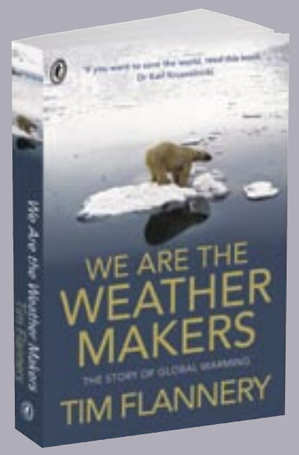

THINKING ABOUT CLIMATE CHANGE

A GUIDE FOR TEACHERS AND STUDENTS

Written for teachers by teachers, this resource is designed to make teaching about climate change easy and accessible. It provides ideas for teachers in all states across key learning areas, and prepared worksheets appropriate for years 7–10. Including material drawn from Tim Flannery's *We Are the Weather Makers*, it offers a valuable learning opportunity for students and will help develop both their thinking skills and understanding of climate change—the science, impacts and solutions.

Also available online at **www.theweathermakers.com**

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This is a free publication.

PURVES
ENVIRONMENTAL FUND

TEXT PUBLISHING

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THINKING ABOUT CLIMATE CHANGE A GUIDE FOR TEACHERS AND STUDENTS

THINKING ABOUT CLIMATE CHANGE

Based on Tim Flannery's *WE ARE THE WEATHER MAKERS*

A GUIDE FOR TEACHERS AND STUDENTS

THINKING ABOUT CLIMATE CHANGE

A GUIDE FOR TEACHERS AND STUDENTS

DEVISED BY:

David Harding

Rose Iser

Sally Stevens

PURVES ENVIRONMENTAL FUND

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About This Resource

Tim Flannery's seminal books *The Weather Makers* and *We Are the Weather Makers* changed minds and hearts about global warming. They contributed to a radical shift in our nation's understanding of climate change and the need for an urgent response.

Now, as a joint initiative between Tim Flannery, the Purves Environmental Fund and Text Publishing, the material from Flannery's award-winning books has been modified into this tool for the nation's classrooms: *Thinking About Climate Change: A Guide for Teachers and Students*.

Across the curriculum disciplines of Maths, Science, the Humanities and Information Technology, this resource offers lesson plans, research aids and discussion suggestions to allow teachers and students to explore the implications and complexities of climate change and to learn and practice relevant skills.

It has been compiled and tested by curriculum professionals and practising teachers and fact-checked by Professor Will Steffen, Director, The Fenner School of Environment and Society, Australian National University.

Professor Flannery is delighted that his work has been adapted into this learning resource. The guide includes a message from him, and material drawn directly from *We Are the Weather Makers*.

Lessons have been constructed for students between years 7 and 10 with a focus on 'Thinking Skills' to ensure its relevance to contemporary classroom practices.

The guide, sponsored by the Purves Environmental Fund, is COMPLETELY FREE. Distributed in multiple copies to all secondary schools in Australia in November 2007, it is also available online at www.theweathermakers.com. This site will be updated with activities, news, links and additional teaching tools.

Every secondary school in Australia was sent a free copy of *We Are the Weather Makers* in 2006, which will allow teachers to support their lessons with direct study from the book. While this resource does not need to be taught alongside class sets of *We Are the Weather Makers*, schools who wish to complete the study unit in this way will be able to purchase multiple copies of the book at a substantial discount through the publisher at books@textpublishing.com.au.

Thinking About Climate Change makes teaching about climate change issues easy and accessible for teachers in all states across key learning areas. We hope that it will provide a valuable learning opportunity for students and will help them develop their understanding of climate change—the science, impacts and solutions.

Acknowledgments

Tim Flannery, the Purves Environmental Fund and Text Publishing would like to thank the authors Rose Iser, David Harding and Sally Stevens, Professor Will Steffen for his climate science expertise, all the education professionals who provided advice and guidance, Alison Atherton for her support and guidance and Gemma Rayner who managed the development of the resource from inception to completion and ensured our vision was realised.

About the Sponsor

The Purves Environmental Fund was set up in 2004 by Robert Purves. Robert is passionate about developing solutions to critical environmental issues. He believes that climate change is the greatest challenge humanity has ever faced.

Robert is a businessman, a farmer, and environmentalist and the father of two teenage sons. As a father, Robert is personally concerned that his children and others be given the opportunity to learn about climate change, and what we can do about it, both as individuals and as a society.

The Purves Environmental Fund has been proud to support Tim Flannery, one of Australia's most eminent scientists and 2007 Australian of the Year, in his efforts to improve awareness of the climate challenge through the 'Weather Makers' series of books. Robert and Tim have also been members of the Wentworth Group of Concerned Scientists since it was convened in 2002.

In 2006 The Purves Environmental Fund sponsored the mail-out of a copy of *We Are the Weather Makers* to every secondary school in Australia. The Purves Environmental Fund is delighted to support this new 'Weather Makers' initiative *Thinking About Climate Change: A Guide for Teachers and Students*. With understanding comes the opportunity to create change—we hope this guide will inspire today's students to be tomorrow's leaders in dealing with the challenges of climate change.

About the Authors

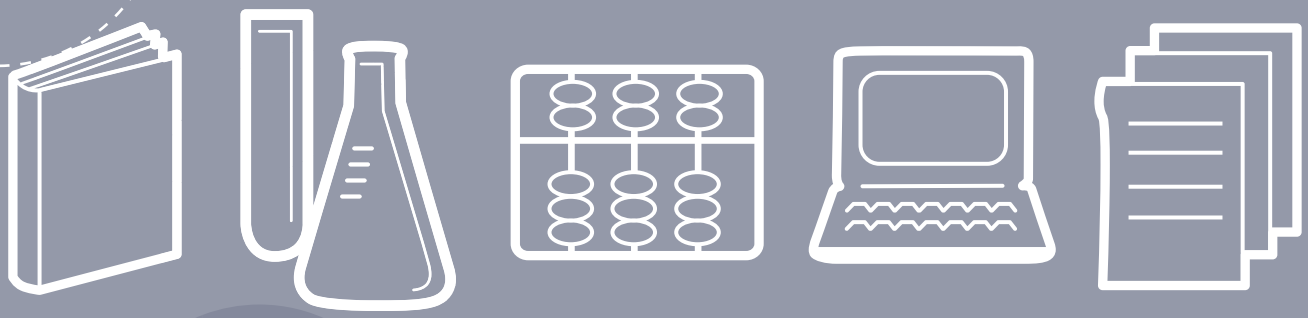
Tim Flannery is a writer, scientist and explorer. He has published over a dozen books, including the award-winning bestsellers, *The Future Eaters* and *Throwim Way Leg*. A leading thinker in environmental science, Tim is a member of the Wentworth Group of Concerned Scientists. He is also the National Geographic Society's Australasian representative and a director of the Australian Wildlife Conservancy. Tim lives in a sustainable house on the Hawkesbury River with his wife and a lot of wildlife. In January 2007 Tim Flannery was made Australian of the Year.

Rose Iser has been teaching, developing curriculum and writing teaching resources for ten years. She is also a lawyer and mother. More recently, she successfully stood for local government and hopes to make a difference to the future of our environment through her writing, teaching and political leadership.

Sally Stevens has been teaching for seven years in the English, History, Geography and International Relations subject areas. She has a keen interest in Middle Years Education and has been a presenter at various conferences on issues including Middle Years Innovation. Sally is passionate about giving prominence to environmental issues in education.

David Harding has been teaching for the past three years in the Maths and Information Technology areas. His teaching methods have a strong focus on discovery based learning and making topics relevant to the world in which his students live. His interest in raising awareness about climate change comes from the time David spent working in the Horticulture sector prior to teaching.

Contents



A Message from Tim Flannery

In the world we currently inhabit, the metabolism of our economy is on a collision course with the metabolism of our planet. That's because fossil fuels provide much of our energy, and in burning them we are liberating dangerous amounts of greenhouse gas to the atmosphere. There is now near universal agreement that this must be severely curtailed in the next few decades, otherwise our planet will experience dangerous climate change. This is both a threat and an opportunity, and because the changes to come in the next half-century will be profound, they are particularly relevant to younger people.

For these reasons, I feel strongly that young Australians should be given the chance to understand climate change as soon as possible. This will help them deal not only with the immediate challenges facing us, but the longer term ones. It will, for example, assist them in making career choices, for some businesses will expand greatly while others will decline. It will also assist them with consumer choices, because as their understanding of climate change grows, individuals will develop new attitudes about what is appropriate and moral. Young Australians may even grow up in a world where the relationships between nations will shift. This may occur in part because the tropical rainforests offer a great way of drawing carbon pollution from the air, so the poorest farmers on our planet may become crucial partners to the wealthy nations as they seek to stabilise their climate.

One of the most exciting, and immediately relevant, opportunities for young people concerns the new technologies for generating electricity, and providing transport without creating greenhouse gas pollution. In coming decades, these vital tools for stabilising our climate will be developed and brought to market by today's school children. And tomorrow's economists will struggle with issues that are new to us. An entire new global market – a trade in carbon – will be established, which will have broad implications for many aspects of our lives.

Climate change has already brought a revolution in the sciences. For the first time, it has forced a deeply integrating trend in the way we view our world. Biologists now know that it's fruitless to attempt to rescue endangered species without understanding how our atmosphere is altering, and once esoteric branches of science, such as the study of Earth's polar ice caps and ocean function, have a new relevance. In short, climate change is teaching us that everything is connected to everything else on Earth.

For all of these reasons, I believe that the study of climate change is relevant to a great many of the subjects our children undertake, and that by increasing their understanding of the issue they will see the relevance of such disciplines anew. Indeed, as their understanding of the issue develops I believe that they will start seeing the world in a new way, a way that most of us have not possessed. That may seem like a large claim, but as we move to address climate change, so many aspects of our world will alter that it will be little short of a revolution.

I hope that in this teacher's pack, and in *We Are the Weather Makers*, you will find the tools you need to engage your classes fully in the issue.

Good Luck,

Tim Flannery
2007 Australian of the Year

How to Use This Resource

There are many different approaches to teaching students about the complex issues surrounding climate change. This teacher resource provides ideas and prepared worksheets appropriate for years 7–10, to enable teachers to develop students' thinking skills through a study of material drawn from Tim Flannery's *We Are the Weather Makers*.

Written **for teachers by teachers**, it is designed to be used in a number of different ways depending on the curriculum directions of your school.

In this resource, you will find a series of individual worksheets organised into four discipline areas: **Humanities, Science, Mathematics** and **IT**. Your students could complete the worksheets:

- in conjunction with an English/literacy-based text study of *We Are the Weather Makers*
- as a multi-disciplinary or cross-curricular unit of work on climate change
- as discrete classes in the disciplines of English, History, Geography, Science, Maths or IT
- as part of a unit of work on climate change or environmental studies in any of the individual disciplines listed above.

We do, however, encourage you to first run a class from the general section of the resource, **Climate Change Context and Overview**, to give students a basic introduction to climate change.

Student Worksheets

Each worksheet is appropriate for a discrete class running for approximately 60 minutes, or multiple classes if project work and research is adopted. The time needed to complete activities and worksheets will of course vary, according to students' year level, skills, prior knowledge, needs and interests. There are sections common to each worksheet:

- An extract from the text *We Are the Weather Makers*, which sits in the 'cloud' at the top of each page
- Reaction to the text: a tool to gauge students' prior knowledge and understanding of the topic and comprehension of the extract
- Three to four learning activities designed to develop students' **thinking skills**
- Reflection and self-assessment—What have I learnt?
- Diagrams of 'thinking tools' and illustrative prompts to help complete activities and experiments

Some worksheets require additional materials, but many of these are supplied in the Tips for Teachers pages that accompany each worksheet or on the website www.theweathermakers.com.

Tips for Teachers

Teachers should read the Tips for Teachers page after reading its companion Student Worksheet when planning lessons. They provide practical directions and guidelines for teachers, and suggest extension activities for students. References on these pages to 'the book' refer to *We Are the Weather Makers*, a free copy of which was sent to all secondary schools in 2006. The Tips for Teachers pages also provide discussion points, explanations of tasks and experiments, references to 'thinking tools' found in the next section of this resource, and other useful information.

Pedagogical focus

Educational practice around Australia has shifted from a focus on knowledge to a focus on skills—particularly thinking and problem-solving skills. Our knowledge of our planet and its climate is ever-changing, but our students require an extensive skill-set to solve the problems faced by humans.

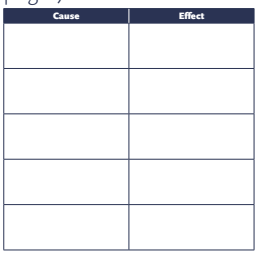
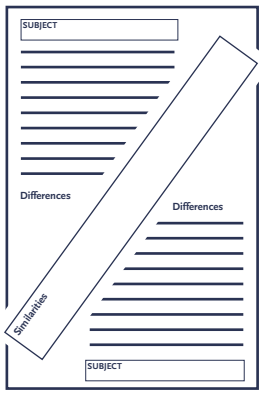
Each of the worksheets incorporates a number of thinking skills which are embedded in the learning activities. Many of these will already be familiar to you, but additional information is supplied in the next section of this resource. Additionally, there are a number of classroom resources for teachers at the end of this guide.

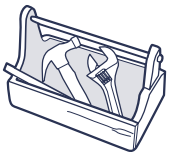
Thinking Skills

The learning activities in this resource are designed to develop the following thinking skills:

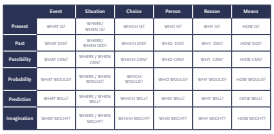
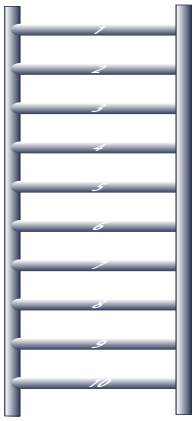
- Critical thinking skills (e.g. analysis, synthesis, summary, evaluation, comparison, classification)
- Creative thinking skills (e.g. elaboration, flexibility, originality)
- Metacognition (e.g. reflection, self-assessment)
- Inquiry and problem-based learning (e.g. decision making)
- Research skills

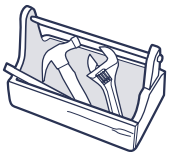
The learning tools employed in many of the activities in this resource are devices which are commonly promoted and used in schools across Australia and internationally. They have been pulled from a variety of different sources. A reference list with a brief explanation is provided below.

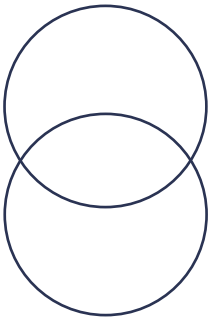
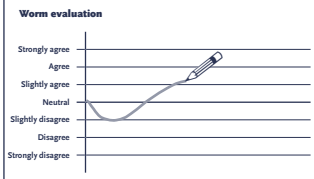
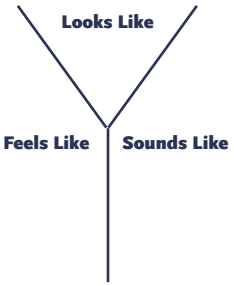
Thinking Tool	Picture where relevant	Explanation
5 Whys Analysis	Students are presented with a 'why?' question to which they respond. They are then asked a further 'why?' question about their response and so on. The process asks students to consider their responses deeply and question the assumptions in their responses.	
A-Z Brainstorm Creativity, elaboration, fluency	A... E... B... F... C... G... D... H... etc.	This is a structured brainstorm in which students are provided with a prompt. Students are asked to think of a word or phrase related to the topic which commences with each letter of the alphabet.
Brainstorm Fluency, elaboration, recall	Participants generate as many ideas as they can about the topic. These are recorded either in table groups or on the board. **Rules** • Quantity not quality • Be free-wheeling, anything goes • Hitch-hiking on others' ideas is to be encouraged • No criticism is allowed (positive or negative comments to be avoided) • Writer must write as said—no paraphrasing	
Cause and Effect Analysis, summary, justification	See classroom resource page 78. 	Students identify causes and effects and make these clear graphically in a table, flow diagram or other diagrammatic form.
Comparison Alley Comparison, analysis	See classroom resource page 83. 	This is another form of graphic representation of comparative analysis—similar to a Venn Diagram.



Thinking Tool	Picture where relevant	Explanation
Graffiti Wall Creativity, Analysis	Students write their responses to a prompt on a large sheet of paper to create a 'graffiti wall' of ideas and responses Steps **1.** Write a different prompt on several large sheets of paper. **2.** Group students and distribute one sheet to each group. **3.** Give students a specified time to write responses to the prompt on the paper. **4.** Circulate topics around the room so that each group responds once to each topic. **5.** Display the Graffiti Walls around the classroom and have students report further on the topics.	
KWL Self-assessment, prediction, inquiry	See classroom resource page 86. What do I **K**now? / What do I **W**ant to know? / What have I **L**earnt?	Students complete two columns of a table at the commencement of a topic or lesson: what do I know about the topic? What do I want to know about the topic? It is useful to combine these on the board as a class. This can generate some focus questions for research. At the completion of the topic or class, students complete the third column: what have I learnt?
Mind Map or Spider Map Creativity, elaboration, fluency	See classroom resource page 79. Mind/Spider map	Mind mapping is a simple process where students undertake creative thinking, planning and summarising. **How can I use it?** • Keep words to a minimum • Print along the lines • Use colour • Use symbols and other three dimensional shapes to help your ideas stand out.
Placemat Decision making, evaluation	See classroom resource page 82.	**1.** Divide a large piece of paper into sections—1 section per group member. **2.** Draw a circle in the middle of the paper. **3.** Each group member writes their own ideas about the issue, or topic in their section. **4.** As each group member shares their responses with the group, appoint a scribe to record the common responses in the circle.
PMI Analysis	See classroom resource page 74. Plus / Minus / Interesting	Students complete the table by writing their own 'pluses', 'minuses' and 'interesting aspects' of the subject.
Predict, Observe, Explain Inquiry, prediction, analysis, justification	Before commencing an activity, students commit to a prediction (predictions could be about the results of an experiment, the responses of others, the meaning of a word or concept, etc.). Predictions must be written down or recoded in some form. Students then observe the activity before explaining the ways in which their prediction matched the results and why.	

Thinking Tool	Picture where relevant	Explanation
Question Matrix Inquiry	See classroom resource page 80. 	Students use question stems as prompts to generate their own questions on a topic. They can then share their questions with classmates and select the most probing, relevant and answerable questions.
Ranking Ladder Decision-making	See classroom resource page 77. 	Students are scaffolded through the process of prioritising according to certain criteria. The exercise requires students to consider the relative importance of items and justify their evaluation. **Steps** **1.** List or brainstorm items **2.** Identify and make known the criteria for evaluation **3.** Rank items according to criteria individually or in groups and complete ranking ladder chart **4.** Compare and justify ranking
SMART Goals Reflection, analysis, personal learning	**SMART GOALS – Specific, Measurable, Achievable, Realistic, Time-limited** • **SPECIFIC:** Describe what you want to accomplish with as much detail as possible. Outline the steps you need to do it. • **MEASURABLE:** Describe your goal in terms that can clearly be evaluated. • **ATTAINABLE:** Identify a goal you know you are actually capable of achieving with a little stretch! • **RELEVANT:** Make sure it fits in with what you're trying to do. • **TIME-LIMITED:** Break longer term goals into shorter ones and clearly specify target completion dates. **Starters:** I would like to have achieved... My goal is to... I want to complete... I want to improve on... I'd like to try to... By the end of the semester I want to... An area I'd like to focus on this semester is...	
SWOT Analysis Analysis, justification	See classroom resource page 75. 	Students analyse the subject matter and list the Strengths, Weaknesses, Opportunities and Threats. Students record their responses either individually or as a group on the SWOT Table and should also be asked to justify their responses.



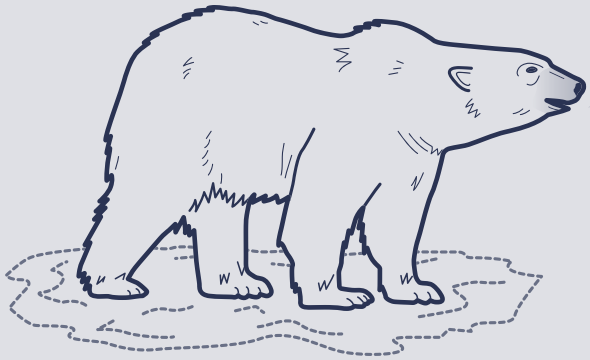
Thinking Tool	Picture where relevant	Explanation
Think, Pair, Share (Collaboration, checking understanding)	1. **THINK**—Students think individually about an issue, question or problem and record their thoughts. 2. **PAIR—**Discuss ideas with a partner and record what they have shared. 3. **SHARE**—Share with the whole group or join another pair to reach consensus.	
Venn Diagram Comparison	See classroom resource page 85. 	Venn Diagrams help students to illustrate the relationship between or among two or more sets of things or ideas. This strategy helps students to make their thinking explicit and visible. They are useful for finding similarities and differences. How can I use it? 1. Draw two large circles that overlap. 2. Each circle should represent a different topic/issue. Students should record all the 'differences' between the topics/issues in these sections of the circles 3. The overlapping section is to record the 'similarities'.
Worm Evaluation Analysis, evaluation, decision-making	See classroom resource page 84. 	Like the 'worm' used during televised political debates in Australia, students graphically represent their responses to arguments. The axis should be labelled with a range from strongly disagree to strongly agree and students graphically illustrate the level of their agreement while listening to a debate or discussion.
Y Chart Classification, evaluation	See classroom resource page 76. 	A Y Chart lists what the topic looks like, sounds like and feels like. Students should record their feelings and thoughts in the relevant section of the Y Chart. **How can I use it?** The Y Chart helps students clarify concepts or ideas. Have students draw a Y and label it accordingly. They should then list all their responses to these sections.

Links with Curriculum Standards in Australia

The different curriculum frameworks across the States of Australia all share some key learning standards. The worksheets in this resource have been matched to many of these common standards in the matrix below. The authors recognise that the emphases or wording of the standards may differ across the states and that some states are currently reviewing their key learning standards.

Worksheets	BCKG	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
English		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓				✓			✓
Speaking and listening		✓		✓	✓	✓	✓	✓	✓												✓			
Reading				✓	✓	✓	✓	✓							✓		✓							✓
Writing		✓	✓			✓	✓	✓	✓	✓			✓		✓	✓								✓
Viewing and representing		✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓							
Geography		✓	✓	✓	✓	✓	✓	✓	✓					✓	✓			✓				✓		✓
Communicating geographical information and applying appropriate geographical tools						✓	✓	✓							✓			✓						
Knowledge of the characteristics of environments and how communities interact with the environment		✓	✓	✓	✓	✓	✓	✓	✓					✓	✓							✓		✓
History				✓					✓															
Knowledge of the nature of history, past societies and periods and their legacy				✓					✓															
Science				✓	✓					✓	✓	✓	✓	✓	✓	✓	✓			✓				
Nature and practice of science										✓	✓	✓	✓	✓		✓	✓							
Applications and uses of science					✓						✓	✓	✓	✓		✓	✓							
Implications of science for society and the environment										✓		✓	✓			✓				✓				
Current issues, research and development.				✓											✓	✓				✓				
Mathematics																		✓	✓	✓	✓	✓		
Working Mathematically																		✓	✓	✓	✓	✓		
Number																			✓		✓	✓		
Patterns and Algebra																								
Measurement, Chance and Data																		✓		✓				
Technology/ICT/IST			✓	✓		✓	✓	✓	✓		✓					✓		✓	✓				✓	✓
Knowledge of a range of computer software and hardware			✓	✓														✓	✓				✓	✓
ICT for communicating			✓	✓		✓	✓	✓	✓		✓					✓								
Responsible use of information and software technology			✓	✓																			✓	✓
Thinking Skills		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Problem-solving skills			✓		✓		✓		✓		✓		✓		✓	✓	✓	✓	✓	✓	✓	✓		✓
Creativity, imaginative and interpretive		✓	✓				✓		✓			✓		✓	✓	✓	✓					✓		
Reasoning, processing, critical thinking and inquiry				✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓			✓				
Reflection, evaluation and metacognition		✓	✓		✓	✓		✓	✓		✓	✓		✓		✓								
Research skills				✓	✓	✓			✓						✓						✓		✓	✓
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

Climate Change Context and Overview



This section of the guide is designed to provide an overview of some of the issues and implications of climate change and a broader context for study. It contains: an edited introduction from ***We Are the Weather Makers***, a chapter-by-chapter breakdown of the book, a number of comprehension exercises to ensure students have a grounding in the issues, and a range of further research suggestions and resources. It is advisable to look over the materials here before beginning any unit of study on climate change, because although the lessons contained throughout this resource are designed to stand alone, a basic level of climate change awareness is assumed.

This is an edited extract from Tim Flannery's *We Are the Weather Makers*.

'We are the weather makers' is a serious thing to say. And if anyone had said to me a decade ago that our planet was in urgent danger I wouldn't have paid much attention. But in the last decade climate science has undergone a revolution, and now we understand a great deal more about Earth's climate system and how it is changing. Climate is always changing, of course, but it is now doing so at an unnatural pace, and we are causing it. Unfortunately, most of those changes will damage our world.

My hope is that people can continue to have the chance, as I did, to stand on a glacier high atop a tropical mountain, and to look way down over dense jungles, plains and mangrove swamps, and finally see tropical reefs in the distance.

It should be everyone's birthright to experience our wonderful planet to the fullest, to have the chance to see polar bears, great whales and Antarctic glaciers in real life. I believe that it's profoundly wrong to deprive future generations of this just so we can continue wasting electricity and driving oversize cars.

In 1981, when I was in my mid-twenties, I climbed Mt Albert Edward, one of the highest peaks on the tropical island of New Guinea.

The bronzed grasslands of the summit were a contrast to the green jungle all around, and among the alpine tussocks grew groves of tree-ferns, whose lacy fronds waved above my head.

Downslope, the tussock grassland ended abruptly at a stunted, mossy forest. A single step could carry you from sunshine into the gloom, where the pencil-thin saplings were covered with moss, lichens and filmy ferns.

In the leaf litter on the forest floor I was surprised to find the trunks of dead tree-ferns. Tree-ferns grew only in the grassland, so it was clear that the forest was climbing towards the mountain peak. I guessed it had swallowed at least thirty metres of grassland in less time than it takes for a tree-fern to rot on the damp forest floor—a decade or two at most.

Why was the forest expanding? I remembered reading that New Guinea's glaciers were melting. Had the temperature on Mt Albert Edward warmed enough to permit trees to grow where previously only grasses could take root? Was this evidence of climate change?

I am a palaeontologist, someone who studies fossils and geological periods, so I know how important changes in climate have been in determining the fate of species. But this was the first evidence I'd seen that it might affect Earth during my lifetime. I knew there was something wrong, but not quite what it was.

Despite the good position I was in to understand the significance of these observations, I soon forgot about them. What seemed like more urgent issues demanded my attention. Rainforests were being felled for timber and to make agricultural land, and the larger animal species living there were being hunted to extinction. In my own country of Australia, rising salt was threatening to destroy the most fertile soils. Overgrazing, water pollution and the logging of forests all threatened precious ecosystems and biodiversity— the range and variety of life forms that exist in our environment.

So is climate change a huge threat, or nothing to worry about? Or is it something in between—an issue that we must soon face, but not yet?

Even scientists don't agree on every aspect of climate change research. We are trained sceptics, always questioning our own and others' work. A scientific theory is only valid for as long as it has not been disproved. And climate change can be difficult for many people to think about calmly because it arises from so many things we take for granted in the way we live.

Some things about climate change are certain. It results from a special kind of air pollution. We know exactly the size of our atmosphere and the volume of pollutants pouring into it. The story I want to tell here is about the impacts of some of those pollutants (known as greenhouse gases) on all life on Earth.

For the last 10,000 years Earth's thermostat, or climate control, has been set to an average surface temperature of around 14°C. On the whole this has suited human beings splendidly, and we have been able to organise ourselves in a most impressive manner—planting crops, domesticating animals and building cities.

Finally, over the past century, we have created a truly global civilisation. Given that in all of Earth's history the only other creatures able to organise themselves on a similar scale are ants, bees and termites—which are tiny in comparison to us and have small resource requirements—this is quite an achievement.

Earth's thermostat is a complex and delicate mechanism, at the heart of which lies carbon dioxide (CO_2), a colourless and odourless gas formed from one carbon and two oxygen atoms.

CO_2 plays a critical role in maintaining the balance necessary to all life. It is also a waste product of the fossil fuels—coal, oil and gas—that almost every person on the planet uses for heat, transport or other energy needs. On dead planets such as Venus and Mars, CO_2 makes up most of the atmosphere, and it would do so here if living things and Earth's processes didn't keep it within bounds. Our planet's rocks, soils and waters are packed with carbon atoms itching to combine with oxygen and get airborne. Carbon is everywhere.

For the past 10,000 years CO_2 has made up around three parts per 10,000 in Earth's atmosphere. That's a small amount—0.03%—yet it has a big influence on temperature. We create CO_2 every time we burn fossil fuels to drive a car, cook a meal or turn on a light, and the gas we create lasts around a century in the atmosphere. So the proportion of CO_2 in the air we breathe is now rapidly increasing, and this is causing our planet to warm.

By late 2004, I was really worried. The world's leading science journals were full of reports that glaciers were melting ten times faster than previously thought, that atmospheric greenhouse gases had reached levels not seen for millions of years, and that species were vanishing as a result of climate change. There were also reports of extreme weather events, long-term droughts and rising sea-levels.

We cannot wait for someone to solve this problem of carbon emissions for us. We can all make a difference and help combat climate change at almost no cost to our lifestyle. And in this, climate change is very different from other environmental issues such as biodiversity loss or the ozone hole.

The best scientific evidence indicates that we need to reduce our CO_2 emissions by 70 per cent by 2050.

How can we do this?

If your family owns a four-wheel-drive and replaces it with a hybrid fuel car, which combines an electric motor with a petrol-driven engine, you can instantly cut your transport emissions by 70 per cent.

If your home's electricity provider offers a green option, you will be able to make equally major cuts in your household emissions for the daily cost of an ice cream. Just ask for your power to come from renewable energy sources such as wind, solar or hydro.

And if you encourage your family and friends to vote for a politician who has a deep commitment to reducing CO_2 emissions, you might change the world.

We have all the technology we need to change to a carbon-free economy. All we need is to apply our knowledge and develop our understanding. The main things stopping us going forward are the pessimism and confusion created by people who want to go on polluting so that they can make money.

Our future depends on readers like you. Whenever my family gathers for a special event, the true scale of climate change is never far from my mind. My mother, who was born when motor vehicles and electric lights were still novelties, glows in the company of her grandchildren, some of whom are not yet ten.

To see them together is to see a chain of the deepest love that spans 150 years, for those grandchildren will not reach my mother's present age until late this century. To me, to her, and to their parents, their welfare is every bit as important as our own.

Climate change affects almost every family on this planet. 70 per cent of all people alive today will still be alive in 2050.

Do you understand what the author, Tim Flannery, means by 'climate change'? Check your understanding by answering these questions.

1. Why are scientists worried about the climate changing?

a. Because the Earth's climate always stays the same.

b. Because climate change will make our world safer.

c. Because the climate is changing very quickly.

d. Because humans have no control over climate change.

2. When the author was in New Guinea in 1981, he saw evidence that the forest was creeping up the mountain. What was the evidence?

a. Dead grassland tree-ferns on the forest floor.

b. Smaller trees higher up the mountain.

c. Moss and lichens on the ground.

d. None of the above.

3. List three further pieces of evidence mentioned by the author that have made him conclude that the Earth's climate is changing.

4. What gas does the author argue is the main cause of climate change? Where does this gas come from?

5. Why does the author say that we need to reduce our CO_2 emissions by 70% by 2050?

6. What questions do you have? Using a Question Matrix write down any questions that you have about the following:

a. Carbon dioxide and climate change

b. Human activities and climate change

c. The impact of climate change

	Event	Situation	Choice	Person	Reason	Means
Present	WHAT IS?	WHERE/ WHEN IS?	WHICH IS?	WHO IS?	WHY IS?	HOW IS?
Past	WHAT DID?	WHERE/ WHEN DID?	WHICH DID?	WHO DID?	WHY DID?	HOW DID?
Possibility	WHAT CAN?	WHERE / WHEN CAN?	WHICH CAN?	WHO CAN?	WHY CAN?	HOW CAN?
Probability	WHAT WOULD?	WHERE / WHEN WOULD?	WHICH WOULD?	WHO WOULD?	WHY WOULD?	HOW WOULD?
Prediction	WHAT WILL?	WHERE / WHEN WILL?	WHICH WILL?	WHO WILL?	WHY WILL?	HOW WILL?
Imagination	WHAT MIGHT?	WHERE / WHEN MIGHT?	WHICH MIGHT?	WHO MIGHT?	WHY MIGHT?	HOW MIGHT?

7. The author has highlighted in bold several 'key' sentences—sentences that help to summarise main ideas. Locate these 'key' sentences. Can you find three other sentences that you believe are 'key' sentences? Highlight them or write them on cards and stick them around the walls of your classroom.

8. Do you understand all of the words and concepts below?

a. glacier

b. biodiversity

c. ecosystem

d. pollution

e. fossil fuels

f. carbon

g. emissions

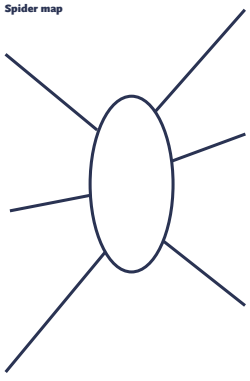
h. renewable energy

i. hybrid car

Look up any words that you don't understand either in a dictionary or on the Internet. Write down a brief definition of five of the words.

9. You can 'draw' the connections between ideas in a number of ways. Try connecting the ideas below in either a Spider Map or a Cause and Effect table.

Spider map



Cause	Effect

This activity will help you to think about how all of these ideas fit together.

glacier
ecosystem
fossil fuels
emissions
energy
biodiversity
pollution
carbon
renewable
hybrid car

Regardless of the curriculum approach to climate change chosen by your school, it may be appropriate to commence your unit with an opportunity for students to familiarise themselves with the entire text of *We Are the Weather Makers*.

There are a number of ways in which this can be achieved. A few ideas are listed below:

- **Summarising the text:** In small groups, students can write a blurb of 50 words or less for each chapter. These can be illustrated with an appropriate graphic, drawing or collage.
- **Key words:** Students can select 20 key words or phrases from the text and create an index of the sections of the text that deal with each of these key concepts.
- **Key sentences:** Students can locate key sentences which capture the message from each chapter. These sentences can be further synthesised to try to tell the story of the book in as few words as possible. Students can reduce the message of the book to captions which can be displayed on posters, stickers or postcards.
- **Scavenger hunt:** Teachers can create a scavenger hunt or use the one below to challenge students to locate and interpret sections of the text.
- **Documentary:** Students can imagine helping someone who is translating the text to a documentary: what sections could the script include? What footage could be used to illustrate passages of the text? What passages would be difficult to convey on film? Why?

Teachers will find a summary of each chapter below and a sample scavenger hunt on page 15.

Summary of *We Are the Weather Makers*

Introduction: What is Climate Change?
Flannery recounts an experience in New Guinea which prompted him to focus his attention on climate change. The role of CO_2 in global warming is introduced and it is argued that 'we cannot wait for someone to solve this problem of carbon emissions for us' (p.7). Some actions that individuals can take to reduce personal carbon emissions are suggested.

Part One: The Atmosphere

Chapter 1: Everything is Connected
The atmosphere is described as 'The Great Aerial Ocean' which protects all life. Flannery chronicles the history of the atmosphere and how its content influenced the beginning of life on Earth.

Chapter 2: The Great Aerial Ocean
The difference between weather and climate and the layers of the atmosphere are explained. The roles of ozone, water vapour and carbon dioxide in regulating Earth's temperature are introduced. The Keeling Curve is discussed.

Chapter 3: The Greenhouse Gases
The concentrations of CO_2 in the atmosphere over time are explained. Other greenhouse gases are introduced: methane, HFCs and CFCs. The carbon cycle and the role of forests and oceans in the cycle are explained.

Chapter 4: Ice Ages and Sunspots
Milankovic's theories to explain the heating and cooling of the Earth are explained: Earth's orbit around the sun, the Earth's tilt on its axis, the 'wobble' of Earth on its axis. The role of sunspots in influencing Earth's recent climate change is dismissed.

Chapter 5: Time's Gateways
Occasions when one climatic era has given way to another throughout Earth's history are explained. Again, the role of CO_2 in these historic changes in climate is discussed. A timeline is provided to assist readers.

Chapter 6: Born in the Deep-freeze
The sources of scientists' knowledge about Earth climatic history are revealed: tree rings and ice-cores. These can inform us of previous eras of global warming and cooling. The impact of disruptions to the Gulf Stream is also explained.

Chapter 7: The Long Summer
The warm weather of the past 8000 years has fostered civilisation as we know it. Changes in CO_2 concentrations in the atmosphere have influenced climate and civilisation over time.

Chapter 8: Digging Up the Dead
Our use of fossil-fuels (particularly coal and oil) is explained in terms of history, processes and effects.

Part Two: One in Ten Thousand

Chapter 9: Magic Gates, El Niño and La Niña
Dramatic changes that have been recorded in our climate and their association with the effects of El Niño and La Niña are explored. The chapter also examines the ways the effects of climate change can be detected by observing the reactions of species such as butterflies, birds, caterpillars, frogs and possums.

Chapter 10: Peril at the Poles
Discusses the effect of dwindling sea-ice and warmer waters on the food chain and habitats for animals including lemmings, caribou, penguins, polar bears and seals in the Arctic circle and Antarctica.

Chapter 11: The Great Stumpy Reef?
Explains the causes and effects of coral bleaching.

Chapter 12: A Warning from the Golden Toad
'The golden toad is the first documented victim of global warming' (p.108). The toad's fate is explained.

Chapter 13: Rainfall
The interaction between global warming and rainfall is explained. Areas of the globe are already experiencing more or less rainfall which is affecting inhabitants of these regions.

Chapter 14: Extreme Weather
The causes and effects of devastating hurricanes such as Katrina are explained. Increases in heat-waves are also discussed.

Chapter 15: Rising Waters
As ice melts, sea levels are rising. The global effects of rising seas are discussed.

Part Three: The Science of Prediction

Chapter 16: Model Worlds
Computer simulations of climate changes—including their limitations—are discussed. Predictions made at the Hadley Centre and by the CSIRO are listed.

Chapter 17: Danger Ahead
The full impact of greenhouse gases is discussed as are the efforts required to avert a temperature increase of 1-3 degrees.

Chapter 18: Retreating Up the Mountains
This chapter explains the implications of temperature increase for Australia and the world's biodiversity. Many species will be adversely affected while malaria spreading mosquitoes will thrive.

Chapter 19: How Can They Keep on Moving?
Flannery describes the way that species have previously adapted to changes in climate by moving to new habitats. He argues that the modern world offers little scope for animals, birds and sea-creatures looking for new homes.

Chapter 20: The Three Tipping Points
'Scientists are aware of three big tipping points for Earth's climate: a slowing or collapse of the Gulf Stream; the death of the Amazon rainforests; and the explosive release of methane from the sea floor.' (p.177) These three scenarios are explained.

Chapter 21: The End of Civilization
'A rapid shift to another kind of climate could place a stress on our global society, for it would alter the location of sources of water and food, as well as their volume.' (p. 190) Flannery asks why we have done so little about global warming.

Part Four: People in Greenhouses

Chapter 22: The Story of Ozone
The success of the Montreal Protocol in dealing with the hole in the ozone layer is explained.

Chapter 23: The Road to Kyoto
The purpose of the Kyoto Protocol and Australia's reluctance to ratify it are explained.

Chapter 24: Cost, Cost, Cost
The costs of acting on climate change and doing nothing on climate change are compared.

Chapter 25: People in Greenhouses Shouldn't Tell Lies
The efforts made by countries to reduce carbon emissions are explained and other possible solutions, such as sequestration, are discussed.

Chapter 26: Last Steps on the Stairway to Heaven?
The benefits and possibilities of a hydrogen economy and a carbon-free electricity grid are discussed.

Part Five: The Solution

Chapter 27: Bright as Sunlight, Light as Wind
'In our war on climate change we must decide whether to focus our efforts on transport or the electricity grid.'(p. 232) Wind and solar power are explained.

Chapter 28: Nuclear?
Alternative sources of energy including nuclear and geothermal energy are discussed.

Chapter 29: Hybrids, Minicats and Contrails
Ways of decarbonising our transport system are explained: hybrid cars, increasing public transport, flying aircraft lower.

Chapter 30: Over to You
'If everyone takes action to rid atmospheric carbon emissions from their lives, I believe we can stabilise and then save the Arctic and Antarctic. We could save around four out of every five species currently under threat.' (p. 249) Flannery urges individuals not to wait for governments to act, but to take personal action...now.

Scavenger Hunt

Look through the book and FIND
(Record the page number on which you found the information)

The meaning of the term 'coral bleaching'. What is it and how does it happen?	The amount that the sea-level is expected to rise if global temperatures increase by 3 degrees.	How CO_2 gets into the atmosphere.
An alternative form of energy for the electricity grid and any benefits and problems associated with this.	The name of a species affected by climate change and how the species has been affected.	How water vapour is involved in global warming.
Efforts that some governments have made to combat climate change.	Evidence scientists have that the climate is changing.	An alternative form of energy for transportation and any benefits and problems associated with this.
A theory put forward by someone who is sceptical about climate change.	Something that is happening in the Arctic as a result of global warming.	Three things that you can do today to combat climate change.

You will have come across other books, films and websites on climate change. You may find it useful to refer to some of these resources:

Books

The Atlas of Climate Change: Mapping the World's Greatest Challenge, K. Dow and T. E. Downing, Earthscan Publications

Heat: How to Stop the Planet Burning, George Monbiot, Allen Lane

An Inconvenient Truth, Al Gore (film, book and blog)—www.climatecrisis.net/blog

Living in the Hothouse: How Global Warming Affects Australia, Ian Lowe, Scribe

Six Degrees: Our Future on a Hotter Planet, Mark Lynas, Fourth Estate

Links

www.bbc.co.uk/climate

www.greenhouse.gov.au

www.koshland-science-museum.org

www.pewclimate.org/

www.planetark.com.au

www.realclimate.org/

www.theweathermakers.com

www.worldviewofglobalwarming.org

www.wwf.org.au

www.youthclimatecoalition.org/

A comprehensive list of further resources can be found at the Australian Sustainable Schools Initiative website: www.environment.gov.au/education/aussi

The **Australian Youth Climate Coalition**, a national umbrella organisation representing youth organisations across Australia, can provide speakers and group facilitators to schools around the country. The AYCC draws on the significant experience of many of its member groups, as well as its own 'Climate Messenger' program to deliver excellent presentations concerning a broad range of issues surrounding climate change. To find out more visit www.youthclimatecoalition.org or call (02) 9247 7934.

You can compare the information in these resources, or use them to conduct research projects on climate change.

Research projects

If you choose to embark on a research project on climate change, you can follow these steps:

1. Choose the questions you wish to answer
2. Decide what sort of information you need to find
3. Find suitable resources for information and images
4. Read the resources and extract the information you need
5. Organise and summarise the information you find
6. Present your findings in an interesting format
7. Check that you have answered your questions

You can complete a research project on topics like the following:

- How will climate change affect me?
- Which animals are most at risk of climate change?
- What is causing climate change?
- What can we do about climate change?
- What alternative energy sources are currently used in Australia?
- What alternative energy sources are feasible in your local area?
- What new alternative energy sources are being developed?

Humanities Worksheets

Worksheet Number	Title	Topic	Discipline	Page
1	Introduction	Changes in our environment	English, Geography	18
2	So what are you going to do about it?	Ecological footprint	English, Geography	20
3	Sayonara world	Kyoto Protocol	English, Geography, History	22
4	Nuclear—No, No or Now, Now?	Nuclear Energy	English, Economics, Geography	24
5	Weather...or not?	Extreme weather events	English, Geography	28
6	It's the end of the world as we know it...	Economic Impact	English, Economics, Geography	30
7	You say El Niño...I say La Niña	El Niño	English, Geography	32
8	Time's gateways—come on in!	Consequences of rapid warming	English, History, Geography	34

Teaching students about climate change in a Humanities classroom offers a number of Thinking Skills possibilities. As well as enhancing comprehension and developing research and IT skills, many lessons involve non-fiction text analysis and issue study. Encourage your students to disagree! There are many perspectives and opinions on climate change, and these worksheets should be provoking as many questions as they are providing answers. Ultimately, these lessons should encourage students to think about the science, impacts and solutions of climate change.

Don't forget: Student Worksheets provide the framework for lessons; Tips for Teachers pages contain the tools you need and pointers to classroom resources. Your school was sent a free copy of ***We Are the Weather Makers*** in 2006, which will allow you to support your lessons with direct study of the book. See the chapter breakdown in this resource (pp. 13–14). Of course there are many other resources which can support your lesson planning, some of which are listed on p. 16. While these lessons are designed to stand alone, it may be worth covering **Climate Change Context and Overview** (pp. 9–16) before beginning this area of study.

TIPS FOR TEACHERS

STUDENT OUTCOMES

- Self-assessment of prior knowledge of climate change issues
- Evaluation of the distinctive features of the contemporary global environment
- Predictions about environmental change

KLA: English, Geography

Thinking skills: Classifying & Evaluating (Y Chart), Decision-making (Ranking Ladder), Comparing (Venn Diagram)

Key reading from *We Are the Weather Makers* (see p. 10 of this resource)

Introduction – What is Climate Change?

Further reading from the book

Chapter 15 – Rising Waters, Chapter 21 – The End of Civilisation?, Chapter 30 – Over to You

Materials/resources

REQUIRED: Post-it notes

OPTIONAL: Cardboard, coloured textas

Teacher prompts (questions, activities, starters)

TASK 1: Explain to students the concept of a **Y Chart** (see p. 7). You may choose to have students doing this individually, in pairs or in small groups.
Extension: *Students could sketch an aspect of the environment based on the information included in the Y Chart.*

TASK 2: Make sure students understand how to construct a **Ranking Ladder** (see p. 6). You could give students ten post-it notes on which to write their top ten responses. Have students place these on the board and compare the whole class' response. Lead a discussion about the differences and similarities in responses. Students could categorise the responses into groups including: business, environment, housing, possessions, etc. The class could undertake a decision-making process to reach consensus on ten items they would include.
Extension: *In small groups, students could conduct Internet and library research to develop the 'secret documents' to place into the time capsule.*

TASK 3: Prompt students to reflect on their understanding of the environmental problems facing the world today. Ask them to consider which of these will continue to be a problem in the future, and what the consequences of their getting worse might be. Encourage them to reconsider their ranking of important information in Task 2 in light of their predictions.
Extension: *Students could turn their Y Chart predictions into a role-play or oral presentation focussing on what they believe the environment will be like in the year 2200.*

TASK 4: Make sure students understand the principles behind **Venn Diagrams** (see p. 7).

What have they learnt?

Give a prize for the most creative answer to the question: 'Why do you think you would have found the documents in the water if they were buried on the mainland?'

Collect the students' responses about what they would like to explore further. Use these to guide future lesson planning.

Notes and reflections

STUDENT WORKSHEET

It should be everyone's birthright to experience our wonderful planet to the fullest, to have the chance to see polar bears, great whales and Antarctic glaciers in real life. I believe that it is profoundly wrong to deprive future generations of this just so we can continue wasting electricity and driving oversized cars. p. 12

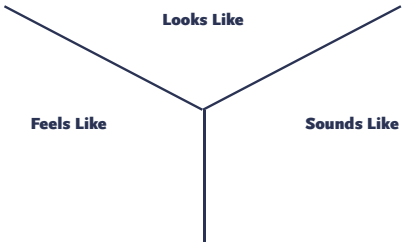
We Are the Weather Makers

Reaction to text

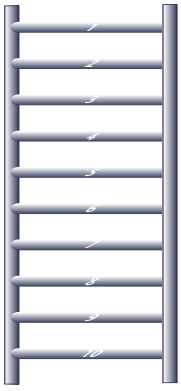
Construct a table detailing four things you already know and four things you want to know about the environmental problems confronting planet earth.

Tasks

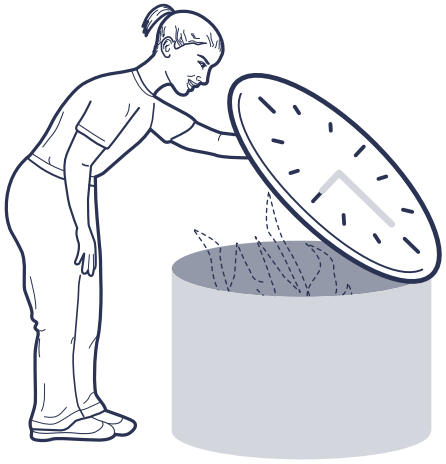
1) Construct a **Y Chart** detailing what the environment around you looks like, feels like and sounds like at the moment. Include information about your local community as well as the city you live in. Share your responses with a partner and add some of their responses to your chart.



2) You and your partner have been asked to prepare a secret document about the current state of the planet. It will be placed in a time capsule for future generations. The capsule will be sealed and buried on the coast of South Australia. You could include information about Planet Earth's forests, atmosphere, water, population, resource use, etc. Make a list of 30 pieces of information you would include about the environment of our world. Then, compare your list with a partner and together decide on a 'Top Ten' of information you would place into the secret documents based on your current knowledge. Construct a **Ranking Ladder** with the most important information at the top and the least important at the bottom.

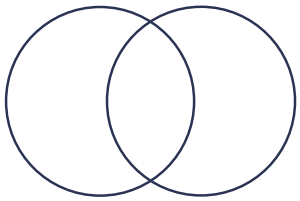


3) Now imagine you are a teenager living in the year 2200. You and your friends stumble upon the secret documents while swimming at the beach. The environment around you in the year 2200 is a



completely different world to that which you read about in the documents. Using another **Y Chart**, make some predictions about what the environment will look like, feel like and sound like in the year 2200.

4) Now construct a **Venn Diagram** detailing the differences and similarities between the world in 2200 and the world now.



What have I learnt?

- Why do you think you would have found the documents in the water if they were originally buried on the coast?
- What are two things you would like to explore further about the concept of climate change?

TIPS FOR TEACHERS

STUDENT OUTCOMES

- Assessment of personal ecological footprint using ICT
- Goal setting
- Written communication of actions to reduce global warming

KLA: English, Geography

Thinking skills: Evaluating (SMART Goals)

Key reading from *We Are the Weather Makers*

Chapter 30 – Over to You

Further reading from the book

Chapter 17 – Danger Ahead, Chapter 21 – The End of Civilisation, Chapter 25 – People in Greenhouses Shouldn't Tell Lies

Materials/resources

REQUIRED: Internet access

OPTIONAL: Cardboard, textas

Teacher prompts (questions, activities, starters)

TASK 1: Make sure all computers are able to access this site. While it should not be blocked by school servers, it is best to double check. Make sure students are honest in their responses as it is not a competition.
Extension: *You could have students write their ecological footprint on a continuum somewhere in the room. Alternatively, have students form a line from the most global hectares required to the least. Students could revisit the website in a month's time to see if their footprint has been reduced based on changes they have made in their lives and at home.*

TASK 2: You could give students a piece of cardboard on which to write their lists so they are more inclined to keep them for an extended period of time. Maybe ask students to complete two copies – one to take home and one to display in the classroom.
Extension: *You could group students who have selected the same goals and have them undertake a discussion about HOW they will implement these changes. They could devise lists of ways they will make these changes. You could have these groups meet weekly to discuss their progress. They could complete a log book or journal weekly outlining their progress and see if this contributes to a reduction in their ecological footprint down the track.*

TASK 3: Ensure that students are familiar with **SMART Goals** (see p. 6).

What have they learnt?

Help students find addresses of community leaders to whom they could send letters. Provide envelopes and have the students send these to the relevant people. Display any responses around the room.

Notes and reflections

STUDENT WORKSHEET

If everyone takes action to rid atmospheric carbon emissions from their lives, I believe we can stabilise and then save the Arctic and Antarctic. We could save around four out of every five species currently under threat, limit the extent of extreme weather events and reduce, almost to zero, the possibility of any of the three great disasters occurring this century, especially the collapse of the Gulf Stream and the destruction of the Amazon.

But for that to happen, everyone needs to act on climate change now the delay of even a decade is far too much. p. 249

We Are the Weather Makers

Reaction to text

Think about three changes you are able to make to your life that you think might help 'rid atmospheric carbon emissions'. Write them down.

Tasks

1) Go to the following website and complete a short online survey to determine your 'Ecological Footprint'. The ecological footprint measures the resources we have, how much we use, and who uses it. You will discover the impact your daily life has on the environment. Click on the 'Personal' link to begin the survey—it should take you about 10 minutes to finish. When finished, copy your results into the table below:

www.epa.vic.gov.au/ecologicalfootprint/calculators/default.asp

Number of planets needed	
Global hectares required to sustain your lifestyle	
Food	
Transport	
Shelter	
Goods & services	

The average number of global hectares required for the average Australian is 7.7. Is your figure higher or lower than this?

2) Look at the section of this website about 'Tips on Reducing Your Ecological Footprint'. Refer to your list from the beginning of this study. How many of the things you wrote are detailed in this section of the website? Write a list of four actions to reduce carbon emissions that you can talk to your family about undertaking in your home.

3) Think about 3–4 things that you can personally change in your own lifestyle to help improve your Ecological Footprint.

Make a list of **SMART Goals** that you can implement. Remember —they must be Specific, Measurable, Attainable, Relevant and Time-limited. Display a copy in your classroom. Make sure you discuss your goals with someone who will support you in implementing them.

What have I learnt?

Tim Flannery says that community leaders 'need to hear your voice'. Write a letter to a public figure or other influential member of the community explaining your concerns about global warming and climate change.

TIPS FOR TEACHERS

STUDENT OUTCOMES

- Understanding of the Kyoto Protocol
- Oral presentation of arguments for and against signing the Kyoto Protocol

KLA: English, Geography, History

Thinking skills: Analysis (Think, Pair, Share, PMI), Evaluation (Worm Evaluation Line)

Key reading from *We Are the Weather Makers*

Chapter 23 – The Road to Kyoto

Further reading from the book

Chapter 22 – The Story of Ozone, Chapter 24 – Cost, Cost, Cost

Materials/resources

REQUIRED: Internet access

Teacher prompts (questions, activities, starters)

TASK 1: In addition to encouraging students to undertake their own research, provide them with a couple of newspaper articles to analyse. Ask them to consider the tone, style of language, audience, publication etc. Ensure students are familiar with a **Think, Pair, Share** exercise.

TASK 2: Ensure that students are familiar with **PMIs** (p. 5). This activity also requires some pre-teaching related to the Kyoto Protocol, CO_2 Emissions and Ozone Depletion. Refer students to Chapters 22 and 24 as well as the websites included. The more exposure they have to material, the better detail they should provide in their PMI.
Extension: *Have students write some of their responses on post-it notes and create a whole class PMI around the room. They could also make a list of all resources, websites and quotes they found that helped them in constructing their PMI.*

TASK 3: Make sure students are aware of what is required of them in a debate. You may need to spend some time explicitly teaching the structure of a debate.
Extension: *Invite a panel of judges in to evaluate the debates. They could be parents, the Principal, members of local government, other students, teachers, etc. You could video the debates and look back on persuasive techniques that were used.*

TASK 4: Make sure your students know how to create **Worm Evaluation** lines (p. 7). Students can do this in their books or on a sheet that you could collect.
Extension: *Collect the completed Worm Evaluation lines and give them back to each student. Have them evaluate their own performance and comment on the strengths and weaknesses in their argument.*

What have they learnt?

Once the students have submitted their entry for the competition elicit observations from them about the appropriateness of the prize. Have students investigate how environmentally friendly Plasma TVs are.

Notes and reflections

STUDENT WORKSHEET

The Kyoto Protocol is almost as famous as the hole in the ozone layer. It sets modest goals for reductions in CO_2 emissions of around 5 per cent. But four nations—USA, Australia, Monaco and Lietchtenstein—have refused to ratify it, which would compel them to abide by its rules, and it has been bitterly contested. Why?
p. 202

We Are the Weather Makers

Reaction to text

Why do you think this issue is 'bitterly contested'? Brainstorm three key words/sentences that are related to the debate about climate change to use later in the lesson. It may be helpful to look at Chapters 22 & 24 of *We Are the Weather Makers*.

Tasks

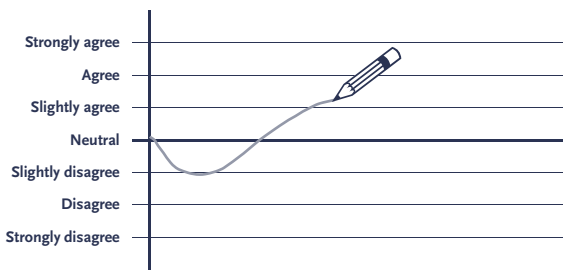
1) Investigate key aspects of the Kyoto Protocol using the information provided, references from the book and websites listed below. Using a **Think, Pair, Share** approach, analyse the style of communication and the language employed in 2 of these resources.

2) Construct a **PMI** detailing all the interesting points and those for and against Australia's decision not to sign the Kyoto Protocol.

Plus	Minus	Interesting

3) Form small groups. These will be your debating teams. Your teacher will tell you which teams are for and which are against the topic—'Australia should sign the Kyoto Protocol.' The 'For' teams will represent the United Nations and the 'Against' teams will represent Australia. As a team, you must share the information from your PMI and decide what is most relevant, valuable and persuasive for your argument. Once you have done this you must decide on the order of your speakers and allocate information/points that each speaker will argue.

4) Students in the audience should undertake a **Worm Evaluation** line for each speaker.



What have I learnt?

Imagine you are entering a competition to win a Plasma TV. In 25 words or less, you must say why you think Australia should or shouldn't sign the Kyoto Protocol.

Links

www.greenhouse.gov.au/international/kyoto/

www.gc3.cqu.edu.au/kyoto-protocol/index.php

www.cana.net.au/kyoto/

www.carbonplanet.com/home/kyoto_protocol_faq.php

www.education.theage.com.au/pagedetail.asp?intpageid=1397&strsection=students&intsectionid=0

TIPS FOR TEACHERS

STUDENT OUTCOMES

- Evaluation of the arguments for and against Nuclear Power
- Group work and group decision-making
- Synthesis of information and opinion into advertising campaign
- Oral presentation and written report

KLA: English, Economics, Geography

Thinking skills: Inquiry (5 Whys), Analysis (SWOT), Evaluation (PMI)

Key reading from *We Are the Weather Makers*

Chapter 28 – Nuclear?

Further reading from the book

Chapter 27 – Bright as Sunlight, Light as Wind
Chapter 29 – Hybrids, Minicats and Contrails

Materials/resources

REQUIRED: Task 1 statements (p. 26)

OPTIONAL: Coloured paper, pencils, textas, magazines, poster paper, Internet access

Teacher prompts (questions, activities, starters)

TASK 1: Run through the process of a **5 Whys** exercise (p. 4) and a **SWOT Analysis** (p. 6). Ask the students to state their position regarding nuclear energy, as established in their Reaction to the Text. Provide students with the arguments/statements on p. 26 for their SWOT Analysis. Students can undertake this task individually or in pairs/small groups.
Extension: *Photocopy and cut out the statements. Divide the students into groups and have the students organise the statements into a group SWOT Analysis. Students could share their completed analysis with another group or present to the class.*

TASK 2: Have the students form small groups to decide whether they are for or against the use of nuclear energy. Give them a specified time frame to reach consensus. If they cannot agree, you may need to move students into another group.
Extension: *You could ask students to write a paragraph justifying WHY they are either for or against the use of nuclear energy. These statements could then be shared with the group to see if the arguments presented sway any group members to change their way of thinking.*

TASK 3: Give students a set time to decide on a company name, a slogan and to divide up the required tasks. Students can then work independently on their task.
Extension: *You could ask groups to present this as a portfolio. They would need to be provided with sufficient materials including access to the Internet to ensure their campaign was comprehensive and well presented.*

TASK 4: Students should also submit a written report containing the scripts for the television and radio advertisements and the email and poster design.
Extension: *You could have students undertake a* **Worm Evaluation** line *(p. 7) for each of the group's presentations. Alternatively, they could complete a* **PMI** *(p. 5) to evaluate the presentations. Another idea is to invite guests in to your class who could be the 'ad executives' who would decide on the best campaign. Prizes could be awarded.*

Notes and reflections

STUDENT WORKSHEET

NUCLEAR FOR—Nuclear power already provides 18 per cent of the world's electricity, with no CO_2 emissions. Its defenders argue that it could supply far more...

NUCLEAR AGAINST—With a fifteen year period before any power is generated, and even longer before any return on the investment is seen, nuclear power is not for the impatient. p. 238

We Are the Weather Makers

Reaction to text

What is your initial reaction—should the world invest in nuclear power or not? With a partner conduct a **5 Whys** activity to justify your response.

Tasks

1) Look at the statements provided. Work out whether each statement points out a strength or weakness in the use of nuclear power. Conduct a **SWOT Analysis** for nuclear power and place the statements in the appropriate quadrant: is the statement a Strength, Weakness, Opportunity of or Threat to nuclear power?

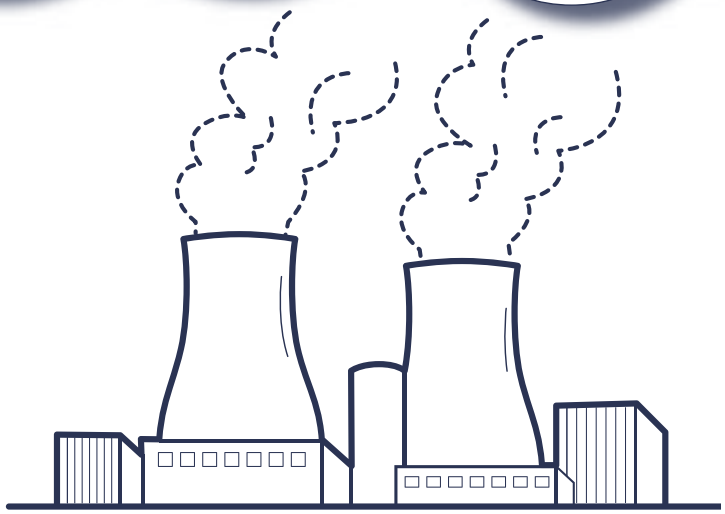
Strengths	Weaknesses
Opportunities	**Threats**

2) Do the statements give rise to further questions? Write down 3–4 questions you have about nuclear power.

3) Form small groups (approximately 4 students) and decide where you stand—are you for or against nuclear energy? Have a brief discussion in your group and try to reach agreement. What further information do you need?

4) Imagine your group has been commissioned by either a nuclear power company or an anti nuclear lobby group (you can choose which). Your job is to 'sell' the message to the public that nuclear energy is either important and should be used, or dangerous and should not be used. Think about your own strengths and weaknesses, likes and dislikes within the group and divide up the following tasks.

- Devise a name for the company/lobby group
- Create a slogan that will be used in all the forms of media through which you will advertise (TV, RADIO, BILLBOARDS, YOUTUBE, EMAIL, SMS etc)
- The advertising campaign must include the following: a storyboard for a television ad, a speech for radio ad, an email letter for the local residents and a billboard poster.



5) Present your television, youtube or radio campaign to the class as an oral report and also submit a written report in accordance with the teacher's instructions.

Plus	Minus	Interesting

What have I learnt?

Construct a **PMI** for the use of nuclear energy.

1. Nuclear power already provides 18 per cent of the world's electricity, reducing CO_2 emissions. It could supply far more.

2. With a fifteen-year period before any power is generated, and even longer before any return on the investment is seen, nuclear power is not for the impatient.

3. Nuclear energy is uneconomical compared to other sources.

4. Nuclear reactors produce plutonium, and plutonium is terrible because it can be used to make bombs.

5. Plutonium symbolises nuclear war.

6. Nuclear energy must be bad, because so many people are against it.

7. Nuclear waste is a threat.

8. At present, the reserves of uranium that can be profitably sold are enough for at least a hundred years.

9. Solar energy would involve a considerably greater cost if relied upon for most of the world's energy.

10. Giving up on nuclear energy is unlikely to reduce the danger of nuclear wars.

11. Nuclear energy is energy released from the atomic nucleus.

12. The United States produces the most nuclear energy, with nuclear power providing 20 per cent of the electricity it consumes. France produces the highest percentage of its electrical energy from nuclear reactors—80 per cent as of 2006.

13. The use of nuclear power is controversial because of the problem of storing radioactive waste for indefinite periods, the potential for possibly severe radioactive contamination by accident or sabotage, and the possibility that its use in some countries could lead to the proliferation of nuclear weapons.

14. Nuclear power does not directly produce carbon dioxide, which has led some environmentalists to advocate increased reliance on nuclear energy as a means to reduce greenhouse gas emissions (which contribute to global warming).

15. Nuclear power is not cost-effective because of the huge costs of constructing a nuclear plant, tax expenditures involved in research and security, and the undetermined costs of storing nuclear waste. The real cost of nuclear power is very high if all the expenses are honestly taken into account including public scientific research and long-term management of nuclear waste.

16. The life-cycle energy impacts of nuclear plants undermine their potential as an alternative energy source.

TIPS FOR TEACHERS

STUDENT OUTCOMES

- Understand the connection between global warming and extreme weather
- Communicate this understanding to classmates
- Recall knowledge of Hurricane Katrina
- Generate research questions and conduct research into extreme weather conditions

KLA: English, Geography

Thinking skills: Communication (Think, Pair, Share), Analysis (Cause & Effect Table, Mind Map or Spider Map), Creative thinking and inquiry (Question Matrix)

Key reading from *We Are the Weather Makers*

Chapter 14 – Extreme Weather

Further reading from the book

Chapter 9 – Magic Gates, El Niño and La Niña
Chapter 13 – Rainfall, Chapter 5 – Rising Waters

Materials/resources

REQUIRED: Internet access, library resources

OPTIONAL: A3 paper, coloured pencils/textas, coloured paper

Teacher prompts (questions, activities, starters)

TASK 1: Explain the process of a **Think, Pair, Share** to students (p. 7). You may wish to model an example of a **Cause and Effect** table (p. 4). You may like to ask students to explore the chapter fully to detail as many weather events, causes and effects as possible.

Cause	Effect
Hurricane Mitch 1998: 290 km winds	Destroyed homes, killed 10,000 people, left 3 million people homeless.

Extension: *You could ask students to hypothesise what some of the effects of the extreme weather events may be. They could then undertake research to explore the accuracy of their predictions.*

TASK 2: Explain how to develop a **Mind Map** or **Spider Map**. (p. 5) Refer students to pages 125–130 of the book to find their information. You could provide them with A3 paper to encourage them to include as much detail as possible.
Extension: *Have students present their Mind Maps or Spider Maps to the class through an oral presentation.*

You could display these around the room and have students use the Question Matrix to develop a series of questions as part of a 'Wonderings Wall' where students post questions about the topic that they would like to know more about or investigate further. Use coloured paper and make this a feature in your room.

TASK 3: Introduce students to the process of a **Questions Matrix** (p. 6). Students will need access to a library, the Internet, journal/magazine articles, etc. to undertake this research. You can use references from the book and from p. 16 of this resource. You should also try to provide some of your own to ensure students can source a variety of material. Give students clear objectives and a format they can follow.
Extension: *You could develop this into a larger research task. Instead of 5–10 focus questions you could ask students to develop more or require that they provide greater depth in their responses.*

What have they learnt?

Conduct the quiz with prizes for the winning team. You could then distribute the questions between the groups and ask students to evaluate the questions and justify their reasoning.

Notes and reflections

STUDENT WORKSHEETS

[It is likely that] extreme weather events are becoming more frequent.

Here is a small sample from the past few years: the most powerful El Niño ever recorded (1997–98), the most fatal hurricane in 200 years (Mitch, 1998), the hottest and deadliest European summer on record (2003), the first South Atlantic hurricane ever (2002), unprecedented flooding in Mumbai, India (2005), the worst storm season ever experienced in the USA, the most economically devastating hurricane on record (Katrina, 2005), and Monica, the most powerful cyclone ever recorded in Australia (2006).

How could global warming make hurricanes and cyclones more powerful? The answer lies in the warming of the oceans, and the capacity of the warmer air to hold water vapour, the fuel that drives these extreme storms. p. 125

We Are the Weather Makers

Reaction to text

- How would you explain the connection between global warming and more powerful hurricanes and cyclones to a Grade 4 student?
- In your own words, write a short paragraph explaining this process. What further information do you require to outline your case convincingly?

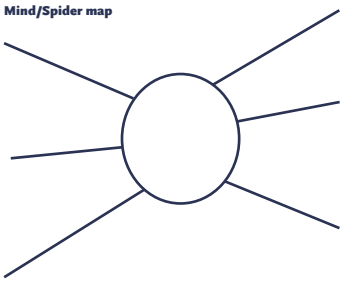
Tasks

1) Undertake a **Think, Pair, Share** for the following task. Complete a **Cause and Effect** table, explaining extreme weather events. Using dot-points, detail a cause and correspond all the effects of this event. With a partner, exchange ideas and add to the detail of your **Cause and Effect** table. Then you and your partner should form a group with another pair to share all ideas.

Cause	Effect

2) Hurricane Katrina devastated New Orleans, USA in 2005. Complete a **Mind Map** or **Spider Map** using as much information as you have about Hurricane Katrina.

Mind/Spider map



3) Choose an extreme weather event and undertake a mini-research project. Choose from either: cyclones, floods, extreme heat (bushfires, drought, etc.), extreme cold (blizzards, snowfall, etc.), hurricanes or tsunami. Using the **Questions Matrix**, design 5–10 focus questions to investigate using the websites listed. Remember to include headings, diagrams, pictures and a bibliography.

	Event	Situation	Choice	Person	Reason	Means
Present	WHAT IS?	WHERE/ WHEN IS?	WHICH IS?	WHO IS?	WHY IS?	HOW IS?
Past	WHAT DID?	WHERE/ WHEN DID?	WHICH DID?	WHO DID?	WHY DID?	HOW DID?
Possibility	WHAT CAN?	WHERE / WHEN CAN?	WHICH CAN?	WHO CAN?	WHY CAN?	HOW CAN?
Probability	WHAT WOULD?	WHERE / WHEN WOULD?	WHICH WOULD?	WHO WOULD?	WHY WOULD?	HOW WOULD?
Prediction	WHAT WILL?	WHERE / WHEN WILL?	WHICH WILL?	WHO WILL?	WHY WILL?	HOW WILL?
Imagination	WHAT MIGHT?	WHERE / WHEN MIGHT?	WHICH MIGHT?	WHO MIGHT?	WHY MIGHT?	HOW MIGHT?

What have I learnt?

- Again use the **Question Matrix** to come up with a quiz for your classmates. Each person in the class should write 4 questions and submit them to the teacher on post-it notes.
- You will form teams of 4 and compete against other teams to answer the questions.

TIPS FOR TEACHERS

STUDENT OUTCOMES

- Awareness of common consumption patterns in Australia and the reliance on resources
- Evaluation of what constitutes necessary resource consumption
- Analysis of the economic impact of climate change

KLA: English, Economics, Geography

Thinking skills: Collaboration (Think, Pair, Share), Analysis and Elaboration (Spider Map), Comparison, Justification, Prediction

Key reading from *We Are the Weather Makers*

Chapter 21 – The End of Civilisation?

Materials/resources

REQUIRED: Blank map of Australia, atlases

OPTIONAL: Art and craft equipment, magazines and business newspapers, Internet access

Teacher prompts (questions, activities, starters)

Reaction to text: Ensure students are familiar with a **Think, Pair, Share** exercise (p. 7).

TASK 1: It could assist students to look through some supermarket catalogues or the business section of a newspaper to consider which commodities and businesses would be affected.
Extension: *List some companies connected to each commodity and detail the effects on employment, trade, local regions, etc. Consider the use of petrol to make plastics and the use of water to drive coal power-plants.*

TASK 2: Show students how to construct a **Spider Map** (p. 5). It would be useful to discuss the term 'economics' and help students grasp the breadth of the meaning of economic impact (e.g. employment, lifestyle, educational resources, technological resources).
Extension: *Students could discuss Australia's reliance on trade: what commodities do we export? Which commodities might not be exportable in the future? What alternative possibilities are there for export and trade?*

TASK 3: There are various websites that provide further information on the effects of rising sea-levels. Students can explore these using a process of **Predict, Observe and Explain**.
Extension: *Students can model the effects of sea-level change using tactile dioramas or models or computer graphics.*

What have they learnt?

Students could make collages, posters, models or sculptures of their essential items for survival. A display of these could prompt questions about what we are doing to protect these resources.

Notes and reflections

STUDENT WORKSHEET

Our civilisation is built on two foundations: our ability to grow enough food to support a large number of people who are engaged in tasks other than growing food; and our ability to live in groups large enough to support great institutions such as our parliament, our courts and our schools and universities... p. 188

Think of a city you are familiar with and imagine what it would be like if its citizens woke one morning to discover that no fresh water came from their taps. No clothes could be washed, no toilets would flush, filth would accumulate very quickly. Imagine the result if petrol supplies came to a halt. Food could not be delivered, garbage wouldn't be removed, and people couldn't get to work. p. 190

We Are the Weather Makers

Reaction to text

- Conduct a **Think, Pair, Share**. List 5 aspects of our civilisation that you simply can't live without and briefly explain why.
- Compare your list with a partner, then share with a group.
- As a group decide on the top 4 things that you all agree on. List them on the board.

Tasks

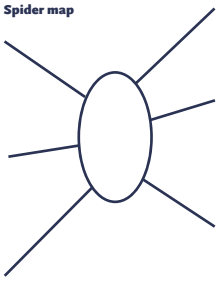
1) Read the quotes above. Construct a table predicting the economic impacts these events would have on civilisation. Use the following headings:

- No fresh running water
- No available petrol
- No food delivered
- No garbage removed
- People not able to travel to work

Then, detail the personal impact this would have on your life.

2) Form small groups and use the information in your table to compare notes and add to the information you have already recorded. Turn your ideas into a **Spider Map** about the economic impact of the situation.

Spider map



Make sure your group includes the following impacts on the spider's legs: impact to businesses, households, groups, individuals, cities, country towns, community groups and institutions.

3) Make a list of the things you would need and those you would want if you faced such a situation. Remember, a need is something you cannot survive without and a want is something you would like, but is not essential. Make sure you explain WHY.

4) Using a blank map of Australia and an Atlas, shade the regions that are most densely populated. Make sure you label your map correctly using BOLTS (Border, Orientation, Legend, Title, Scale). Label the states and capital cities. Comment on why you think these areas are the most heavily populated. Now make a prediction about what would happen to these regions if rising sea-levels affect them. Share your responses with a group and come up with a paragraph answer to share with the class.

What have I learnt?

Return to the list on the board and your response to Task 3. Do you still agree that these are the things you couldn't live without? Have a class discussion about whether your opinions have changed or stayed the same and justify why.

TIPS FOR TEACHERS

STUDENT OUTCOMES

- Understand the meaning and effect of El Niño climate conditions
- Synthesis of knowledge in a creative form
- Oral communication of knowledge

KLA: English, Geography

Thinking skills: Self-assessment and prediction (KWL), transferral of knowledge to illustration, analysis and synthesis of knowledge (script writing)

Key reading from *We Are the Weather Makers*

Chapter 9 – Magic Gates, El Niño and La Niña

Further reading from the book

Chapter 11 – 2050: The Great Stumpy Reef?, Chapter 13 – Rainfall

Materials/resources

REQUIRED: ***We Are the Weather Makers***, copies of a blank world map (see p. 87)

OPTIONAL: Copies of maps to be used in weather forecast presentations, atlases, video camera, Internet access

Teacher prompts (questions, activities, starters)

TASK 1: Ensure that students are familiar with **KWL tables** (p. 5). Ask students to read the relevant passage and then complete the task. Make sure that the students paraphrase the definitions before you step in to do it for them!
Extension: *Students could think of their own names for El Niño and La Niña. Write these names on large paper and place them around the classroom. Students should be able to explain the relevance and appropriateness of the names.*

TASK 2: Students may find it useful to use an Atlas. Some pre-teaching of meteorological symbols and mapping devices may be useful depending on the skill level of students.
Extension: *Refer students to pages 98–100 of the book and read about the effects of El Niño on Indonesia's coral reefs. Construct a* **Cause and Effect** *table* (p. 4) *to indicate the effects on coral reefs. Students could devise an education campaign to teach their school mates about the precarious future of the reefs.*

TASK 3: It may be useful to watch a weather forecast and discuss the terminology used and the order of information presented.
Extension: *Students could devise a script for a weather report from the past or future to compare against the script they have written for Task 3. Students could complete a* **Venn Diagram** (p. 7) *to illustrate the similarities and differences in climate conditions.*

What have they learnt?

Students can refer to the 'W' column to indicate which questions have been answered and which remain the topics of possible further research.

Notes and reflections

STUDENT WORKSHEET

Global warming's effect on Earth's climate is a bit like a finger on a light switch. Nothing happens for a while, but if you increase the pressure, at a certain point a sudden change occurs, and conditions flick from one state to another.

Climatologist Julia Cole refers to the leaps made by climate as 'magic gates', and she argues that since temperatures began rising rapidly in the 1970s our planet has seen two such events—in 1976 and 1998.

…The 1998 magic gate is tied up with the El Niño–La Niña cycle, a two-to eight-year-long cycle that brings extreme climate events to much of the world. pp. 75-77

We Are the Weather Makers

Reaction to text

What do you think the term 'El Niño' means? Construct a **KWL table** on the topic of El Niño.

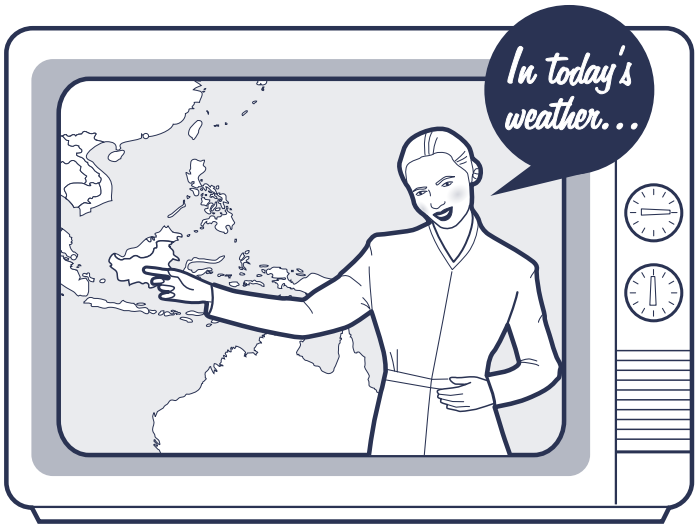
What do I **K**now?	What do I **W**ant to know?	What have I **L**earnt?

Tasks

1) After reading the relevant passage from *We Are the Weather Makers*, try to explain the term El Niño in your own words to a classmate. Then explain in writing why this term and La Niña were used by Peruvian fishermen.

2) List the areas of the world that Professor Flannery identifies as being directly affected by El Niño and La Niña. Use a blank world map and shade these areas. Based on the descriptions of how El Niño and La Niña work, highlight other areas of the world which you believe will be affected. Illustrate the paths of the changes during the El Niño and La Niña cycle. Use a key and symbols correctly.

3) Write the script for a meteorologist presenting a report on the weather patterns as a result of El Niño and La Niña. Be sure to include: daily conditions, forecasts, warnings and illustrations to help your audience. Present your report to the class or film it.



What have I learnt?

Complete the **KWL table** indicating the knowledge you now have about El Niño and La Niña.

Links

www.elnino.noaa.gov/

www.en.wikipedia.org/wiki/El_Nino

www.bom.gov.au/climate/glossary/elnino.shtml

TIPS FOR TEACHERS

STUDENT OUTCOMES

- Knowledge of changes to planet Earth over time
- Evaluation of importance of environmental phenomena
- Vocabulary building

KLA: English, History, Geography

Thinking skills: Comparison & Analysis (Comparison Alley), Decision-making & Evaluating (Placemat)

Key reading from *We Are the Weather Makers*

Chapter 5 – Time's Gateways

Further reading from the book

Chapter 3 – Greenhouse Gases, Chapter 4 – Ice Ages and Sunspots, Chapter 6 – Born in the Deep Freeze

Materials/resources

OPTIONAL: Internet access, library resources, coloured paper

Teacher prompts (questions, activities, starters)

TASK 1: Give students a word length that you expect them to reach. Refer them to the book and ensure they are familiar with Chapter 5 which provides a great deal of useful reference material. You can also refer them to other resources as listed on p.16.
Extension: *You may ask students to turn their journal entry into a mini-report. You could have them include some sub-headings. If students are able to access the Internet or a library, ask them to research historical facts about this time and include them in their journal entry or report. Alternatively, students could form expert groups and investigate one aspect of this historical period. Reports the groups produce could form a booklet produced by the entire class.*

TASK 2: Explain the concept of a **Comparison Alley** (p. 4). You could provide students with a hard copy each or have them copy one into their books.
Extension: *Students could complete the Comparison Alley either individually or in pairs/small groups. They could alternatively complete it as a* **Think, Pair, Share** (p. 7).

TASK 3: Explain how students undertake a **Placemat** activity (p. 5). It may be a good idea to reinforce the objectives of effective group work. You could give the students coloured paper on which to complete their Placemat.
Extension: *Students could present this task in a variety of ways: pack a suitcase of the items, develop a role play, make a diorama, draw/paint their objects etc. Try to incorporate a variety of learning styles in the modes of presentation.*

What have they learnt?

Students could form groups and develop a spelling test/quiz for other groups in the class. The groups could rotate the tests between them either in one lesson or at the beginning of lessons over a longer period of time.

Notes and reflections

STUDENT WORKSHEET

The last time Earth was afflicted was 65 million years ago, when every living thing weighing more than 35 kilograms, and a vast number of smaller species was destroyed. This is when dinosaurs vanished, and the cause is widely believed to have been an asteroid colliding with Earth. So much debris exploded into the atmosphere that the climate changed, which caused the great global dying...

Ten million years later—55 million years ago—there was another global event. The Earth's surface abruptly heated by 5 to 10° C... p. 41

The climate change of 55 million years ago seems to have been driven by a vast, natural gas driven equivalent of a barbeque... p. 42

Now, Earth stands to lose far more from rapid warming than the world of 55 million years ago. Back then warming closed a geological Period, while we might, through our activities, bring to an end an entire Era. p. 44

We Are the Weather Makers

Reaction to text

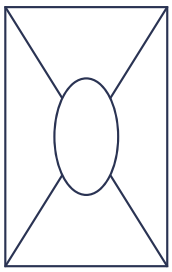
What do we stand to lose from rapid warming? List 5 aspects of our planet you wouldn't like to see disappear and compare your list with that of a partner.

Tasks

1) You have travelled back in time 55 million years. You document what you see on your voyage in a journal entry. Your entry should detail what the world looks like 55 million years ago: species of flora and fauna inhabiting the world, temperatures, CO_2 levels, ocean changes, the atmosphere, etc. Conduct your own research to complete this.

2) Complete a **Comparison Alley**, to compare the differences and similarities between the world you have visited 55 million years ago and the world today. You should use the information you gather for the first task to complete this graphic organiser.

3) Instead of moving house, let's say you had to move planets. You and your family have to set up a new shelter and find new resources on a new planet. In small groups, complete a **Placemat** by listing 10 things you would take from the environment to help you do this.



What have I learnt?

Construct a glossary of 5 new words. Find their definitions either using the text or a dictionary. Display the words and meanings around the classroom.

Science Worksheets

The Science classroom is, in many ways, the neatest fit for discussion of climate change. It offers a demonstration of the practical implications of a number of scientific principles as well as encouraging students to consider questions of cause and effect. The thinking skills involved in these lessons range from Communication and Analysis to Science-based skills such as Prediction, Synthesis, Classification and Ranking. These lessons should encourage students to think about the science, impacts and solutions of climate change.

Don't forget: Student Worksheets provide the framework for lessons; Tips for Teachers pages contain the tools you need and pointers to classroom resources. Your school was sent a free copy of ***We Are the Weather Makers*** in 2006, which will allow you to support your lessons with direct study of the book. See the chapter breakdown in this resource (pp. 13–14). Of course there are many other resources which can support your lesson planning, some of which are listed on p. 16. While these lessons are designed to stand alone, it may be worth covering **Climate Change Context and Overview** (pp. 9–16) before beginning this area of study.

TIPS FOR TEACHERS

STUDENT OUTCOMES

- Understanding of the carbon cycle
- Distinguishing between a carbon sink and a carbon source
- Observing and reporting on an experiment involving a carbon sink

KLA: Science

Thinking skills: Communication (Think, Pair, Share), Classification, Analysis (reporting on experiment activity)

Key reading from *We Are the Weather Makers*

Chapter 1 – Everything is Connected

Further reading from the book

Chapter 3 – The Greenhouse Gases, Chapter 8 – Digging Up the Dead

Materials/resources

REQUIRED: crushed chalk (not dustless), vinegar, beaker or glass jar, post-it notes

Teacher prompts (questions, activities, starters)

TASK 1: Confirm that students are familiar with **Think, Pair, Share** exercises (p. 7). Students need to be clear about the difference between a carbon source and a carbon sink, but this understanding may develop as a result of the classification task. Ask small groups to complete the task using post-it notes. You could ask students to write them in the appropriate column on the board and discuss results.
Extension: *Ask students to think of some more sinks and sources.*

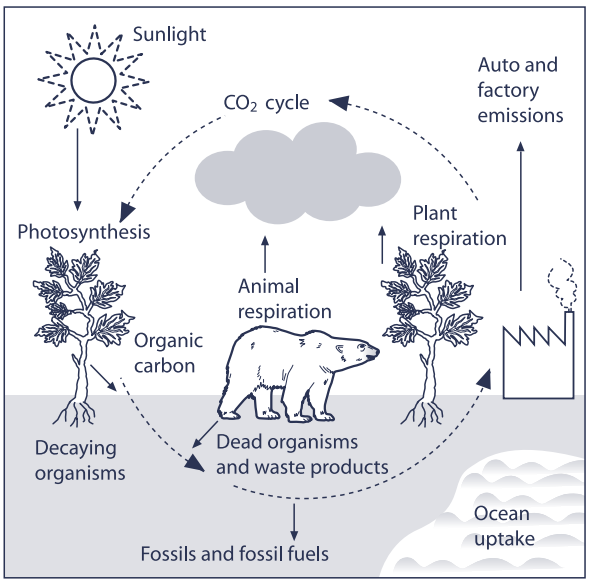
TASK 2: Explain to students that one of the major sinks for CO_2 is the ocean. Many organisms living in the ocean use CO_2 to make calcium carbonate ($CaCO_3$) shells. Over millions of years these shells have broken down into chalk. You can display some shells. Place crushed chalk into a jar and add vinegar so the chalk releases CO_2. Explain the reaction resulting from the addition of vinegar to chalk. This can be expressed as **$CaCO_3(s) + {}_2CH_3COOH(l) \rightarrow Ca(CH3COO)2(s) + H_2O(l) + CO_2(g)$**. Ask why carbon combines with so many different molecules in the carbon cycle. **NB:** Make sure that the chalk for this experiment is composed of calcium carbonate.

TASK 3: Discuss the form of carbon (solid coal, liquid hydrocarbon petroleum, and gas hydrocarbon methane). Write chemical equations for the carbon cycle. The dominant chemical reactions are:

Photosynthesis: $CO_2 + H_2O \rightarrow$ sunlight $\rightarrow CH_2O + O_2$ (carbon dioxide, water and sunlight yield carbohydrate and oxygen)
Respiration: $CH_2O + O_2$ g $CO_2 + H_2O$ (carbohydrate and oxygen yield carbon dioxide and water and energy)
Fermentation: ${}_2CH_2O \rightarrow CO_2 + CH_4$ (carbohydrate decomposes to carbon dioxide and methane)
Combustion: (Organic Carbon, C, H, O) + $O_2 \rightarrow CO_2 + H_2O$ + energy (hydrocarbon and oxygen yield carbon dioxide and water and energy).
NB: You may choose to explain to the students that the main carbohydrate produced initially by photosynthesis is sugar (fructose or glucose). Fermentation in animal stomachs produces methane with the aid of bacteria (anaerobic fermentation) but in air produces alcohol with the aid of yeast (aerobic).

What have they learnt

Students may prefer to display the information about the carbon's life cycle in a **Y Chart** (p. 7).



STUDENT WORKSHEET

Carbon is everywhere on the surface of planet Earth. It is constantly shifting in and out of our bodies as well as from rocks to sea or soils, and from there to the atmosphere and back again... p. 27

All of the carbon in coal was once tied up in CO_2 floating in the atmosphere... p. 13

The volume of carbon circulating around our planet is enormous. Around a trillion tonnes of it is tied up in living things, while the amount buried underground is far, far greater...

The places where carbon goes when it leaves the atmosphere are known as carbon sinks, as are the oceans and the soil and some of the rocks under our feet. p. 28

We Are the Weather Makers

Reaction to text

- Given what you have read above, list all the things you can see around you that contain carbon.
- Identify two items in your list that are completely different. **Think, Pair, Share**: how is it that carbon can be in both of them?

Tasks

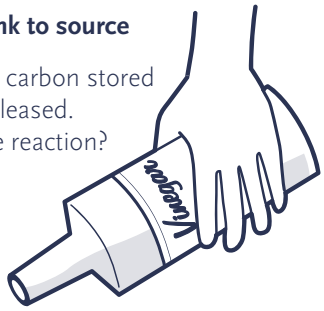
1) Sink or source?

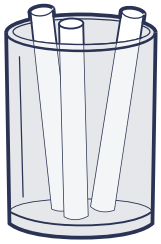
If a carbon sink stores carbon, a carbon source releases carbon. Which of the following do you think are 'sinks' and which are 'sources'? Make a list of each.

- long-lived trees
- limestone
- plastic
- burial of organic matter
- burning of fossil fuels
- burning of organic matter
- weathering of limestone rocks
- respiration of living organisms.

2) Experiment – from sink to source

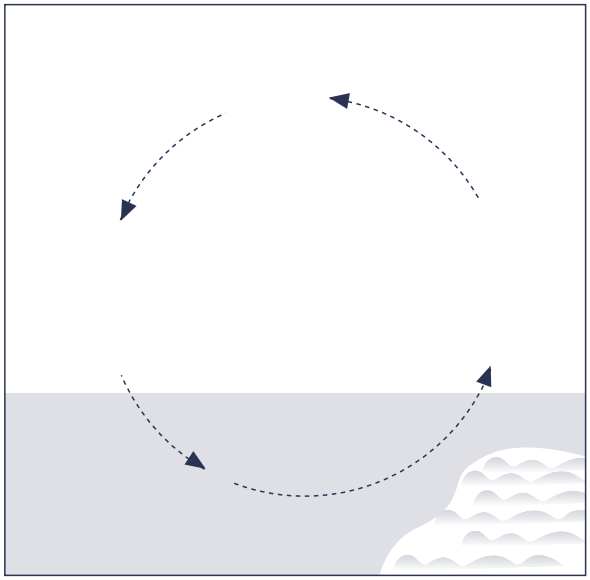
You will observe how the carbon stored in chalk (limestone) is released. What is happening in the reaction? Can you write a chemical equation? Record the experiment. Dinosaur breath could have been released when the vinegar was added to the chalk—True or false?





3) Drawing the carbon cycle.

Illustrate how carbon is transferred between carbon sinks and carbon sources by completing an illustration of the carbon cycle like the one below.



What have I learnt?

Pretend you are a carbon atom—write your own CV. What have you done in your lifetime?

WORKSHEET 10: CO_2—too much of a good thing

TIPS FOR TEACHERS

STUDENT OUTCOMES

- Understand the role of CO_2 in respiration and photosynthesis
- Observe the effects of photosynthesis and respiration of plants
- Synthesis of understanding of CO_2

KLA: Science

Thinking skills: Analysis (PMI), Summary (scientific report writing), Transferral (illustrating)

Key reading from *We Are the Weather Makers*

Introduction – What is Climate Change?

Further reading from the book

Chapter 3 – The Greenhouse Gases

Materials/resources

REQUIRED: Small leafy plant, large jar with lid (big enough to contain the plant), small container with lime water, large paper for Graffiti Wall

Teacher prompts (questions, activities, starters)

TASK 1: Acquaint students with the principles of a **PMI analysis** (p. 5). You will probably want to prepare for this class by conducting the experiment the day before the class so that students can observe the results immediately. Alternatively, conduct this class over two days. Although results will vary, your students should be able to note that the lime water turns milky. If left for several days, white deposits of lime-stone form around the edge of the container at the surface of the lime-water. (This is the result of carbon dioxide in the air combining with the lime-water.) The chemical equation is $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$.
Extension: *Students can think of other ways to demonstrate the emission of carbon dioxide. How could this form of experiment be used to demonstrate personal carbon dioxide emissions?*

TASK 2: We exhale approximately 200ml of CO_2 every minute—and a mixture of other gases depending on what we have inhaled. Students could breathe through a straw into some lime-water. It takes a while for a reaction to occur.
Extension: *Students can write a series of chemical equations which represent the role of carbon in respiration. These equations can be displayed in the form of mock street signs which suggest creating carbon dioxide-free zones. Students could also explore the ways in which carbon neutrality can be achieved with respect to human emissions from respiration.*

TASK 3: Students may have assumed that CO_2 is always undesirable. It is important for students to appreciate the role of CO_2 in the natural carbon cycle.
Extension: *Students can consider the point at which CO_2 becomes a problem and the ways in which human activity is interfering with the 'cycle that forms the basis of life on Earth.'*

What have they learnt?

To create multiple **Graffiti Walls** (p. 5), list different questions or prompts on separate sheets for students to respond to: for example—CO_2 is necessary for..., CO_2 is produced when..., etc. Encourage students to reflect upon what initial assumptions they carried. Explore the ways in which these were broken.

Notes and reflections

STUDENT WORKSHEET

Earth's thermostat is a complex and delicate mechanism, at the heart of which lies carbon dioxide (CO_2), a colourless and odourless gas formed from one carbon and two oxygen atoms.

CO_2 plays a critical role in maintaining the balance necessary to all life. It is also a waste product of the fossil fuels—coal, oil and gas—that almost every person on the planet uses for heat, transport or other energy needs. On dead planets such as Venus and Mars, CO_2 makes up most of the atmosphere, and it would do so here if living things and Earth's processes didn't keep it within its bounds... p. 5

Were it not for plants and algae, we would soon suffocate in CO_2 and run out of oxygen. Through photosynthesis (the process whereby plants create sugars using sunlight and water) plants take our waste CO_2 and use it to make their own energy, creating a waste stream of oxygen along the way. It's a neat sustaining cycle that forms the basis of life on Earth. p. 28

We Are the Weather Makers

Reaction to text

- Considering the text above, in what ways is a plant a person's best friend?
- Complete a **PMI analysis** on carbon dioxide.

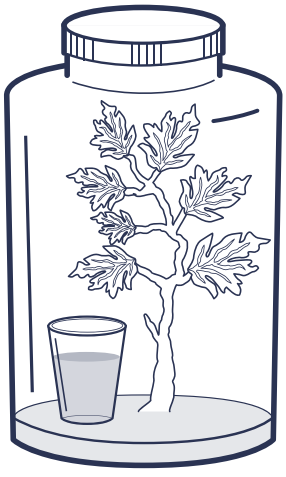
Plus	Minus	Interesting

Tasks

1) During the day, plants use sunlight and water to create their own energy—so what do they do at night or in the absence of sunlight? The following experiment will explain this.

Aim: ***To test for carbon dioxide produced by plants during respiration***

Materials: Small leafy plant, large jar with lid (big enough to contain the plant), small container with lime water



Method:
1. Place the plant inside the large jar.
2. Fill the small container with lime water and place it inside the jar.
3. Close the jar and store it in a dark place overnight.

Observations: What has happened to the lime water? Why? Write a chemical equation to explain this observation. How does this experiment show that carbon dioxide and water vapour are produced during cellular respiration?

2) What gas do humans and animals exhale? Write the formula for this exhaled gas.

3) CO_2 is also released as old vegetation rots. List the ways in which CO_2 is digested and released by plants and then draw a diagram illustrating the role of plants in the carbon cycle.

What have I learnt?

Graffiti Wall: Write a statement or phrase, or draw a graphic which indicates what you have learnt about CO_2.

TIPS FOR TEACHERS

STUDENT OUTCOMES

- Understanding of the composition and effect of greenhouse gases
- Understanding of the effects of greenhouse gases on the temperature of the Earth
- Design, implementation and observations of an experiment simulating the Greenhouse Effect
- Generation of new terms for greenhouse gases

KLA: Science

Thinking skills: Prediction, transferral of verbal information to diagram, synthesis (designing experiment), analysis (cause and effect), fluency and creativity (devising new terms)

Key reading from *We Are the Weather Makers*

Chapter 2 – The Great Aerial Ocean

Further reading from the book

Chapter 3 – The Greenhouse Gases, Chapter 17 – Danger Ahead

Materials/resources

REQUIRED: seed trays, soil, seeds, water, plastic food wrap and thermometers

OPTIONAL: overhead transparencies, coloured pens

Teacher prompts (questions, activities, starters)

TASK 1: Explain the following to your students:

'Gases in the atmosphere absorb some forms of radiative energy. In particular, greenhouse gases, which are transparent to the visible and ultraviolet radiation that we receive from the Sun, absorb heat energy that is radiated by the Earth's surface back towards space. The greenhouse gases re-radiate this heat energy in all directions, and some of it returns to the Earth's surface, making it warmer than it would otherwise be.

Greenhouse gases are natural constituents of the atmosphere, and the natural greenhouse effect raises the Earth's surface temperature by 33°C. Without this natural greenhouse effect, the Earth's surface would be completely frozen. The additional greenhouse gases added to the atmosphere by human activities warm the Earth's climate even further.' Professor Will Steffen, Director, The Fenner School of Environment and Society, ANU

While it is tempting to draw a template for students to copy students will learn more if they make an initial attempt individually. Alternatively, groups could draw their interpretation on overhead transparencies. These can be presented to the group, discussed and revised.
Extension: *Elicit suggestions from students of other gases that are also 'greenhouse gases'. Students could be assigned to groups and allocated one of the 'greenhouse gases' other than CO_2. In these groups they could illustrate the derivation, content and effects of their allocated gas. The greenhouse gases are: CO_2, methane, nitrous oxide, water vapour and three fluronated gases (sulfur hexafluoride, hydroflurocarbon, perflurocarbon).*

TASK 2: The premise of the experiment could be for the plastic wrap to act as a greenhouse gas and trap warmth.
Extension: *Students could extend the experiment by suggesting the routine addition of CO_2 to the air contained by the plastic wrap. They may also suggest the addition of other greenhouses gases. Students could make predictions about the addition of these gases.*

TASK 3: Introduce the students to the **Cause and Effect** table (p. 4). Students should think beyond the mere existence of CO_2 and consider the proximity of Venus to the sun, the existence of other gases etc.
Extension: *Students could investigate the CO_2 levels on other planets and draw graphs representing the CO_2 levels and temperatures of other plants.*

What have they learnt?

You could suggest words such as ceiling, wrap, insulation, etc. Students could compete with other groups or complete an **A-Z Brainstorm** (p. 4).

Notes and reflections

STUDENT WORKSHEET

Greenhouse gases trap heat near Earth's surface. As they increase in the atmosphere, the extra heat they trap leads to global warming. This warming in turn places pressure on Earth's climate system, and can lead to climate change...

If CO_2 made up 1 per cent of the atmosphere, it could bring the surface temperature of our planet to boiling point. p. 15

We Are the Weather Makers

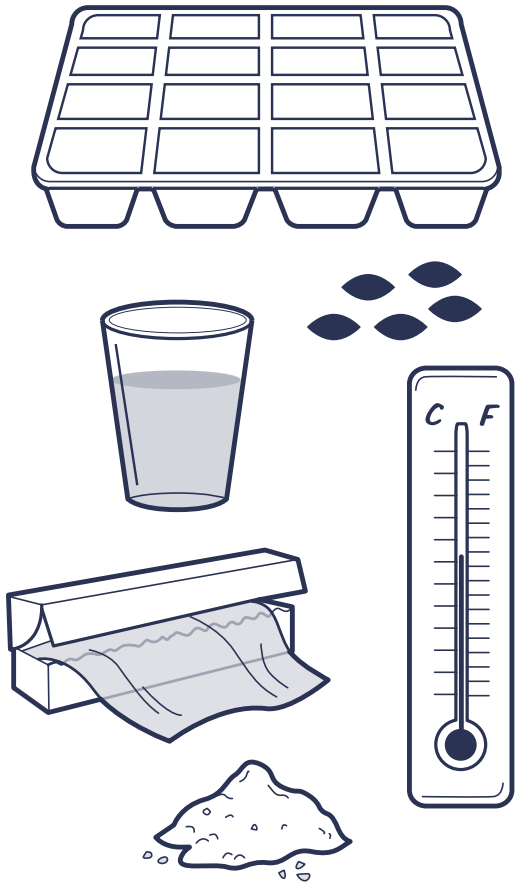
Reaction to text

What would our planet look like if the surface temperature was at boiling point?

Tasks

1) Illustrate the existence and the effect of greenhouse gases in a labelled diagram. Show the earth, effect of the gases, the passage of sunlight and heat.

2) Design an experiment to show the 'greenhouse effect'. Your experiment should involve the following materials: seed trays, soil, seeds, water, plastic food wrap and thermometers. Conduct the experiment if possible and record your results.



3) Some idea of the power greenhouse gases have to influence temperature can be gained from other planets. The atmosphere of Venus is 98 per cent CO_2, and its surface temperature is 477°C.

Complete a **Cause and Effect** table to indicate the reasons for the high temperature on Venus. Consider all of the differences between Earth and Venus.

Cause	Effect

What have I learnt?

The term 'greenhouse' is used to describe the effect of CO_2. Make a list of other words which could be used to explain the effect of the gases.

TIPS FOR TEACHERS

STUDENT OUTCOMES

- Understanding the role of oceans in absorbing CO_2
- Demonstrating an understanding of how CO_2 is absorbed by sea water
- Designing an experiment to demonstrate the role of water temperature in CO_2 absorption
- Summarising knowledge of the role of oceans in absorbing CO_2 in the form of an educative campaign

KLA: Science

Thinking skills: Prediction, synthesis (devising a survey and campaign), transferral of verbal information to diagram, synthesis (designing experiment), ranking

Key reading from *We Are the Weather Makers*

Chapter 3 – The Greenhouse Gases

Further reading from the book

Chapter 19 – How Can They Keep On Moving?
Chapter 15 – Rising Waters

Materials/resources

REQUIRED: soft drink cans, ice, coloured paper for brochure

OPTIONAL: multimedia equipment

Teacher prompts (questions, activities, starters)

TASK 1: The answer is WATER, SOIL, ATMOSPHERE. Ask students to consider the difference in absorbtion potential between oceans and other large bodies of water. You could provide students with the following information: Atmosphere contains 750 Gigatons (GtC) of carbon at present. Vegetation and soils in the land contain about 2200 GtC. Surface ocean contains 1000 GtC and deep ocean contains 39,000 GtC.
Extension: *Students could break down these categories further: layers in the atmosphere (p. 16 of the book), types of oceans or specific ocean regions, types of soil—in terms of time or content.*

TASK 2: Although it is tempting to draw a template for students to copy, students will learn more if they make an initial attempt individually. Alternatively, groups could draw their interpretation on overhead transparencies. These can be presented to the group, discussed and revised.
Extension: *Students could present their diagrams and explain the process to a group of younger students. They could make a multi-media presentation of this information and combine this further information to complete Task 4 as a multi-media presentation.*

TASK 3: It would be advisable to have some soft-drinks and ice on hand if students wish to demonstrate this or devise their experiment to directly mirror Flannery's comments.
Extension: *Students could interpret Flannery literally and use soft-drink cans in their experiment or devise a more complex simulation of this idea. Students could also come up with a list of ways of testing the acidity of water.*

TASK 4: Students need to be clear on the information they are trying to present and the arguments they are trying to persuade others to heed.
Extension: *This could involve a multi-media presentation which includes all of the information learned in the previous three tasks.*

What have they learnt?

Combine students' questions for a quiz at the beginning of their next class.

Notes and reflections

STUDENT WORKSHEET

If we take the long-term view, there really is only one major carbon sink on our planet—the oceans. They have absorbed 48 per cent of all the carbon emitted by humans between 1800 and 1994... p. 30

Sea water also contains carbonate. It reaches the oceans from rivers that have flowed over limestone or other lime-containing rocks, and it reacts with the CO_2 absorbed into the oceans. At present there is a balance between carbonate concentration and the CO_2 absorbed. As the CO_2 concentration increases in the oceans, however, the carbonate is being used up.

The oceans are becoming more acid, and the more acid an ocean is the less CO_2 it can absorb.

Before the end of this century the oceans are predicted to be taking in 10 per cent less CO_2 than they do today. In the meantime we continue to pour more and more CO_2 into the atmosphere. p. 31

We Are the Weather Makers

Reaction to text

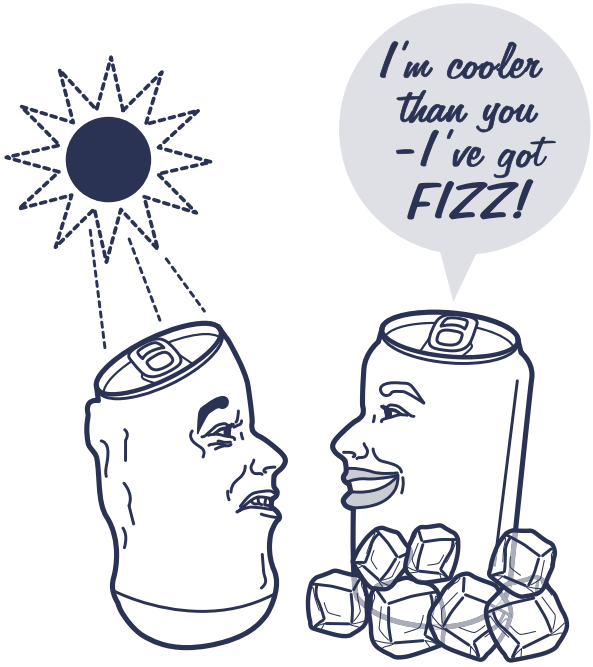
Did you know the important role of sea water in absorbing CO_2? Do you think that many other people in your family, school or community are aware of this? Design a survey to measure what others know about the role of the sea in absorbing CO_2.

Tasks

1) Rank the following global reservoirs in terms of the volume of carbon they hold:

SOIL, WATER, ATMOSPHERE

2) Describe in a diagram how and why sea water absorbs carbon dioxide.



3) In his book, Flannery says 'Scientists are worried that changes in ocean circulation brought about by global warming might degrade the effectiveness of this "carbon kidney". There are many ways that this could happen, one of which you can see in a warm can of soft drink. That fizz on opening the can fades – indicating that the liquid has quickly released the CO_2 that gives it its sparkle. Cold drinks hold their fizz longer. Cold sea water can hold more carbon than warm sea water, so as the ocean warms it becomes less able to absorb the gas.' (p.30).

Design and conduct an experiment to show what Flannery means.

4) Write a brochure for an advertising campaign called: **Keep our oceans cold.** Include reasons for the focus on ocean temperature and persuasive arguments for its importance.

What have I learnt?

Write a question for a science test on oceans as carbon sinks. Your question could be a TRUE/FALSE, multiple choice or short answer question. You could include diagrams to label or ask classmates to draw a diagram. Be creative.

TIPS FOR TEACHERS

STUDENT OUTCOMES

- Understanding of the characteristics and effects of water vapour
- Observing and understanding the effects of heating and cooling on water vapour
- Understanding and evaluating the role of water vapour in global warming

KLA: Science

Thinking skills: Analysis (Y Chart), observing and justification

Key reading from *We Are the Weather Makers*

Chapter 2 – The Great Aerial Ocean

Further reading from the book

Chapter 14 – Extreme weather, Chapter 13 – Rainfall, Chapter 4 – Ice Ages and Sunspots

Materials/resources

REQUIRED: jars, rubber balloons with wide necks or a large rubber glove, chalk dust

OPTIONAL: matches, Internet access

Teacher prompts (questions, activities, starters)

Reaction to text: Ensure students are familiar with a **Y- Diagram** (p. 7).

TASK 1: Another method of conducting this experiment is to use a rubber glove and insert your hand into the fingers in order to pull the glove in and out of the jar. Students should observe that dust clouds form when the glove or balloon are pulled out of the jar (and the air has more room to move and becomes cooler) and disappear when the air is again compressed.
Extension: *This experiment can also be tried by dropping a lit match into the jar—although having students use chalk dust is probably safer.*

TASK 2: In preparation for this task, students may find a little research useful. The quote on p. 47 under Task 2 can be found at www.space.com/scienceastronomy/planetearth/warmer_wetter_000128.html. One environmentalist website includes the following analysis of the role of water vapour:

> **MYTH:** Water vapour is the most important, abundant greenhouse gas. So if we're going to control a greenhouse gas, why don't we control it instead of carbon dioxide (CO_2)?
>
> **FACT:** Although water vapour traps more heat than CO_2, because of the relationships between CO_2, water vapour and climate, to fight global warming nations must focus on controlling CO_2.
>
> Atmospheric levels of CO_2 are determined by how much coal, natural gas and oil we burn and how many trees we cut down, as well as by natural processes like plant growth. Atmospheric levels of water vapour, on the other hand...are determined by temperatures. The warmer the atmosphere, the more water vapour it can hold. As a result, water vapour is part of an amplifying effect. Greenhouse gases like CO_2 warm the air, which in turn adds to the stock of water vapour, which in turn traps more heat and accelerates warming. Scientists know this because of satellite measurements documenting a rise in water vapour concentrations as the globe has warmed. The best way to lower temperature and thus reduce water vapour levels is to reduce CO_2 emissions.
>
> Source: Global Warming Myths and Facts
> www.environmentaldefense.org/page.cfm?tagID=1011

Students (and teachers) are encouraged to explore the range of understandings on the subject at this website and others mentioned on p. 16.

Extension: *Put water vapour on mock trial with a prosecutor, defence team, jury and scientific expert.*

TASK 3: Ensure that students are familiar with **Spider Maps** (p. 5). Alternatively, other forms of diagram may offer a more useful visual representation for this exercise. Students could select their own graphic organiser on which to base their illustration and understanding.

What have they learnt?

This could be presented as a narrative or as a storyboard.

Notes and reflections

STUDENT WORKSHEET

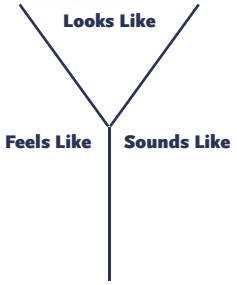
So how do CO_2 and water vapour interact? As the concentration of CO_2 increases, it warms the atmosphere just a little, which allows it to retain more water vapour. This in turn magnifies the original warming. You can think of CO_2 as the lever that shifts our climate...

The difference between a desert and New York City at night is a single greenhouse gas—the most powerful of them all—water vapour. p. 20

We Are the Weather Makers

Reaction to text

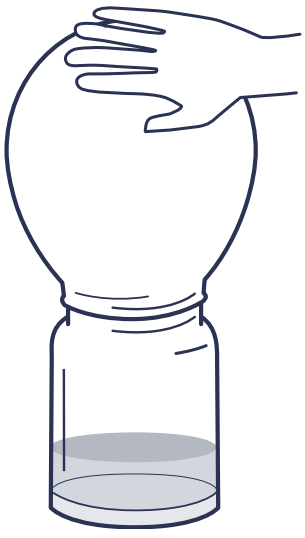
Do you live in, or have you travelled to a humid climate? Complete a **Y Chart** to describe the atmosphere when it contains a high density of water vapour.



Tasks

1) Water vapour is a gas that responds very simply to heating and cooling—or compression and decompression. Conduct the experiment below to demonstrate this:

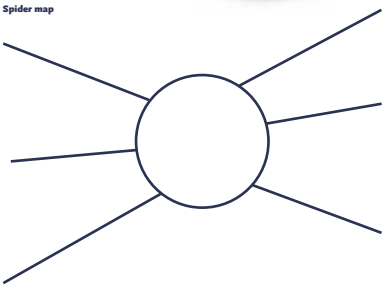
Put a few centimetres of water in the bottom of a jar. Place a large rubber balloon over the mouth of the jar and leave for 10 mins. Remove the balloon and quickly drop some chalk dust into the jar before replacing the balloon. Push the balloon into the jar a little way and hold there before quickly releasing it. What happens? Why? Write a report to explain your observations and your analysis.



2) In a recent study of satellite data which appeared in the science journal *Nature*, researchers compared measurements of sea surface temperature, air temperature and humidity from three satellites. According to one of the researchers, 'Water vapour is really the primary greenhouse gas in the atmosphere and has a greater influence on global warming than carbon dioxide, but we're not sure whether this increase of water in the atmosphere will lead to an increase in global warming.'

List 5 arguments to support or contradict the idea that water vapour is responsible for global warming. Make sure you back up your case with scientific evidence.

3) The interaction between CO_2, warmth and water vapour is a complex one. Illustrate the relationship as a **Cause and Effect** table or **Spider Map**.



What have I learnt?

Imagine yourself as a water molecule. Describe your state in different parts of the globe and at different times of the year: when are you gas, liquid, solid? Why?

TIPS FOR TEACHERS

STUDENT OUTCOMES

- Understanding of the species affected or likely to be affected by global warming
- Synthesis of information and evaluation of best ways to convey this information to others to inspire action

KLA: Science

Thinking skills: Identification of information from written material, summary, synthesis, evaluation

Key reading from *We Are the Weather Makers*

Chapter 9 – Magic Gates, El Niño and La Niña

Further reading from the book

Chapter 10 – Peril at the Poles, Chapter 11 – 2050: The Great Stumpy Reef?, Chapter 12 – A Warning from the Golden Toad, Chapter 18 – Retreating up the Mountains and Chapter 19 – How Can They Keep on Moving?

Materials/resources

REQUIRED: World map, *We Are the Weather Makers*

OPTIONAL: Poster paper, coloured paper, pictures of animals

Teacher prompts (questions, activities, starters)

TASK 1: Students could work in groups on particular sections of the text. The information could then be combined on a larger map and displayed prominently.
Extension: *Students could analyse regions more closely and make observations about the types of species being affected in different regions of the globe.*

TASK 2: Students can complete the same task for the earlier chapters. The information can be presented as a **Cause and Effect** table (p. 4).
Extension: *Students can then turn the information collected into quiz questions to test their peers. The class can engage in a collective or individual competition.*

TASK 3: The campaign can be presented in multi-media form, as a poster or brochure. Make the assessment criteria clear and also clarify the expectations of students in terms of the content and level of detail.
Extension: *Students can investigate equivalent real-world campaigns and non-government organisations.*

What have they learnt?

Students could design their own covers. A paragraph explaining their choice should accompany their design.

Notes and reflections

STUDENT WORKSHEET

With so many species relocating, it's inevitable that changes to the environment will block their way...

Tiny marine organisms called copepods, for example, have been detected up to 1000 kilometres from their usual habitat...

With only 20 per cent of their original habitat now able to support them, [Edith's checkerspot butterfly] may not be around next century...

The early onset of spring activity is a key clue to climate change. In the bird world the common murre, a Northern Hemisphere seabird, has begun to lay its eggs on average twenty-four days earlier each decade over the period its nesting has been studied...

As some species shift rapidly in response to climate change, others are left behind. A key food item might arrive too late to be of use to a predator, or move too far north for that predator to use it. pp. 80-81

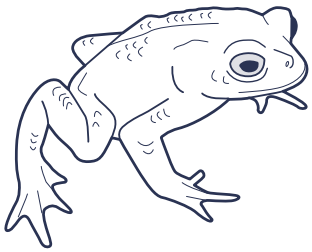
We Are the Weather Makers

Reaction to text

Are you surprised to read of these changes to wildlife? Have you heard of others?

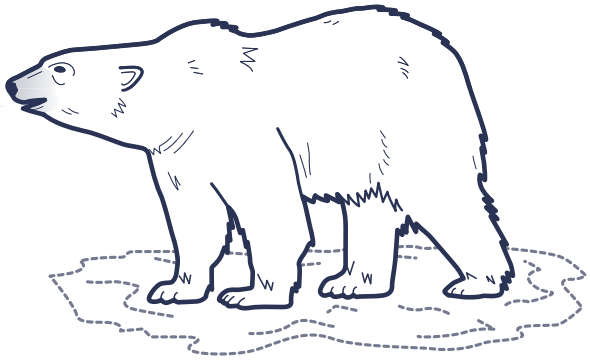
Tasks

1) In groups read sections of Chapters 10, 11 and 12 and mark on a world map which species are affected and where.



2) Look also at Chapters 18 and 19. List the observations that scientists have made and the predictions they have for the species mentioned.

3) Create a campaign titled 'Save Our Species'. What information would you like to convey? How will you convey this? What observations and scientific evidence will you present to make your case for human action? What do you think humans should or can do to save our species?



What have I learnt?

Look again at the cover of *We Are the Weather Makers*. What is this image trying to convey?

Links

www.worldwildlife.org/

www.environment.gov.au/biodiversity/threatened/

www.msnbc.msn.com/id/18427512/

TIPS FOR TEACHERS

STUDENT OUTCOMES

- Understand wind and solar energy sources and analyse their advantages and disadvantages.
- Devise a new method for converting wind or solar energy to electricity
- Justify to an audience the benefits of investing in wind and solar energy

KLA: Science

Thinking skills: analysis, creative thinking, justification

Key reading from *We Are the Weather Makers*

CHAPTER 27 – Bright as Sunlight, Light as Wind

Materials/resources

REQUIRED: Coloured pencils/textas

OPTIONAL: Internet access, *We Are the Weather Makers*

Teacher prompts (questions, activities, starters)

TASK 1: Ensure students are familiar with the process for a **SWOT Analysis** (p. 6). Students may find it useful to read Chapter 27 to complete this exercise and will also benefit from some additional resources on the topic. You could distribute the following prompts to assist students or refer them to the weblinks listed for further information.

Prompts:

- What infrastructure is required?
- How costly is the infrastructure?
- Does the source provide intermittent or continuous power?
- How efficient is this means of producing energy?
- Are any other natural resources affected?

Extension: *Students could present their analyses and vote on whether to invest in wind and solar power.*

TASK 2: Students will find searching for this idea on the Internet useful (www.ecogeek.org/content/view/584/), but can also rely on their imaginations.
Extension: *You could conduct a 'New Inventors' exhibition with everyone's designs. Students could decide on the appropriate criteria for assessing the inventions and then cast their votes accordingly.*

TASK 3: This can be presented as either a tool for selling this form of energy, running through the arguments established in Task 1, or as a broader ideological booklet, incorporating comparisons to non-renewable energy sources.
Extension: *Students could complete something as extensive as preparing plans, designs, costings, etc. Students could look into whether any schools in their state use alternative energy.*

What have they learnt?

Students can present this information as a flow diagram of required actions.

Notes and reflections

STUDENT WORKSHEET

Two researchers from Princeton University in the US investigated whether the world possesses the technologies required to run an electricity network like the one we currently enjoy, while at the same time making deep cuts in CO_2 emissions. They identified fifteen basic types of technologies...which are developed now and could play a vital role in controlling the world's carbon emissions for at least the next fifty years. p. 231

We Are the Weather Makers

Reaction to text

List four natural sources of energy and the current technologies which convert these into electricity. Why are they called 'renewable energy sources'?

What have I learnt?

Think ahead to the year 2200. What sort of technology will exist to generate and transfer energy? What will governments be required to do in order for these technologies to exist?

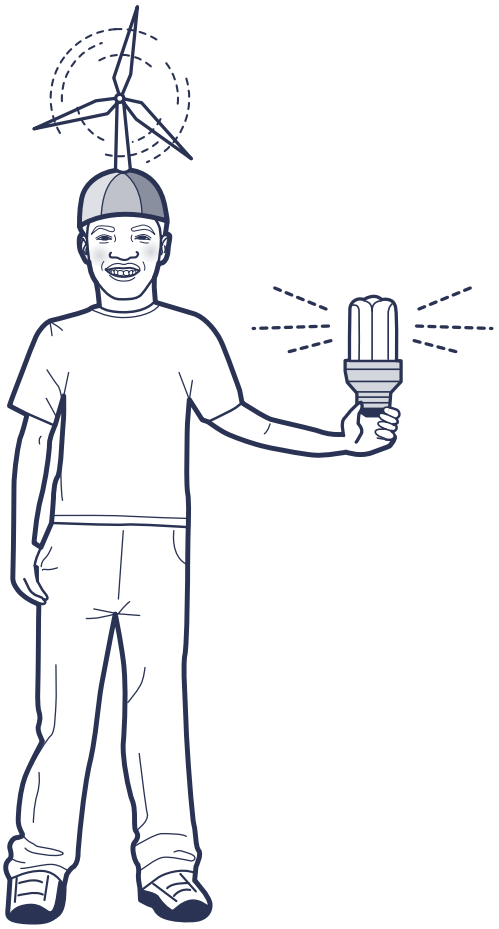
Tasks

1) Conduct a **SWOT Analysis** which looks at the advantages and disadvantages of alternative sources of energy.

Strengths	Weaknesses
Opportunities	Threats

2) Recently, a student in America designed a freeway turbine which is propelled by the wind generated by cars travelling down a freeway. Design or illustrate a new way of converting renewable energy into electricity—be creative!

3) Produce a booklet for consumers looking into purchasing that form of energy or a campaign for governments to invest in the energy.



TIPS FOR TEACHERS

STUDENT OUTCOMES

- Evaluating scientific evidence and arguments and their relative merit
- Evaluating methodology of a scientific experiment
- Understanding of models simulating climate change

KLA: Science

Thinking skills: Evaluation, analysis, recall, decision-making

Key reading from *We Are the Weather Makers*

Introduction – What Is Climate Change?, Chapter 30 – Over to You

Further reading from the book

Chapter 3 – The Greenhouse Gases, Chapter 16 – Model Worlds

Materials/resources

REQUIRED: Introduction – What Is Climate Change? (pp. 10–11)

OPTIONAL: *We Are the Weather Makers,* Internet access

Teacher prompts (questions, activities, starters)

TASK 1: Ensure students are familiar with a **SWOT Analysis** (p. 6). Teachers can prompt students with questions such as: 'Why was no change experienced?', 'What was missing from the micro-world?', 'What could they have improved?'. There are various websites with examples of students conducting similar experiments. Students could read through these to identify differences in the experiments.

www.youth.net/nsrc/ejournals/ejou023.html

www.keystonecurriculum.org/highschool/week1/lesson_5.html

www.fi.edu/guide/otoole/datalogging.html

TASK 2: To complete this task, students really need to have a good understanding of the concept of 'variables' and controls in scientific experiments. How can CO_2 be isolated as a variable? What other variables interfere in the experiment?
Extension: *Students can consider changing the controls and variables: such as looking at methane as the independent variable or introducing water vapour as an additional variable where CO_2 is either varied or controlled.*

TASK 3: Remind students how to complete a **Ranking Ladder** (p. 6). Students should work on sections of the book in small groups to make the task manageable. Alternatively, students can focus on the information in the introduction.
Extension: *Students can categorise the evidence. Criteria can also be drawn up to try to define sound scientific evidence. The evidence presented by Flannery can be tested against the criteria in a* **Think, Pair, Share** (p. 7) *or* **Ranking Ladder** activity.

What have they learnt?

You could ask students to submit a statement that reflects their beliefs about global warming. Students could then indicate whether they agreed with each statement. For how many statements was there consensus across the class?

Notes and reflections

STUDENT WORKSHEET

If everyone takes action to rid atmospheric carbon emissions from their lives, I believe we can stabilise and then save the Arctic and Antarctic. We could save around four out of every five species currently under threat, limit the extent of extreme weather events and reduce, almost to zero, the possibility of any of the three great disasters occurring this century, especially the collapse of the Gulf Stream and the destruction of the Amazon. p. 249

Even scientists don't agree on every aspect of climate change research. We are trained sceptics, always questioning our own and other's work. A scientific theory is only valid for as long as it has not been disproved. And climate change can be difficult for many people to think about calmly because it arises from so many things we take for granted in the way we live. p. 4

We Are the Weather Makers

Reaction to text

Is there anything in the text above or in the introduction to *We Are the Weather Makers* about which you are sceptical? What evidence do you find most convincing?

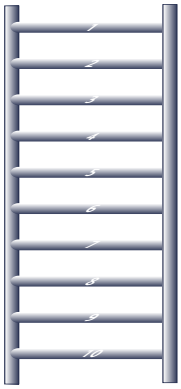
Tasks

1) A school in America had its students complete a simple experiment. They constructed a micro-world (a small covered model of soil and plants) and emitted CO_2 into the world each day to increase the density of CO_2 in the atmosphere. They measured the temperature daily, but after 40 days had recorded no increase in temperature. Analyse their experiment by completing a **SWOT Analysis**.

Strengths	Weaknesses
Opportunities	Threats

2) What do you think they were trying to prove? What could they have done to improve the experiment? In groups, devise a better experiment to demonstrate the same point. Draw a picture to illustrate your experiment.

3) There is some debate about the cause of climate change. Make a list of some of the evidence Flannery has produced in *We Are the Weather Makers* for the need for humans to act to reduce CO_2 emissions. Complete a **Ranking Ladder** to rank the evidence from most to least persuasive. Give reasons. Do you require any further evidence?



What have I learnt?

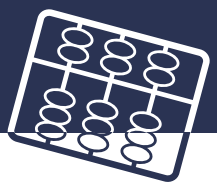
Are you surprised to learn that not all scientists agree? Do you think they will ever agree? What would have to happen for there to be global consensus on global warming?

Maths Worksheets

Worksheet Number	Title	Topic	Page
17	**Sink or swim?**	**Rising sea-levels (Area)**	56
18	**Getting around**	**Emissions from car travel (Whole number)**	58
19	**Ozone: the good news story?**	**Montreal Protocol and CFCs (Graphs and averages)**	60
20	**Energy alternatives**	**Alternative energy sources**	62
21	**So a few good showers will fix it?**	**Rainfall shortage and percentages**	64

A curriculum focus on climate change offers a number of real-world applications for mathematical exercises. Maths is an important tool for analysing the impact of climate change and working towards solutions. The emphasis on Prediction, Comparison and Problem Solving skills in these lessons offers numerous opportunities for Collaborative Learning experiences. These lessons should encourage students to think about the science, impacts and solutions of climate change.

Don't forget: Student Worksheets provide the framework for lessons; Tips for Teachers pages contain the tools you need and pointers to classroom resources. Your school was sent a free copy of ***We Are the Weather Makers*** in 2006, which will allow you to support your lessons with direct study of the book. See the chapter breakdown in this resource (pp. 13–14). Of course there are many other resources which can support your lesson planning, some of which are listed on p. 16. While these lessons are designed to stand alone, it may be worth covering **Climate Change Context and Overview** (pp. 9–16) before beginning this area of study.



TIPS FOR TEACHERS

STUDENT OUTCOMES

- Analysing the potential effect of rising sea-levels
- Understanding of the concept of area and associated calculations

This class would be suitable for: Maths, IT, Geography

KLA: Maths

Thinking skills: Prediction, analysis, estimation

Key reading from *We Are the Weather Makers*

Chapter 15 – Rising Waters

Materials/resources

REQUIRED: Access to a PC and the Internet

OPTIONAL: Graph paper, calculator

Teacher prompts (questions, activities, starters)

TASK 1: Provide students with an appropriate website, such as http://flood.firetree.net. For younger or weaker groups, have students work on the same town. This will make it easier for students to have discussions when they work through some of the later tasks.
Extension: *Have students research the various predictions that exist about how high, and at what rate, sea levels may rise.*

TASK 2: To assist students with this estimation you may wish to provide them with a sheet of graph paper. Have students hold the graph paper on the screen to help them work out how much of the town is now underwater.
Extension: *Ask students to look closely at the map and to consider population density when estimating the percentages. If large areas of the town appear to be less densely populated than others, have students factor this into their estimations.*

TASK 3: Using the population of the town from the Census website, and the estimate of the percentage of the town that will be affected by the rising sea levels, students should calculate the decrease in the town's population.

What have they learnt?

You may need to prompt student to generate reasons why towns may not be as severely affected as they first thought. For example, if the town is on a cliff face, or if large areas of the town are used for farming etc.

Notes and reflections

STUDENT WORKSHEET

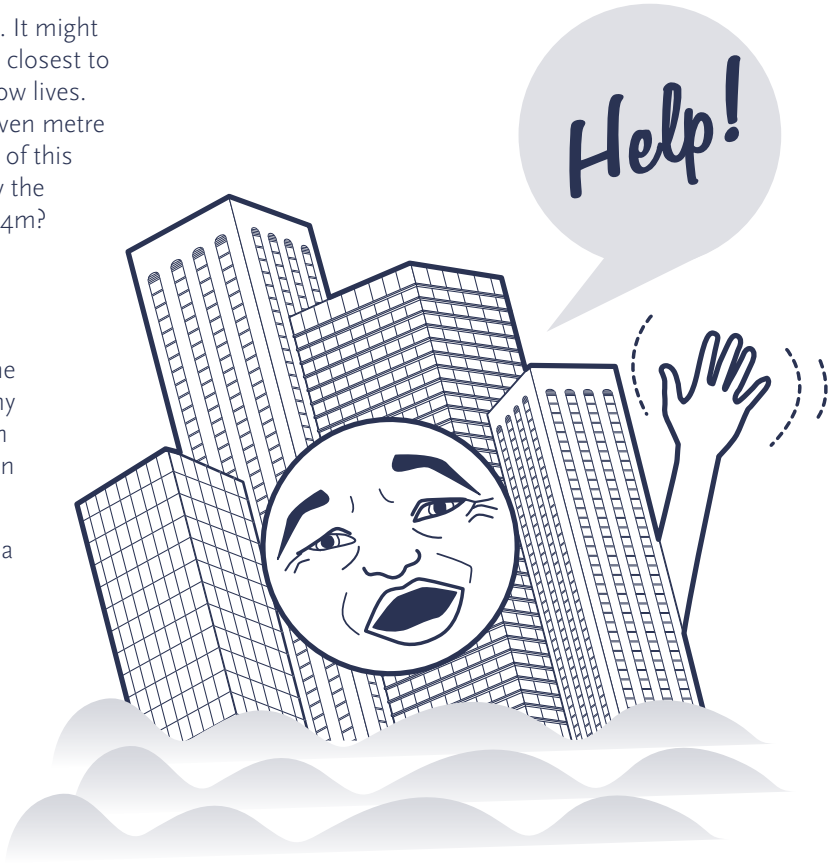
Two out of every three people on earth live within eighty kilometres of the coast. p. 141

Climate scientists are now debating whether humans have already tripped the switch that will create an ice-free Earth. If so, we have already committed our planet and ourselves to a rise in the level of the sea of around sixty-seven metres. p. 134

We Are the Weather Makers

Reaction to text

Pick out a coastal town that you know about. It might be a capital city; it could be the coastal town closest to you; maybe a town where somebody you know lives. In your workbook predict the effect that a seven metre rise in sea levels will have on the population of this town. How many people will be displaced by the rising sea? What about if the sea level rose 14m?



Tasks

1) Log onto the website provided by your teacher. This site will allow you to observe the effect that the rising sea level will have on any town within Australia up to 14 metres. Zoom into your selected town and simulate a rise in the sea level of seven metres.

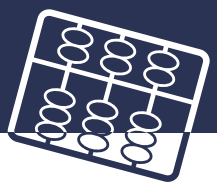
2) Estimate the percentage of the town's area that is now underwater and record this in your workbook.

3) Log onto the census website www.abs.gov.au and look up the population of your selected town. Using the percentage you estimated in the last step, calculate the effect that the rising sea level will have on this town's population.

4) Repeat the tasks above for an increase in sea level of 14 metres.

What have I learnt?

In your workbook record the difference in your initial prediction and your actual results. Can you come up with an explanation for this difference? You should consider things like the population size, geography of the area, what the land is used for.



TIPS FOR TEACHERS

STUDENT OUTCOMES

- Reinforcing mathematical operations and understanding of whole numbers
- Self-reflection on the impact of students' personal car travel on carbon emissions

KLA: Maths

Thinking skills: Comparison, self-reflection

Key reading from *We Are the Weather Makers*

Chapter 30 – Over to You

Further reading from the book

Chapter 3 – The Greenhouses Gases, Chapter 29 – Hybrids, Minicats and Contrails

Materials/resources

REQUIRED: Internet access or photocopies of a local map of the area

OPTIONAL: Microsoft Excel

Teacher prompts (questions, activities, starters)

TASK 1: If students are using the computer, rather than using paper you may wish to have them use Microsoft Excel to compile the information gathered.

TASK 2: For a younger class or weaker students, the Internet has a range of carbon calculators that will perform the calculations for students. They can then record the information into Microsoft Excel to assist them with completing this activity.

TASK 3: You may need to remind students that most buses can comfortably seat 45 people.
Extension: *Rather than just having students calculate the bus emissions using their own car route, have students research actual bus routes. This will produce a far more accurate amount of carbon emissions for bus travel.*

TASK 4: To assist students with this task have them create a table that lists each day of the week. Students can then record their weekly commitments, how far they travel, how much CO_2 is currently emitted in carrying out these activities, which alternative method of transport they are going to use, and how much this will reduce their CO_2 emissions.

What have they learnt?

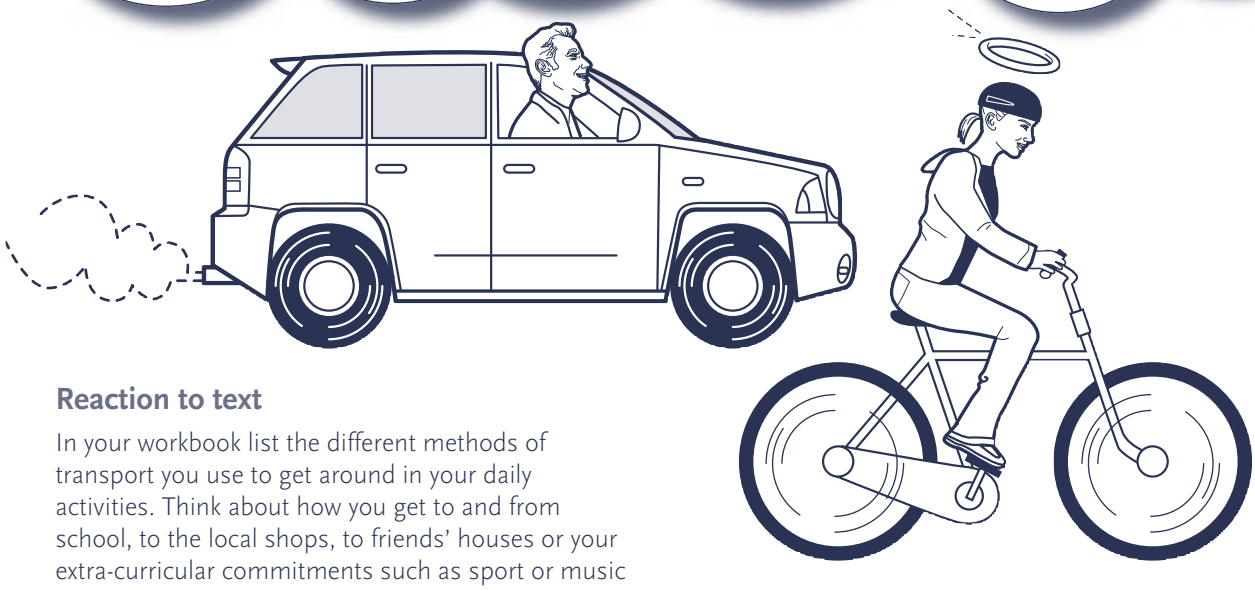
Have students keep a record of when they use alternative means of transport. After a given period, say four weeks, have them compare their predicted reductions with their actual reductions.

Notes and reflections

STUDENT WORKSHEET

It is not possible right now for most of us to do away with burning fossil fuels for transport, but we can greatly reduce their use. Walking or riding a bicycle wherever possible—to school or work or to the shops—is highly effective, as is taking public transport. p. 253

We Are the Weather Makers



Reaction to text

In your workbook list the different methods of transport you use to get around in your daily activities. Think about how you get to and from school, to the local shops, to friends' houses or your extra-curricular commitments such as sport or music lessons.

Tasks

1) Find a map of your local area or log onto the following website www.whereis.com and then select the 'get directions' tab. This will enable you to work out the:

- Distance from home to school
- Distance from home to local shops
- Distance from home to weekly sporting events

Record these in your workbook.

2) Using the table opposite, calculate how many kilograms of CO_2 emissions you would put into the environment each week if you were to drive a car to all these places.

3) Again using the table provided calculate the amount of CO_2 emissions you would put into the environment catching the bus. You may be able to look up your local bus routes on the Internet. Remember to divide the amount of emissions by the total number of people that could be on the bus.

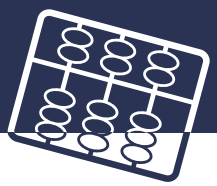
4) Using the information you have just gathered, calculate by how much you can realistically reduce your amount of CO_2 emissions. Work out where you can walk to, and where you can catch a bus. It is not realistic to say you are going to walk or ride your bike everywhere, but there are definitely cuts that you can make. In your workbook create a table that shows where you go each week, what form of transport you are going to take, and how much CO_2 will be released in the atmosphere each week.

What have I learnt?

After four weeks, record the difference between your initial prediction and your actual results. Are there other ways you might modify your routine?

Mode:	CO_2 Emissions per km
Walking	3g
Cycling	3g
Small car	150g
Medium car	190g
Large car	350g
Bus	1200g

Australasian Campuses Towards Sustainability



TIPS FOR TEACHERS

STUDENT OUTCOMES

- Understanding of whole numbers, graphing, calculating averages
- Comparing the effects of CFCs and CO_2
- Understanding of the effects of the Montreal Protocol on global CFC emissions

KLA: Maths

Thinking skills: Comparison (Venn Diagrams)

Key reading from *We Are the Weather Makers*

CHAPTER 22 – The Story of Ozone

Further reading from the book

CHAPTER 23 – The Road to Kyoto

Materials/resources

OPTIONAL: Graph paper, calculators, Microsoft Excel

Teacher prompts (questions, activities, starters)

TASK 1: If students have access to a computer it may be easier for them to use Microsoft Excel to create this line graph.
Extension: *Ask students to research and compare the level of the thinning in the ozone layer in different states of Australia.*

TASK 2: Depending on the year level of the class they may need some direct instruction as to how to calculate an average.

TASK 3: Remind students how to put together a **Venn Diagram** (p. 7). The idea of the diagram is for students to realise that we are still dealing with the damage caused by CFCs prior to the signing of the Montreal Protocol. Students should be working toward the conclusion that both CFCs and CO_2 have a long-lasting effect on our atmosphere, and that even if we reduce our current CO_2 emissions we will be dealing with the effects of these for a long time yet.

What have they learnt?

Have students research the Kyoto Protocol, and what this protocol aims to have achieved by 2050.

Notes and reflections

STUDENT WORKSHEET

Without ozone's very high sun-protection factor, UV radiation would kill you fast, by tearing apart your DNA and breaking other chemical bonds within your cells. p. 198

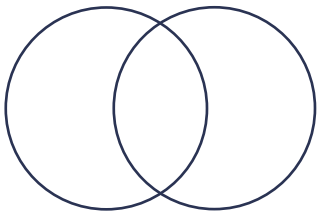
We Are the Weather Makers

Tasks

1) The table opposite outlines the average size of the thinning in the ozone layer from 1980–2006. Create a line graph that shows how the size of the ozone has changed over the last 26 years.

2) Recent studies suggest that the thinning in the ozone layer has stabilised and could even be starting to repair itself. Assuming that the spread of the thinning in the ozone layer has indeed peaked, at 27.5 million square kilometres, calculate the average amount the ozone has reduced since 2000, and based on this calculation how long it will take to repair itself.

3) The Montreal Protocol was signed by a number of countries in 1987. Assuming that the signing of this protocol helped to drastically reduce the amount of CFCs being released into the atmosphere, and from the graph you created, what conclusions can you draw about CFCs and their lasting effect on our atmosphere. Using a **Venn Diagram**, compare and contrast CO_2 and CFCs.

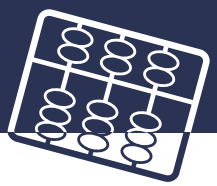


Year	Size (millions of km²)
1980	0.0
1981	2.5
1982	1.25
1983	6.5
1984	10.0
1985	12.4
1986	16.25
1987	12.5
1988	21.25
1989	11.0
1990	21.0
1991	19.8
1992	19.9
1993	23.0
1994	24.75
1995	23.5
1996	23.6
1997	23.0
1998	27.4
1999	24.8
2000	27.5
2001	25.0
2002	15.0
2003	27.5
2004	20.0
2005	25.0

NASA

What have I learnt?

The 'hole' in the ozone layer is a good news story. In the 80s scientists proved that the CFCs we released were damaging the earth. Since then we have been phasing out CFCs and the damage we did is starting to repair itself. What things can we be doing to reduce the damage that CO_2 is having on our environment?



TIPS FOR TEACHERS

STUDENT OUTCOMES

- Understanding of alternative energy sources
- Applying problem-solving strategies to a real scenario

KLA: Maths

Thinking skills: Collaborative Learning (Think, Pair, Share)

Key reading from *We Are the Weather Makers*

Chapter 27 – Bright as Sunlight, Light as Wind

Further reading from the book

Chapter 28 – Nuclear

Materials/resources

REQUIRED: An electricity bill

OPTIONAL: Internet access

Teacher prompts (questions, activities, starters)

TASK 1: Depending on the ability level of the class you may wish to use your own bill to provide students with some basic, but realistic figures to work with. Alternately, to create a greater sense of relevance, students may be asked to bring in their own bill from home. You may wish to have some discussion identifying and clarifying high and low usage.

TASK 2: Rather than explicitly teach students the calculations they need to complete, provide students with prompts to generate their own methods.

- 'What information do we have?'
- 'What additional information do we need?'
- 'How do we work out the additional information?'

Once you have allowed students sufficient time to complete these questions, use the **Think, Pair, Share** approach (p.7) to allow students to share the different methods they have used. As a class, decide upon the most efficient method that could be used for future calculations.

TASK 3: Encourage students to explore different methods to perform this calculation. Provide students with paper to draw pictures, or blocks to assist working this out. Again provide students with the opportunity to share the method they use to solve the problem.

TASK 4: The base of one wind turbine occupies about 25 square metres. The blades would require between 4,000 square metres and 10,000 square metres. However, the land beneath the blades is still available for grazing or cropping.

What have they learnt?

Encourage students to consider how our energy requirements will fall, if sustainable living practices become mainstream. Have students research other forms of sustainable energy, and the costs associated with these.

Notes and reflections

STUDENT WORKSHEET

Two researchers from Princeton University in the US investigated whether the world possesses the technologies required to run an electricity network like the one we currently enjoy, while at the same time making deep cuts in CO_2 emissions.

They identified fifteen basic kinds of technologies, from sequestration to wind, solar and nuclear power, which are developed now and could play a vital role in controlling the world's carbon emissions for at least the next fifty years. p. 231

We Are the Weather Makers

Solar System	Cost (including installation and govt. rebates)	Estimated annual savings on power bill	CO_2 emissions cut per year
1.05KW system	$10, 950	25% low usage 16% high usage	1.232 tonnes
1.5KW system	$17, 000	24% high usage 38% low usage	1.86 tonnes
2.0KW system	$22, 300	32% high usage 50% medium usage	3.26 tonnes

www.healthyhabitat.com.au

Tasks

1) Bring in an electricity bill from home, or use the one provided by your teacher. Assume that the bill is an average monthly or quarterly bill. Calculate the total cost of power for a year. In your workbook calculate the annual saving each of the above systems would provide to the bill you are working with.

2) The time taken to pay for a system like this, using only the savings that the system provides is known as the payback period. Calculate the payback period for each of the above systems. Use your problem solving skills to assist you.

i) What do you know ?

ii) What else do you need to work out?

iii) Which math skills will you need to use to come up with your solution?

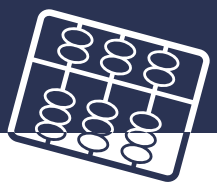
3) Wind power is another sustainable form of energy available in Australia. Wind turbines capable of producing 1MegaWatt (MW) of power are widely available. On average Australia uses approximately 80,000 MW of power per year. Calculate how many wind turbines would be required to provide all of Australia's power.

4) How much land would need to be provided for the amount of wind turbines calculated in question 3? Once you have your answer, compare it with the person sitting next to you. Share the methods you used to get the answer, and then decide which one was the most accurate.

5) Compare the cost of wind power for each kilowatt per hour to the average wholesale price of fossil fuel electricity for each kilowatt per hour. Using the power bill you used in question one, calculate how much more expensive at current usage rates it would be to use wind power.

What have I learnt?

Consider the assumptions you've made about our energy consumption when completing these tasks. What might our energy requirements be in 20 years time? Research other forms of sustainable energy, and the costs associated with these.



TIPS FOR TEACHERS

STUDENT OUTCOMES

- Understanding of the long-term effects of rainfall shortage
- Demonstrate ability to work with percentages and related calculations

This class would be suitable for: Maths, Geography

KLA: Maths

Thinking skills: Problem-solving, prediction

Key reading from *We Are the Weather Makers*

CHAPTER 14 – Extreme weather

Further reading from the book

CHAPTER 13 – Rainfall

Materials/resources

OPTIONAL: Calculators, Internet access

Teacher prompts (questions, activities, starters)

TASK 1: Students may need direct teaching on how to calculate percentages.

TASK 2: Rather than direct students as to which calculations they will need to perform to derive the answer, provide students with question prompts and have them generate their own method for solving the problem. You may wish to use the following types of questions to help students with this:

- 'What information do we already have?'
- 'What extra information do we need?'
- 'What are we trying to achieve?'

Have students share the methods that they have used. As a class group, decide upon the most efficient problem solving methods.

TASK 3: Through class discussion direct students to the idea that after long periods of drought the ground needs to be re-wet before run-off occurs, and that the rainfall does not always fall over the catchment areas. Are there other variables to consider?
Extension: *Ask students to predict the annual average water consumption in 20 years' time, taking into account better efficiency measures offset against population growth.*

TASK 4: Ask students to research current annual rainfalls for your closest capital city. Work out what percentage of the average annual rainfall this equates to. Using this percentage, have students calculate the percentage of inflow that might be expected to run into catchment areas. Using this figure have students calculate how long it will take for the water storage areas to return to 100%.

What have they learnt?

Using a **Think, Pair, Share** approach (p. 7) encourage students to think of ways that water could be "imported" into these capital cities. You may wish to encourage students to think of other ways that water could be harvested. Rainwater tanks, desalinisation, the air.
Extension: *Max Whisson has developed an idea to harvest water from thin air. Using the Internet have students research Max's idea. Have students come up with a* **Venn Diagram** *(p. 7) that compares Max's idea with a desalinisation plant.*

Notes and reflections

STUDENT WORKSHEET

There is hardly a city in Australia that is not facing a water crisis of some sort. p. 120

We Are the Weather Makers

In April 2007, the majority of capital cities on Australia's east coast were under some sort of water restriction. The table below shows the effect the drought had on these cities' water storage levels.

City	Capacity (ML)	Actual (ML)	% Available
Melbourne	1 733 000	540 810	
Canberra	207 379	62 213	
Sydney	2 584 000	980 170	
Brisbane	1 760 050	347 023	

City	Average annual inflow into catchments (ML)	2006 inflow into catchment areas (ML)	Average annual consumption (ML)
Melbourne	521 900	166 172	391 600
Canberra	190 000	22 000	65 000
Sydney	1107 000	805 514	649 700

Melbourne Water, ACTEW, Sydney Catchment Authority, SEQWater

Tasks

1) Complete the first table above by calculating the actual amount of water as a percentage of the water storage capacity, for each of the capital cities.

2) Using the information provided above calculate the 2006 inflow as a percentage of the average annual inflow.

3) According to the figures, Sydney is the only capital city that received enough inflow into catchment areas in 2006 to meet the city's consumption needs. Based on the 2006 inflow information calculate how long it would take to return Sydney's water storage levels to 100%.

4) Based on the information provided, Melbourne and Canberra did not receive enough inflow into catchment areas to meet the cities' water consumption needs. Using the 2006 inflow information, calculate how many years it would take for these cities to run out of water.

What have I learnt?

Rainfall and the water it provides is one our most reliable resources. Everything on planet Earth needs water to survive. Think about what would happen in your town if the water dried up. Using a **Think, Pair, Share** approach come up with some ways that these towns could continue to support human life.

IT worksheets

Worksheet Number	Title	Topic	Page
22	**Is it true...well is it?**	**Evaluation of websites**	68
23	**Geose...Huh?**	**Internet Search Engines** **Geosequestration**	70

Computer usage and skill growth can be incorporated into any of the learning areas covered by this resource. The following lessons focus on students' research skills with a particular emphasis on IT. They should encourage students to think about the science, impacts and solutions of climate change.

Don't forget: Student Worksheets provide the framework for lessons; Tips for Teachers pages contain the tools you need and pointers to classroom resources. Your school was sent a free copy of ***We Are the Weather Makers*** in 2006, which will allow you to support your lessons with direct study of the book. See the chapter breakdown in this resource (pp. 13–14). Of course there are many other resources which can support your lesson planning, some of which are listed on p. 16. While these lessons are designed to stand alone, it may be worth covering **Climate Change Context and Overview** (pp. 9–16) before beginning this area of study.

TIPS FOR TEACHERS

STUDENT OUTCOMES

- Evaluation of websites according to self-generated criteria
- Critical analysis of web-based information

KLA: Information Technology

Thinking skills: Collaboration (Think, Pair, Share), Comparison (Venn Diagram), Analysis (PMI)

Key reading from *We Are the Weather Makers*

Chapter 14 – Extreme Weather

Materials/resources

REQUIRED: Internet access

Teacher prompts (questions, activities, starters)

TASK 1: This task uses search engines, and is closely linked to Worksheet 23: 'Geose...huh?'. You may wish to complete 'Geose...huh?' prior to completing this worksheet.

As students search for these domain name types, encourage them to think about the organisations associated with these extensions and their motives for publishing information on the web. For example .com is a commercial organisation, why have the publishers created this website?

Once students have gathered their definitions and ranked them, facilitate a class discussion about students' justification for these rankings. Direct students to the idea that information from a .edu or a .gov website is more reliable than a website with the ~ extension (an individuals web space).

TASK 2: Using the students' **Venn Diagrams** (p. 7) or a **Question Matrix** (p. 6) and class discussion, tease out the idea that a book is often considered a more reliable source of information because:

- The book has been published by a publisher who has invested a significant amount of money into the book
- The author's name is clearly visible
- The date the book has been published is easy to locate
- The contact details of the publisher are available to anyone who has a query about the information in the book.

These are the things that students should be looking for when they validate whether or not the information published on the Internet is from a reliable source.

TASK 3: Along with anything else that students come up with, a sample checklist should include at least the following things:

- Does the website come from a reliable source? (Check website extension)
- Is the author's name visible?
- Are the author's contact details visible?
- Is the date the website was published visible?
- Is the date the website was last updated visible?
- Does the site look professional?

The final thing you should encourage students to think about is that they should never rely on information from just one source. Use journal articles, books, television or other sources to back up the information they discover on the Internet.

What have they learnt?

Provide students with the following statement.

> *'There is very little regulation of the information that is published on the Internet. Quite often when researching a controversial topic using the Internet two opposing opinions can be found.'*

Have students research what information is regulated on the Internet. Have students create a **PMI** (p. 5) about regulating information published using the Internet.

Notes and reflections

STUDENT WORKSHEET

In 2003 climate scientists announced that, over just a few years, the tropopause (the boundary in the atmosphere between the troposphere and the stratosphere) had risen by several hundred metres. The cause was both warming and expansion of the troposphere due to extra greenhouse gases, as well as cooling and contraction of the stratosphere due to ozone depletion.

We Are the Weather Makers

Reaction to text

How do you think the effects humans have had on the atmosphere are changing our weather patterns? Log on to Google and enter the following phrase, 'global warming vs cyclic weather'. In your workbook record how many sites your Google search returned. Read through some of the different sites, and think about the opinions expressed within them in regard to this topic.

As you have just seen, debate does exist as to whether or not climate change is a result of man, or is due to cyclic weather patterns. Millions of differing views, opinions and so-called facts are published on the Internet, so how do we make informed choices as to which information is reliable?

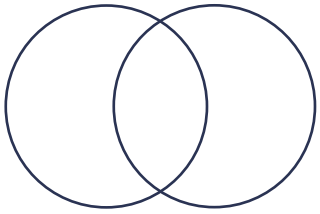
What have I learnt?

Look at the websites that Flannery has listed in the back of the book. Using your checklist, test the reliability of the websites.

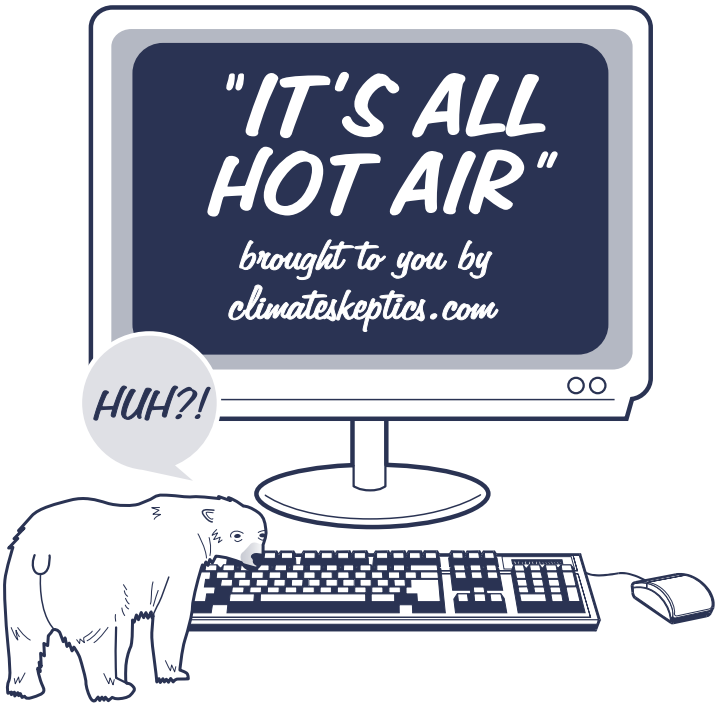
Tasks

1) Using your favourite search engine, look up the meaning of the different website extensions, e.g .com, .org, .gov, .au, .uk, .edu, ~, . After you have researched the definitions of these, think about which of these would be the most reliable source of information. Rank them from most to least reliable.

2) Books are often considered a more reliable resource than the Internet for a number of reasons. Create a **Venn Diagram** that compares and contrasts websites and books. Think about the types of things that books have that make them a more reliable source of information.



3) Using the **Think, Pair, Share** approach, your venn diagram and the list and ranks of the website extensions, create a checklist that you could use to check the validity of websites.



TIPS FOR TEACHERS

STUDENT OUTCOMES

- Demonstrate the ability to use Internet search engines efficiently
- Understanding of geosequestration and other coal-related technologies

This class would be suitable for: IT

KLA: Information Technology, Geography

Thinking skills: Fluency (A-Z Brainstorm)

Key reading from *We Are the Weather Makers*

Chapter 25 – People in Greenhouses Shouldn't Tell Lies

Further reading from the book

Chapter 27 – Bright as sunlight, Light as wind,
Chapter 28 – Nuclear

Materials/resources

REQUIRED: Internet access

Teacher prompts (questions, activities, starters)

TASK 1: Ensure that students are familiar with the **A-Z Brainstorm** (p. 4). To encourage students to generate original words you might organise students to work in pairs. Allow each pair to select a word for each letter from their list that they think no one else will have selected. If the pair generates an original word, allocate them with a point. The pair with the most points after you have gone through the lists can win a reward.

TASK 2: The search operators and an explanation of these can be found at
www.google.com.au/intl/en/help/refinesearch.html
You may wish to have students read through these before attempting this task. The idea of this task is for students to see that the number of sites returned is greatly reduced, and that these sites are now more relevant to the topic of coal and CO_2 emissions. You may also wish to have a discussion with students about logic operators and the importance they play in computer programming.
Extension: *Students can complete this activity using an alternate search engine and compare results.*

TASK 3: Students can do this in their books for you to collect or save to the computer for you to view later.
Extension: *To ensure that students understand the operators and how they work, you may want to restrict students to only viewing sites when they have reduced the number of sites returned to less than 25.*

What have they learnt?

Once the class has already demonstrated an understanding of coal-power and the effect it has on CO_2 emissions you may wish to refine the **A-Z Brainstorm** to words that revolve only around this topic and have students generate at least three words for each letter.

Notes and reflections

STUDENT WORKSHEET

The coal industry is promoting the idea of pumping CO_2 underground in order to take it out of the atmosphere. The process known as geosequestration—it means hiding in the earth—is simple in its approach: the industry would bury the carbon that it had dug up. p. 218

We Are the Weather Makers

Reaction to text

Create an **A-Z Brainstorm** that lists different words related to the topic of coal, and what you know about the effect that burning coal has on CO_2 emissions.

Tasks

1) Using your brainstorm list take five minutes to enter some of these individual words into Google to gather some basic information on the topic. As you use these words to search, note how many search results come back from Google.

It would take forever to search through all of these sites to gather information, and there is no guarantee that the information we require will be found on these sites. The google search operators allow us to refine our search by searching for exact sentences, searching for a group of words that relate to a particular topic, or searching for some words, and excluding others. The table below shows the symbols we need to use to do this.

‘ ’	Find the exact phrase contained in between the talking marks
+	With all of the words after each ‘+’ symbol
-	Without the word after the ‘-’ symbol
Or	With at lease one of the words after ‘or’

2) Use these operators to combine, or exclude words on your brainstorm list to find specific information about burning coal and CO_2 emissions.

3) Practice using your search techniques to find answers to the following questions. To ensure you get relevant sites returned for your search try and get your search results to fewer than 100 sites

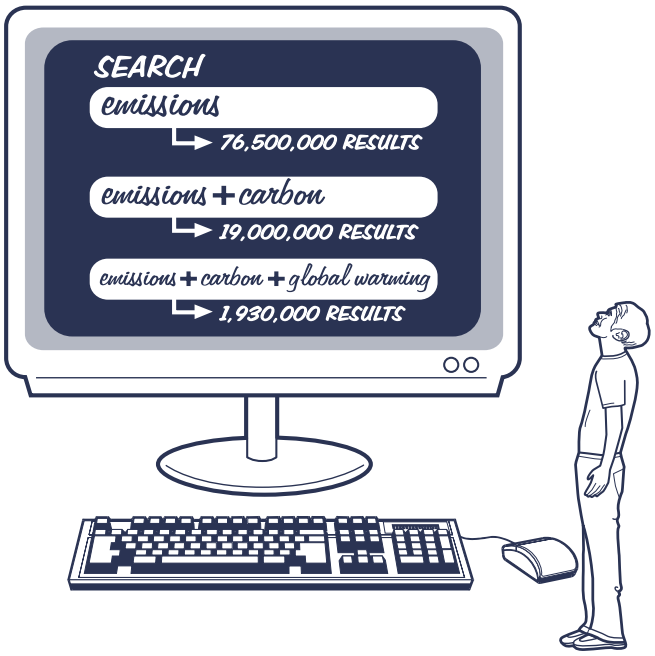
a) Describe the process of geosequestration

b) What is coal gasification?

c) What are some of the problems associated with geosequestration?

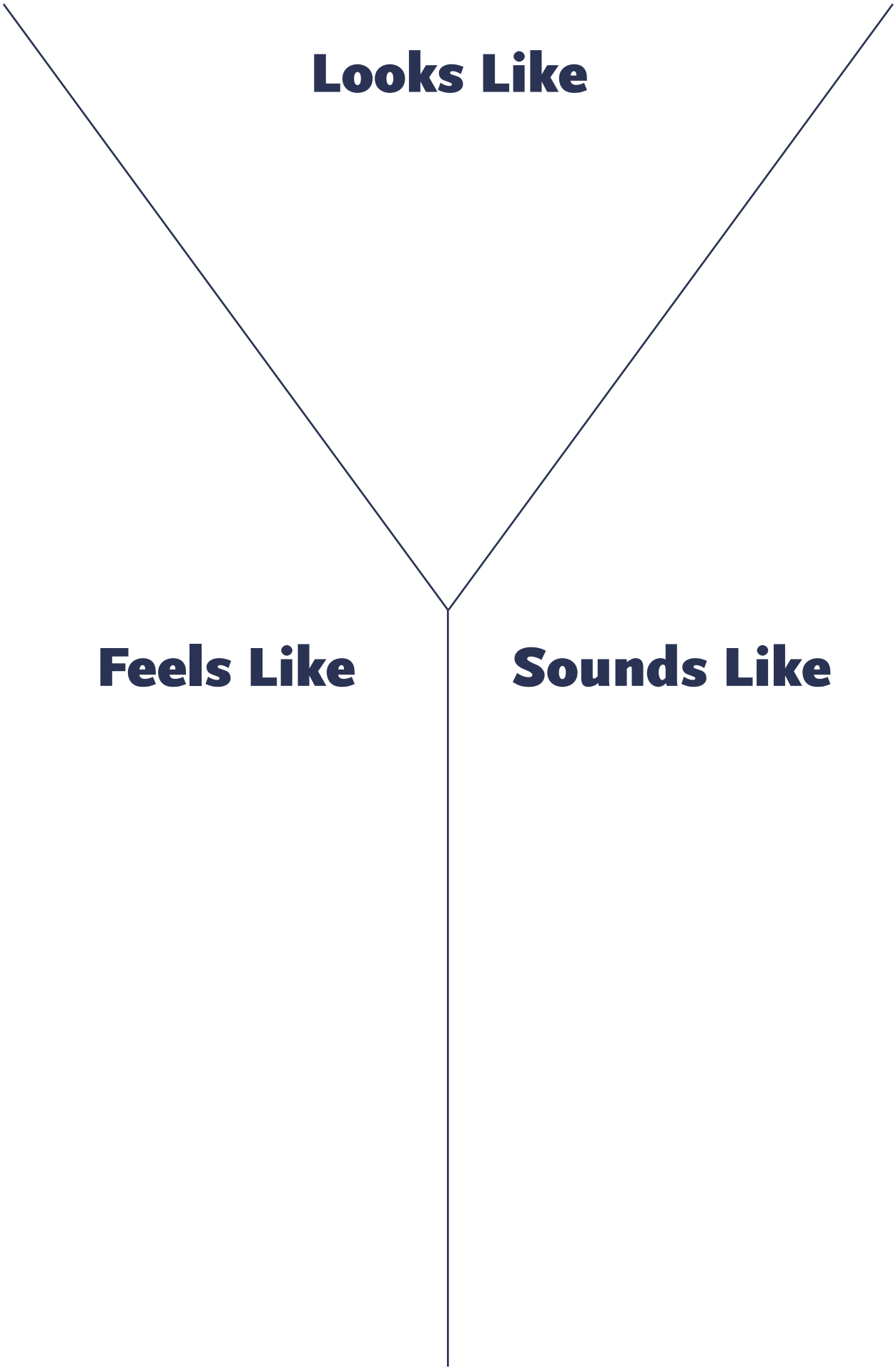
d) What advantages does the coal industry suggest are associated with geosequestration?

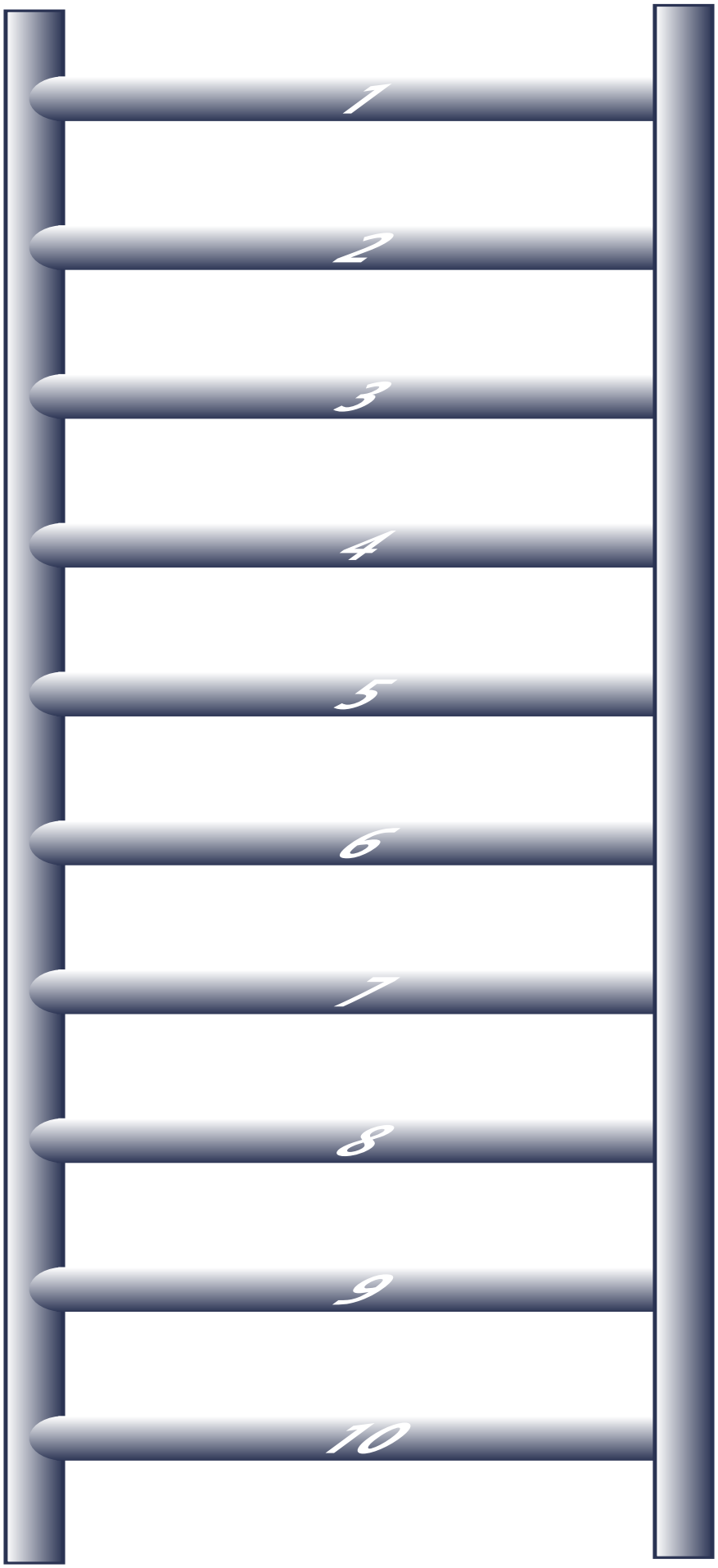
e) Research alternatives to geosequestration for the storage of carbon.



Plus	Minus	Interesting

Strengths	Weaknesses
Opportunities	**Threats**


Looks Like
Feels Like
Sounds Like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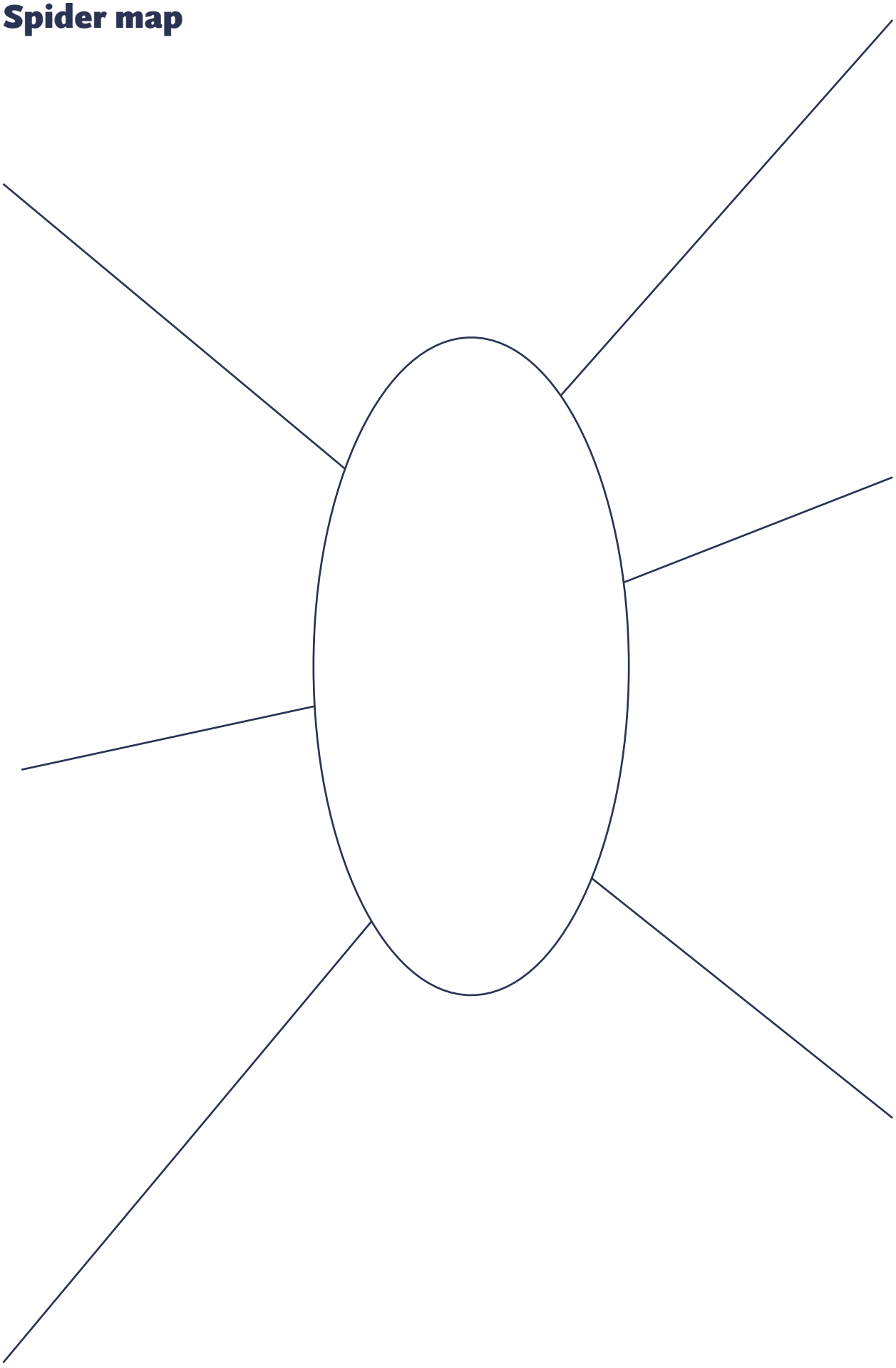
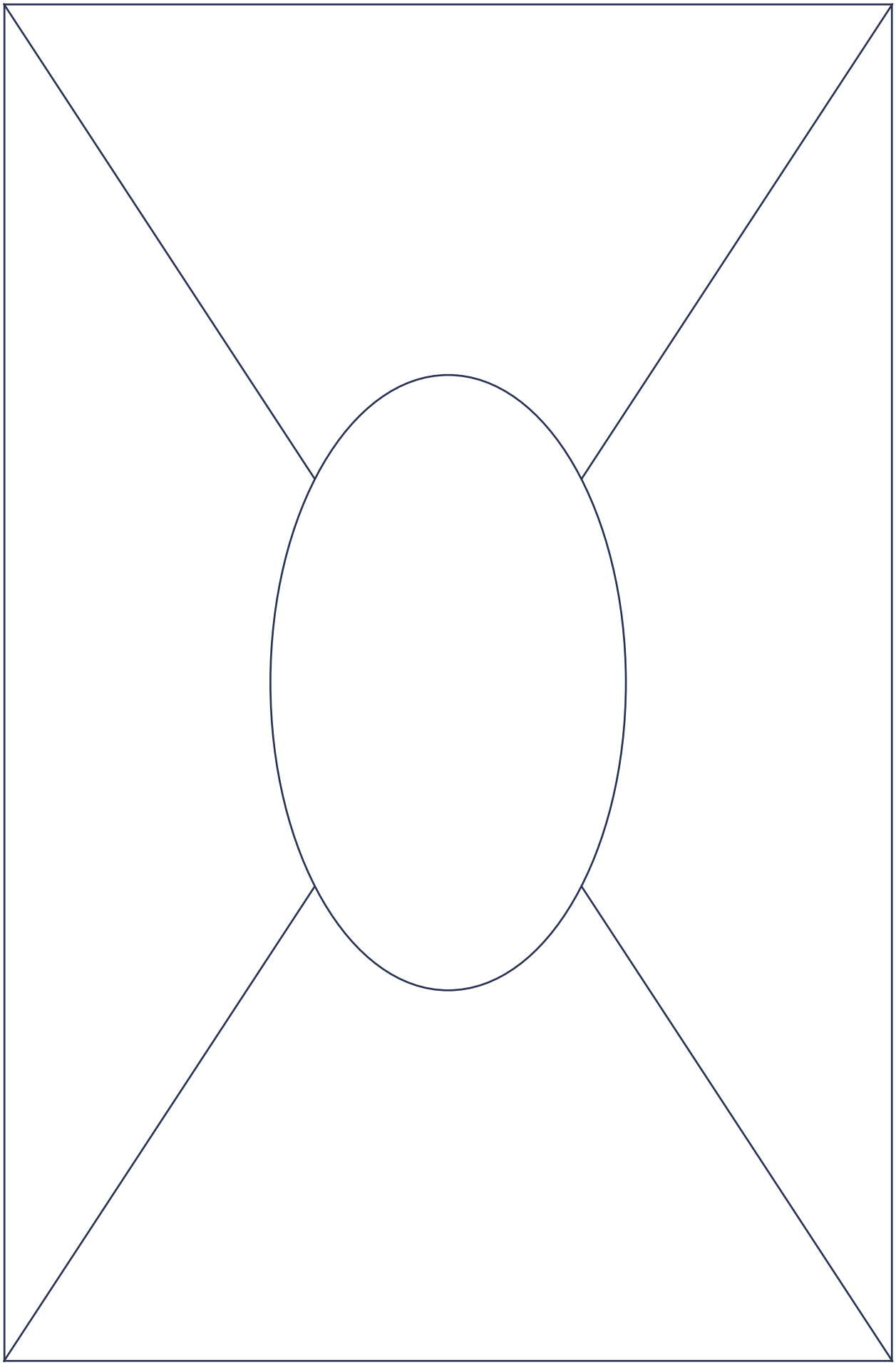
Cause	Effect

Spider map



	Event	Situation	Choice	Person	Reason	Means
Present	WHAT IS?	WHERE/ WHEN IS?	WHICH IS?	WHO IS?	WHY IS?	HOW IS?
Past	WHAT DID?	WHERE/ WHEN DID?	WHICH DID?	WHO DID?	WHY DID?	HOW DID?
Possibility	WHAT CAN?	WHERE / WHEN CAN?	WHICH CAN?	WHO CAN?	WHY CAN?	HOW CAN?
Probability	WHAT WOULD?	WHERE / WHEN WOULD?	WHICH WOULD?	WHO WOULD?	WHY WOULD?	HOW WOULD?
Prediction	WHAT WILL?	WHERE / WHEN WILL?	WHICH WILL?	WHO WILL?	WHY WILL?	HOW WILL?
Imagination	WHAT MIGHT?	WHERE / WHEN MIGHT?	WHICH MIGHT?	WHO MIGHT?	WHY MIGHT?	HOW MIGHT?



SUBJECT

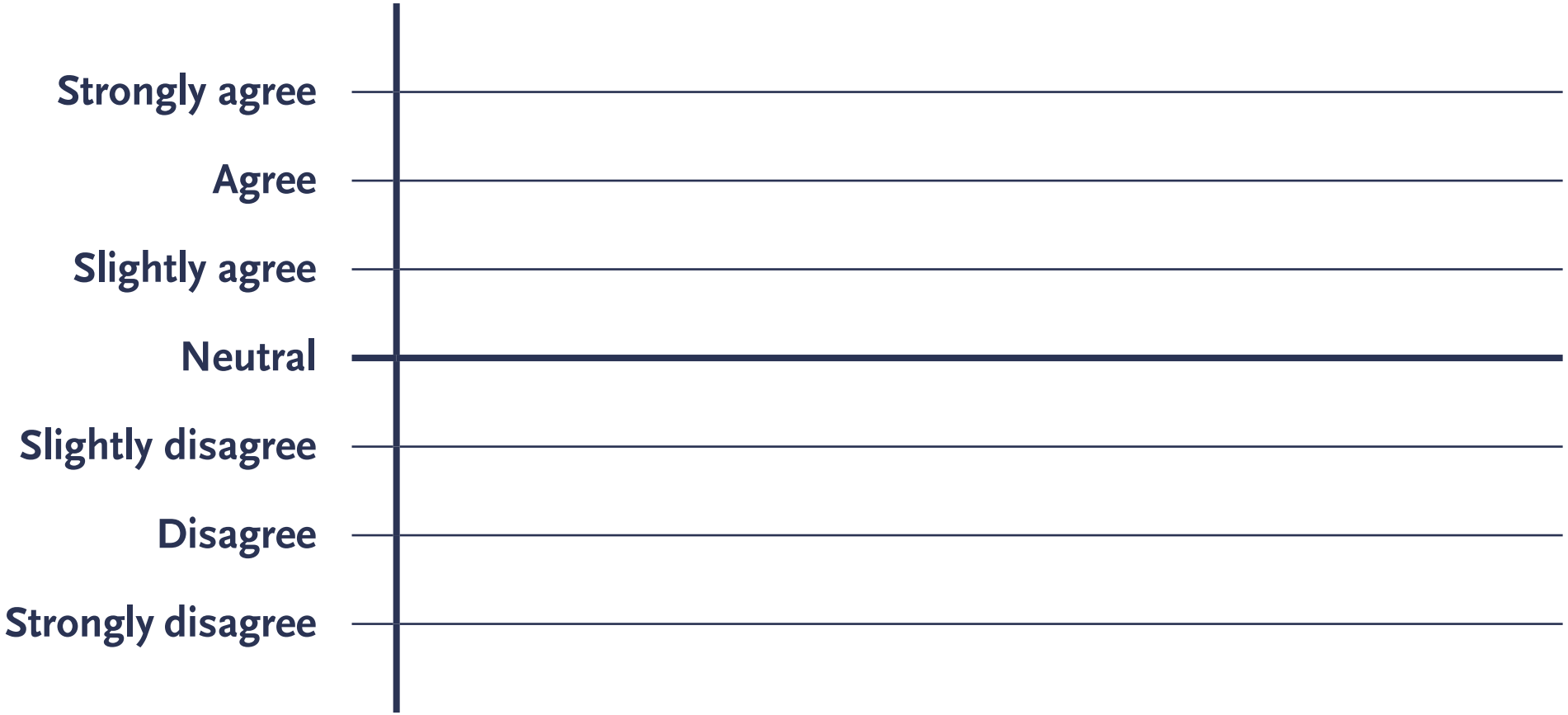
Differences

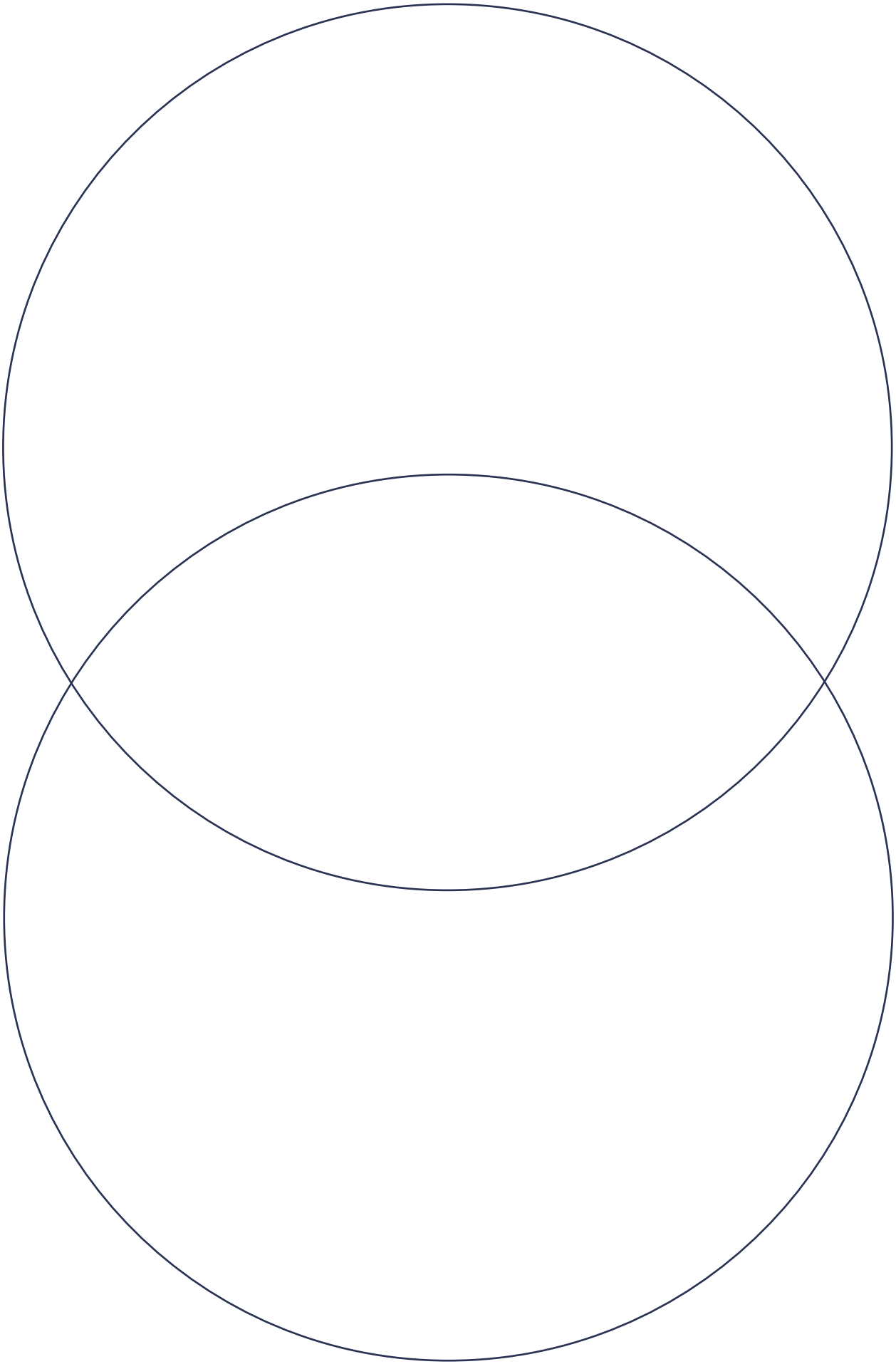
Similarities

Differences

SUBJECT

Worm evaluation





What do I **K**now?	What do I **W**ant to know?	What have I **L**earnt?