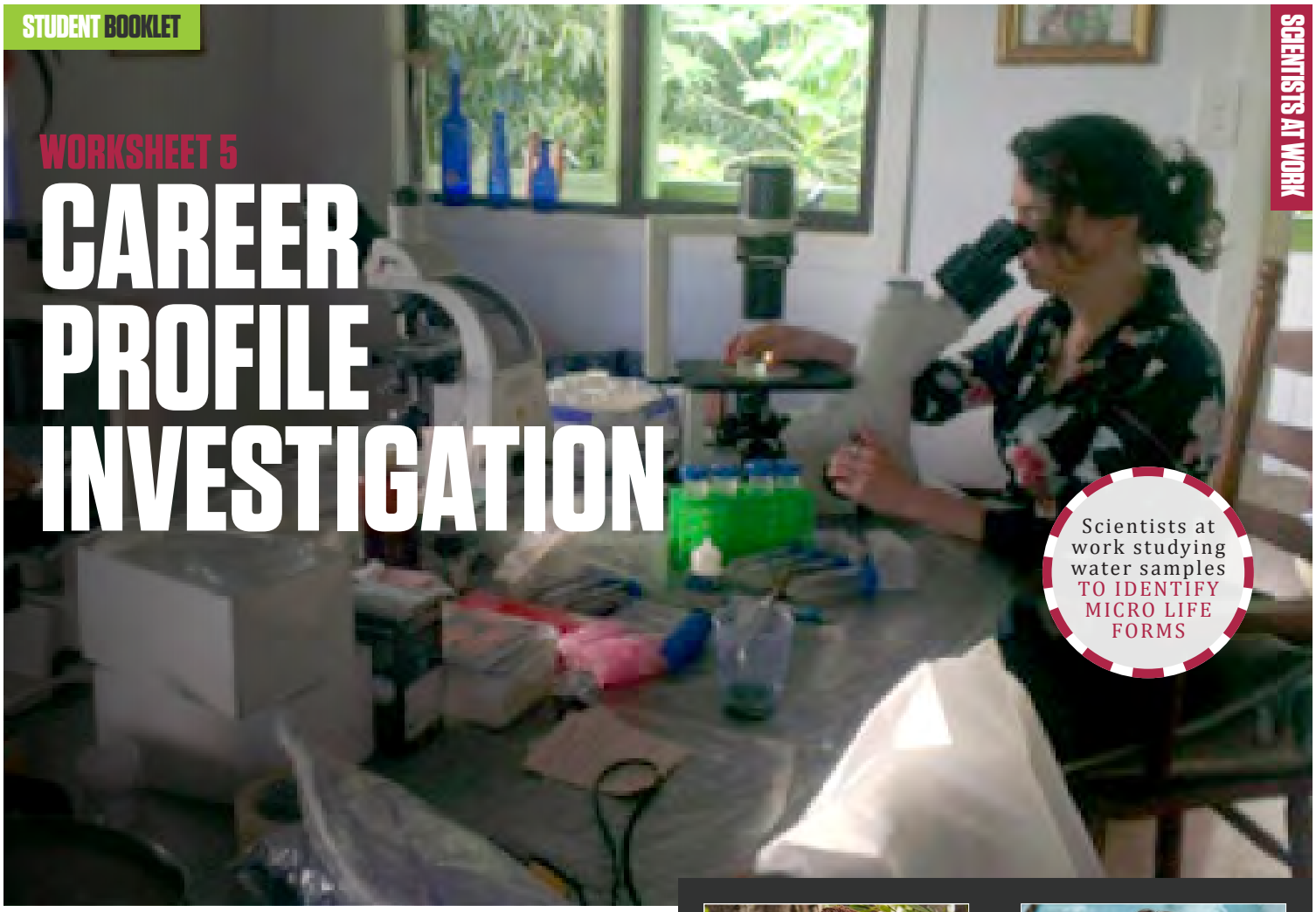
There are countless careers related to understanding the causes and effects of global warming and to finding and applying solutions.

These jobs range from working as a physicist in the Antarctic to communicating the latest scientific breakthroughs to the public. Other examples concern renewable energy, sustainable energy use, helping people affected by climate change and sea level rise. More and more jobs are being created every year.

Read the following career profiles before continuing with this activity.

WORKSHEET 5

CAREER PROFILE INVESTIGATION



Scientists at work studying water samples TO IDENTIFY MICRO LIFE FORMS

PROFILE 1

JAMES HOOPER, CLIMATE CHANGE SCIENTIST

James was co-named Adventurer of the Year in 2008 by National Geographic after traversing from the North Pole to the South Pole to raise awareness of climate change.

careerswithstem.com/science-engineering/profiles/james-hooper

PROFILE 2

MONIKA MARKOWSKA, PALAEO-ENVIRONMENTAL SCIENTIST

Exploring Earth's climate throughout the ages – palaeoclimatology – helps us understand how climate change will affect the planet in the future.

careerswithstem.com/science-engineering/profiles/monika-markowska

PROFILE 3

MONIQUE ALFRIS, SOLAR ENERGY ENGINEER

Monique studied photovoltaic and solar energy engineering at UNSW Australia, where she experienced how solar energy projects were helping people in the developing world. "I lived with villagers in Nicaragua who had no access to electricity or clean water, and applied my skills to help them," she says.

careerswithstem.com/science-engineering/profiles/monique-alfris

PROFILE 4

DR BRIONY ROGERS, CIVIL ENGINEER

Briony makes urban water systems more sustainable and resilient to the impact of climate change.

sciencemeetsbusiness.com.au/field-notes

YOUR TASK

In this activity you will be investigating someone who works in areas like renewable energy, climate change and oceans, and writing a career profile of that person. To do this you may use the internet, search science magazines, or even contact the person themselves – the choice is yours.

You can find sample career profiles of people working in the renewable energy industry on the STELR website: www.stelr.org.au

WORKSHEET 5
CAREER PROFILE INVESTIGATION continued

QUESTIONS TO RESEARCH

The information you gather should include, if possible, the questions in the left hand column of the following table. Use the right hand columns to keep track of your research information. Room has been left at the bottom for you to include any of your own questions.

	Question	Research Information	Reference
1	Name of the person being profiled		
2	Name of the organisation the person works for		
3	Brief description of what the organisation does		
4	Description of the position the person has in the organisation		
5	Subjects they studied at upper secondary school level		
6	Course(s) taken after leaving secondary school		
7	Duties involved in their job		
8	Why they chose this job		
9	The most enjoyable aspects of the job		
10	The challenges they face in the job		
11	How they think this job will change over the next decade		
12	Salary range of people working in this kind of job		
13			
14			

WORKSHEET 5
CAREER PROFILE INVESTIGATION CONTINUED

YOUR REPORT

Use the project space below to complete your report. Be creative in your use of the widgets and include a variety of content such as images, a video, a written report, and so on. Present the findings of your report to your class before submitting it to your teacher.

WORKSHEET 5
CAREER PROFILE INVESTIGATION CONTINUED

GLOSSARY

Term	Meaning