

SAMPLE RESPONSES



Climate change

This booklet is designed to help teachers make overall, on-balance judgments by providing examples of student responses. The responses are not an exhaustive set.

A samples

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A sample: Response 1

Guide to making judgments — Year 9 Science

Student

Purpose: To use evidence and scientific argument to draw conclusions and to inform an opinion about climate change and its effects.

Investigating	Knowledge and understanding	Investigating	Communicating
Draws conclusions and makes predictions consistent with data and evidence. Questions 1, 2, 3, 4, 5, 11, 13	Uses equations and diagrams to describe and explain chemical changes and energy transformations. Questions 8, 9, 10, 12	Uses data, evidence and scientific argument to evaluate and propose hypotheses and to inform an opinion. Questions 6, 7, 14, 15	Uses scientific terminology in conclusions, predictions and arguments. Uses appropriate formats in chemical equations and energy diagrams. Questions 1–15

Consistently and accurately interprets data and evidence to justify valid conclusions and predictions.

Writes chemical formulas with correct ratios and balances chemical equations. Energy diagrams correctly identify all energy forms and illustrate

Provides accurate and insightful scientific arguments, considering all data and evidence.

Displays fluency in the use of scientific terminology when drawing conclusions, making predictions and constructing arguments.

Investigating

Consistently and accurately interpreted data and evidence when making predictions and drawing conclusions. Minor misinterpretation of graphical timescale — “rapid warming” — in responses to Questions 3, 4, 5.

Knowledge and understanding

Used correct word equations and balanced chemical equations to explain combustion of carbon and methane. Accurately illustrated energy forms and energy changes but did not indicate relative amounts of energy transferred or waste heat in solar hot water diagram.

Investigating

Made valid interpretations of evidence to evaluate and propose hypotheses. Considered all data and evidence to provide a reasoned scientific argument about climate change and its effects, though some statements were not directly referenced to evidence.

Communicating

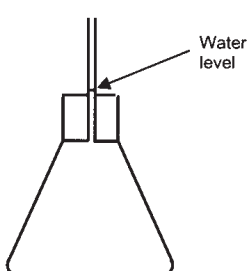
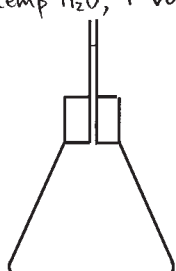
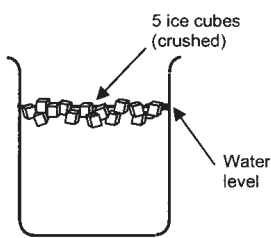
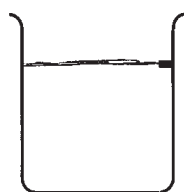
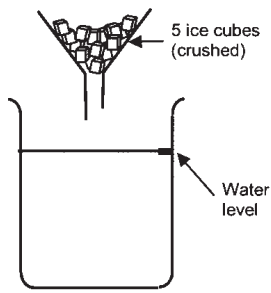
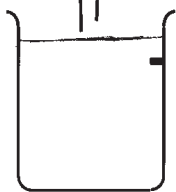
Used scientific terminology accurately when drawing conclusions and constructing an argument. Used accepted formats when writing chemical equations. Energy diagrams clearly drawn and fully labelled.

Overall grade
As this response demonstrates a very high level of Knowledge and understanding, Investigating and Communicating, it is judged to be an overall A.

A sample: Response 1

Recording sheet

Modelling the effect of global warming on sea levels

		Observations Draw the water level after warming or melting
Experiment 1: Warming of the oceans Modelled by warming water in a flask.	Before warming 	After warming ↑ temp H_2O , ↑ volume 
Experiment 2: Warming of floating sea ice Modelled by melting ice floating in a beaker of water.	Before warming 	After warming water level unchanged 
Experiment 3: Warming of ice on land Modelled by melting ice above a beaker of water.	Before warming 	After warming water level ↑ 

A sample: Response 1

Section 1: Interpreting evidence

1. Use your recorded observations from *Modelling the effect of global warming on sea levels* to complete Table 1.

Table 1

Global warming event	Effect on sea level (circle your prediction)	Use the observations from the modelling experiments to support your prediction.
Warming of <u>water</u> in the oceans <ul style="list-style-type: none"> The oceans cover about two thirds of the Earth's surface. 	<div>rise</div> <div>fall</div> <div>no effect</div>	<p>It was shown in the experiment that when the water was heated the water level rose. Therefore when sea water is heated, it will cause the sea level to rise.</p>
Warming of <u>ice</u> in the Arctic Ocean <p>The Arctic ocean is</p> <ul style="list-style-type: none"> about twice the size of Australia mostly covered by floating ice about 3 metres thick. 	<div>rise</div> <div>fall</div> <div>no effect</div>	<p>The melting ice in the experiment did not change the water level. Therefore sea level should not change if the ice from the arctic melted.</p>
Warming of <u>ice</u> in Antarctica <p>The continent of Antarctica is</p> <ul style="list-style-type: none"> about twice the size of Australia covered with a layer of ice about 2 kilometres thick. 	<div>rise</div> <div>fall</div> <div>no effect</div>	<p>The experiment shows that melting ice above the beaker caused the water level to rise. As ice in Antarctica is mostly on land, the warming of ice in Antarctica will cause the sea level to rise.</p>

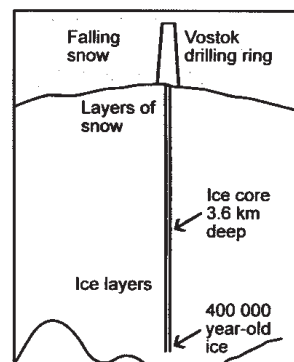
A sample: Response 1

Use the evidence below to answer questions 2 to 5.

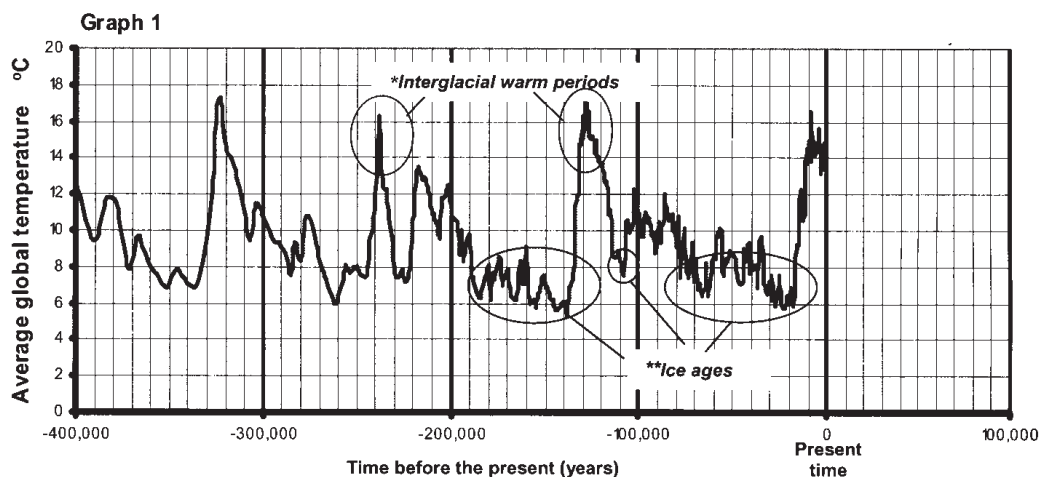
In 1995, scientists at Vostok Station in Antarctica drilled down 3.6 kilometres and retrieved ice cores containing air bubbles which have become trapped in snow over the past 400 000 years.

By analysing the air in the bubbles, scientists were able to calculate the [†]**average global temperature** over the past 400 000 years.

[†]**average global temperature** is the mean temperature of the air at the Earth's surface



Graph 1 shows the results of this investigation.



****Ice ages** refer to times when the polar ice caps expanded and much of the northern hemisphere was covered in ice.

***Interglacial warm periods** are warm times between ice ages

2. Describe how the average global temperature has varied over the past 400 000 years.

The average global temperature has varied greatly in the past 400 000 years. The fluctuation show ice-ages, where the average global temperature was low, and spikes of interglacial warm periods. Each ice age is closely followed by a interglacial warm period.

A sample: Response 1

3. Use any patterns in the graph to predict how the temperature might change in the next 20 000 years. Explain.

According to the graph, the average global temperature during interglacial warm periods rised and peaked in approximately 10 000 years. This is then followed by a rapid decline in temperature. If the pattern continues, the global temperature is likely to decrease in the following 20 000 years.

4. Describe how sea levels may have changed over the past 20 000 years. In your answer, refer to Graph 1 and your answers to question 1.

During the past 20 000 years, the average global temperature increased rapidly. According to the experiment, any increase in water temperature will cause the sea level to rise. Therefore the sea level should have risen in the past 20 000 years.

Aboriginal stories record that the Moreton Bay islands were once part of the mainland, but long ago, water filled all the low areas, separating Stradbroke, Moreton and the other islands from the mainland.

5. Archaeological evidence shows that Aboriginal people have lived in Australia for over 50 000 years. Does the evidence from Graph 1 and the modelling experiments support these Aboriginal stories? Explain.

The evidence does support the Aboriginal stories. Aboriginals have inhabited Australia since the middle of the ice age. They would have experienced a rapid warming making the sea level rise and possibly cutting of the Moreton Bay Islands from the mainland.

A sample: Response 1

6. Does the evidence presented in Graphs 2 and 3 support the following hypothesis? Explain.

"The Earth is becoming warmer due to increased amounts of carbon dioxide in the atmosphere"

The evidence does support the hypothesis. The CO_2 levels have been steadily increasing while the temperature is fluctuating, but still increasing. However, from the two graphs, we can not know whether it is the CO_2 causing the temperature to rise, as it does not state the CO_2 caused a change in temperature. It may just be a coincidence.

7. Offer a different hypothesis to explain the evidence presented in Graph 2 and Graph 3.

"The increase in average global temperature is causing the amount of CO_2 in the atmosphere to increase".
The increased temperature is causing the CO_2 which is dissolved in the ocean (as CO_2 is soluble in water) to escape into the atmosphere (as liquid temperature increases, the amount of gas it can dissolve decreases).

A sample: Response 1

Section 2: Applying knowledge to form an opinion

Since the Industrial Revolution of the 1800s, human activity has been contributing significant amounts of CO₂ into the atmosphere.

For example, heating water for use in homes can produce CO₂.

Most people in Australia choose to use electric, gas or solar hot water systems.

Use the information given below to answer questions 8 to 14.

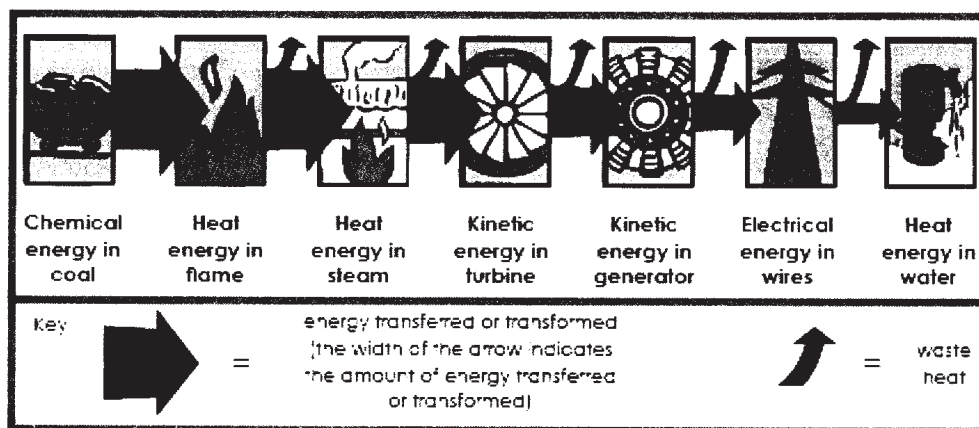
Electric hot water systems

Most of Australia's electricity is generated by burning coal (carbon) which combines with oxygen from the air, producing carbon dioxide.

The heat from burning coal boils water, producing steam to drive turbine-powered generators which produce electricity (electrical energy). Electrical energy is transmitted in wires to the electric hot water system in our homes. The electric element in the hot water system heats the water.

Energy Diagram 1 shows the energy changes that occur when electricity from a coal-fired power station is used to heat water in an electric hot water system at home.

Energy diagram 1: An electric hot-water system



8. Write a word equation for the burning of coal (carbon).

Coal (Carbon) + Oxygen → Carbon dioxide

Use chemical symbols to write a balanced equation for the burning of coal.

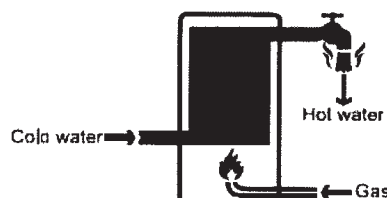
C + O₂ → CO₂

A sample: Response 1

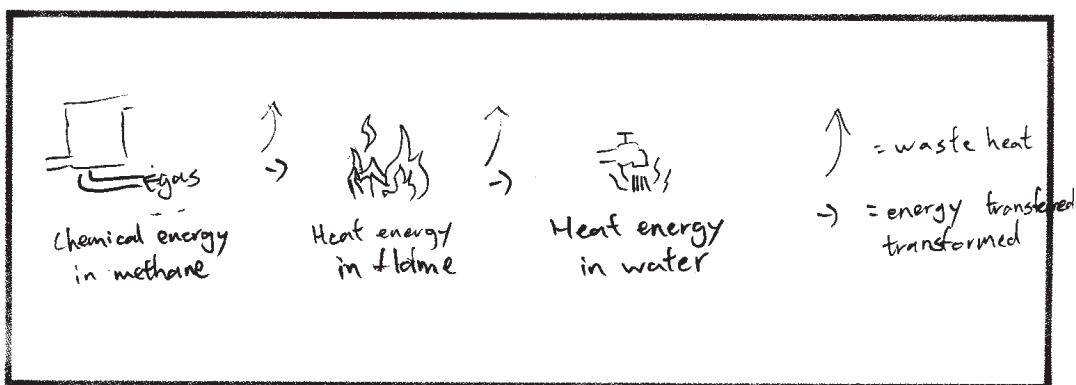
Gas hot water systems

A gas hot water system heats water by burning gas.

The gas used in a gas hot water system is mostly methane (CH_4). Methane burns by combining with oxygen to produce carbon dioxide and water.



9. Draw a labelled energy diagram below (similar to Energy diagram 1 on page 12) to show the energy changes that occur in a gas hot water system.



10. Write a word equation for the burning of methane.

Methane + Oxygen \rightarrow Carbon dioxide + Water

Use chemical symbols to write a balanced equation for the burning of methane.

$\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$

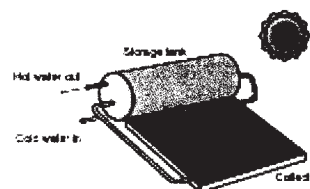
11. Does using a gas hot water system produce more or less CO_2 than using an electric hot water system? Explain by referring to the energy diagrams.

Using gas hot water systems produce less CO_2 than using electric hot water systems. This is because during each transformation / transfer of energy, there is a loss of heat. The more steps there are, the more energy source needs to be used, producing more CO_2 .

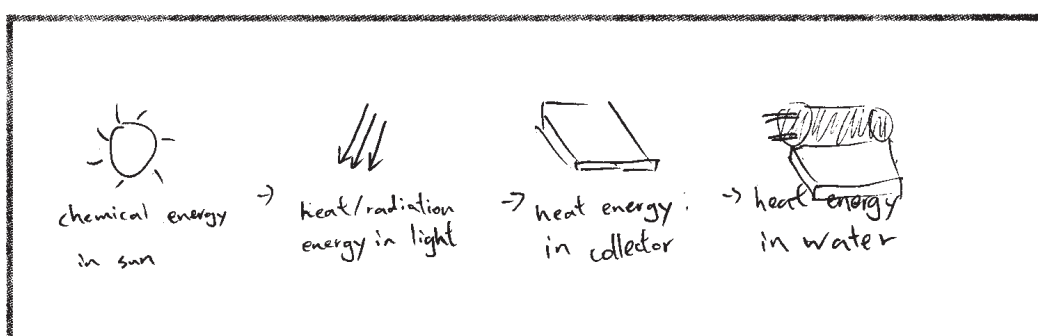
A sample: Response 1

Solar hot water systems

A solar hot water system heats water by absorbing heat from the sun



12. Draw a labelled energy diagram for a solar hot water system.



13. Does using a solar hot water system emit CO_2 ? Explain.

Using a solar hot water system does not emit CO_2 . This is because that in no process does solar hot water combine carbon and oxygen to form CO_2 .

14. Do your answers to questions 8 to 13 support the following hypothesis? Explain.

"Our energy choices can affect the amount of CO_2 released into the atmosphere."

It does support the hypothesis. The three energy choices all emit different amounts of CO_2 , with coal/electricity emitting the most followed by methane then solar (with none). Therefore our energy choices does affect the amount of CO_2 emitted.

A sample: Response 1

"Global temperature changes occur naturally, so there's nothing we can do about it. Anyway, there's no problem being a few degrees warmer."

15. What is your opinion of the statement above?

agree

disagree

partially agree

(circle one)

Justify your opinion by referring to:

- historic and recent temperature and CO₂ data in questions 2 to 8
- information about energy choices in questions 9 to 13
- your predictions from the model in question 1

Global temperature changes do occur naturally. However, as shown in graph 2 and graph 3, the amount of CO₂ in the atmosphere may cause global temperatures to rise. Therefore, if humans choose energy ^{sources} which do not produce as much CO₂, it may reduce the rise in temperature. Since the ocean covers ~ 66% of the earth and Antarctica which is 2x the size of Australia with 2km thick ice covering - a small increase in temperature may cause the sea level to rise significantly and flood coastal cities.

A sample: Response 2

Guide to making judgments — Year 9 Science

Student

Purpose: To use evidence and scientific argument to draw conclusions and to inform an opinion about climate change and its effects.

Investigating	Knowledge and understanding	Investigating	Communicating
Draws conclusions and makes predictions consistent with data and evidence. Questions 1, 2, 3, 4, 5, 11, 13	Uses equations and diagrams to describe and explain chemical changes and energy transformations. Questions 8, 9, 10, 12	Uses data, evidence and scientific argument to evaluate and propose hypotheses and to inform an opinion. Questions 6, 7, 14, 15	Uses scientific terminology in conclusions, predictions and arguments. Uses appropriate formats in chemical equations and energy diagrams. Questions 1–15

Consistently and accurately interprets data and evidence to justify valid conclusions and predictions.

Writes chemical formulas with correct ratios and balances chemical equations. Energy diagrams correctly identify all energy forms and illustrate all transfers and transformations.

Provides accurate and insightful scientific arguments, considering all data and evidence.

Displays fluency in the use of scientific terminology when drawing conclusions, making predictions and constructing arguments.

A

Investigating

Interpreted data and evidence to make accurate predictions and justify valid conclusions, though Questions 3 and 11 lacked detail.

Knowledge and understanding

Used correct word equations and balanced chemical equations to explain combustion of carbon and methane. Energy diagrams correctly identified energy forms but included an unnecessary transfer and did not identify all waste heat.

Investigating

Made valid interpretations of evidence to evaluate and propose hypotheses, though the response to Question 14 lacked detail. Considered all data and evidence to provide a reasoned scientific argument about climate change and its effects.

Communicating

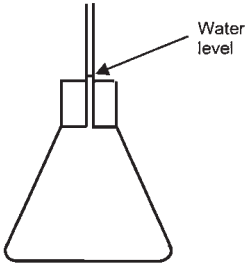
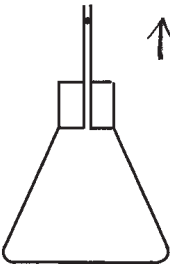
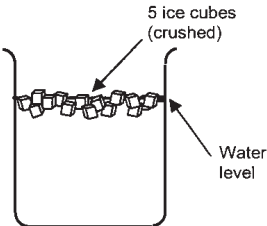
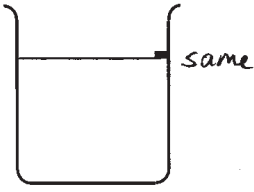
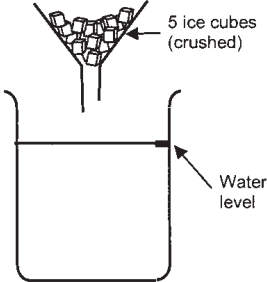
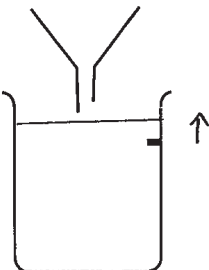
Used scientific terminology accurately when drawing conclusions and constructing an argument. Used accepted formats when writing chemical equations. Energy diagrams clearly drawn and fully labelled.

Overall grade
As this response demonstrates a very high level of Knowledge and understanding, Investigating and Communicating, it is judged to be an overall A.

A sample: Response 2

Recording sheet

Modelling the effect of global warming on sea levels

		Observations Draw the water level after warming or melting
Experiment 1: Warming of the oceans Modelled by warming water in a flask.	Before warming 	After warming 
Experiment 2: Warming of floating sea ice Modelled by melting ice floating in a beaker of water.	Before warming 	After warming 
Experiment 3: Warming of ice on land Modelled by melting ice above a beaker of water.	Before warming 	After warming 

A sample: Response 2

Section 1: Interpreting evidence

1. Use your recorded observations from *Modelling the effect of global warming on sea levels* to complete Table 1.

Table 1

Global warming event	Effect on sea level (circle your prediction)	Use the observations from the modelling experiments to support your prediction.
Warming of water in the oceans <ul style="list-style-type: none"> The oceans cover about two thirds of the Earth's surface. 	<div>rise</div> <div>fall</div> <div>no effect</div>	<p>According to the experiment, the water in the flask rose when warmed. Therefore I predict that the water in the ocean will also rise when warmed.</p>
Warming of ice in the Arctic Ocean <p>The Arctic ocean is</p> <ul style="list-style-type: none"> about twice the size of Australia mostly covered by floating ice about 3 metres thick. 	<div>rise</div> <div>fall</div> <div>no effect</div>	<p>In the experiment, when melting ice floating in a beaker of water, it had no effect to the water level. Therefore I predict that the warming of ice in the Arctic ocean will also have no effect towards the sea level.</p>
Warming of ice in Antarctica <p>The continent of Antarctica is</p> <ul style="list-style-type: none"> about twice the size of Australia covered with a layer of ice about 2 kilometres thick. 	<div>rise</div> <div>fall</div> <div>no effect</div>	<p>When melting ice in a beaker of water, it made the water level rise. Therefore I predict that the warming of ice on land will also make the water level rise.</p>

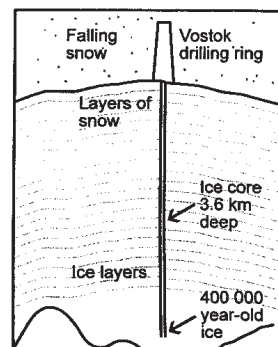
A sample: Response 2

Use the evidence below to answer questions 2 to 5.

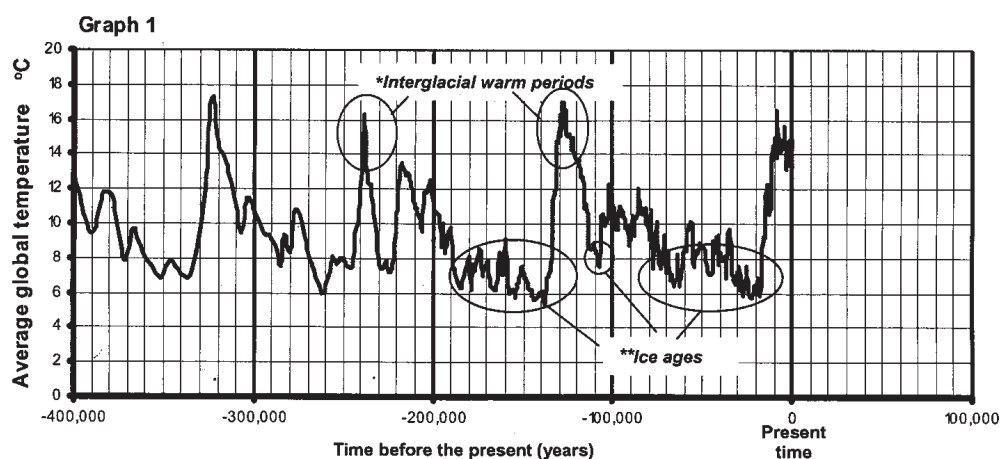
In 1995, scientists at Vostok Station in Antarctica drilled down 3.6 kilometres and retrieved ice cores containing air bubbles which have become trapped in snow over the past 400 000 years.

By analysing the air in the bubbles, scientists were able to calculate the [†]average global temperature over the past 400 000 years.

[†]average global temperature is the mean temperature of the air at the Earth's surface



Graph 1 shows the results of this investigation.



****Ice ages** refer to times when the polar ice caps expanded and much of the northern hemisphere was covered in ice.
***Interglacial warm periods** are warm times between ice ages

2. Describe how the average global temperature has varied over the past 400 000 years.

the average temperature fluctuates in a fairly consistent pattern, peaking at ~~around~~ between 16-18°C roughly every 100,000 years, however in more recent times, in the period between peaks, seems to have more variance and the changes in temp occur much more rapidly.

A sample: Response 2

3. Use any patterns in the graph to predict how the temperature might change in the next 20 000 years. Explain.

As previously seen in the graph, the average temperature should begin to decline over the next 20 000 years to around 12°C .

4. Describe how sea levels may have changed over the past 20 000 years. In your answer, refer to Graph 1 and your answers to question 1.

The sea levels would most likely have begun to rise as the temperature rises too (results show the warming of the water affects causes the water level to rise).

Aboriginal stories record that the Moreton Bay islands were once part of the mainland, but long ago, water filled all the low areas, separating Stradbroke, Moreton and the other islands from the mainland.

5. Archaeological evidence shows that Aboriginal people have lived in Australia for over 50 000 years. Does the evidence from Graph 1 and the modelling experiments support these Aboriginal stories? Explain.

Yes, 50 000 years ago, the world was in an 'ice age'. As global temperatures began to rise, the ocean would have followed, causing it to flood the lower areas surrounding the Moreton Bay.

A sample: Response 2

6. Does the evidence presented in Graphs 2 and 3 support the following hypothesis? Explain.

"The Earth is becoming warmer due to increased amounts of carbon dioxide in the atmosphere"

the results shown in the graphs certainly seem to support the hypothesis. ^{However, while} ~~the~~ the rate of CO₂ seems to increase fairly consistently, the temperature varies slightly more. however there is still a noticeable increase, especially between 1960 & 1990. the amount of CO₂ does not appear to have a totally direct relationship with the temperature.

7. Offer a different hypothesis to explain the evidence presented in Graph 2 and Graph 3.

The amount of carbon dioxide in the atmosphere increases as the temperature rises.

A sample: Response 2

Section 2: Applying knowledge to form an opinion

Since the Industrial Revolution of the 1800s, human activity has been contributing significant amounts of CO₂ into the atmosphere.

For example, heating water for use in homes can produce CO₂.

Most people in Australia choose to use electric, gas or solar hot water systems.

Use the information given below to answer questions 8 to 14.

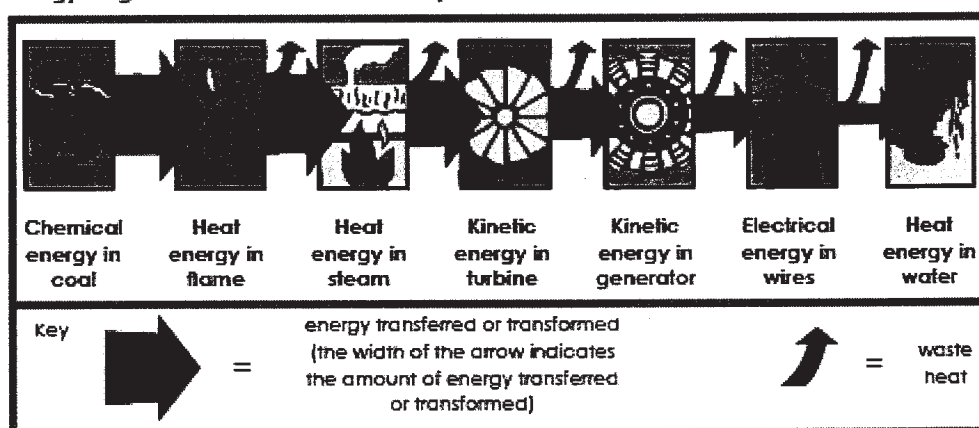
Electric hot water systems

Most of Australia's electricity is generated by burning coal (carbon) which combines with oxygen from the air, producing carbon dioxide.

The heat from burning coal boils water, producing steam to drive turbine-powered generators which produce electricity (electrical energy). Electrical energy is transmitted in wires to the electric hot water system in our homes. The electric element in the hot water system heats the water.

Energy Diagram 1 shows the energy changes that occur when electricity from a coal-fired power station is used to heat water in an electric hot water system at home.

Energy diagram 1: An electric hot-water system



8. Write a word equation for the burning of coal (carbon).

coal (carbon) + oxygen → carbon dioxide

Use chemical symbols to write a balanced equation for the burning of coal.

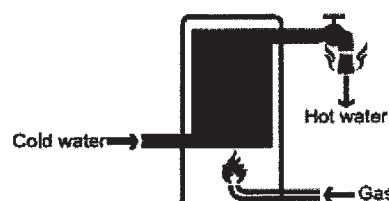
$C + O_2 \rightarrow CO_2$

A sample: Response 2

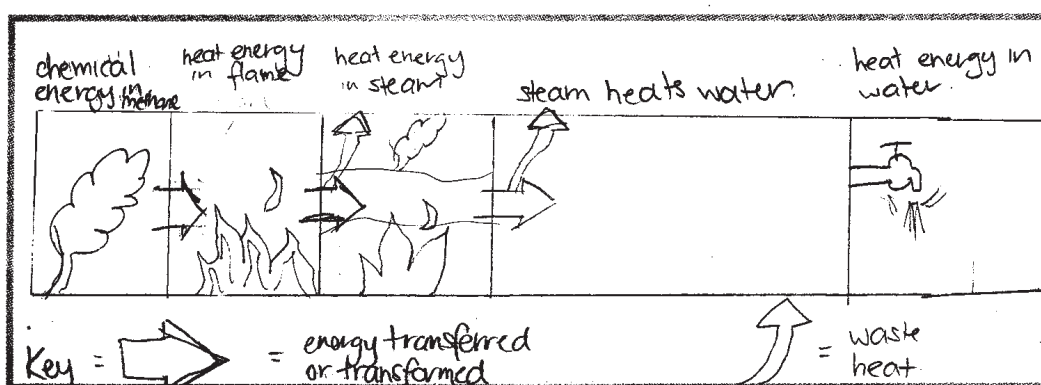
Gas hot water systems

A gas hot water system heats water by burning gas.

The gas used in a gas hot water system is mostly methane (CH_4). Methane burns by combining with oxygen to produce carbon dioxide and water.



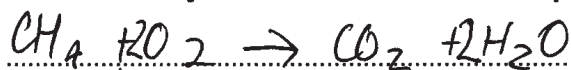
9. Draw a labelled energy diagram below (similar to Energy diagram 1 on page 12) to show the energy changes that occur in a gas hot water system.



10. Write a word equation for the burning of methane.

methane + oxygen → carbon dioxide + water

Use chemical symbols to write a balanced equation for the burning of methane.



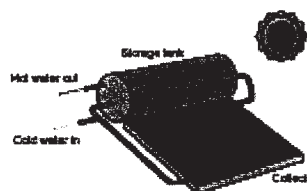
11. Does using a gas hot water system produce more or less CO_2 than using an electric hot water system? Explain by referring to the energy diagrams.

Using the gas hot water system produces less CO_2 than using an electric hot water system because it gives off less waste heat during the process of heating water. Therefore letting off less CO_2 into the atmosphere.

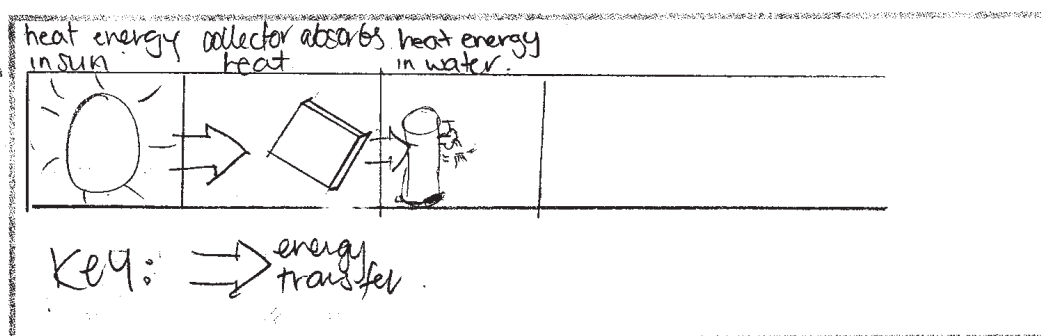
A sample: Response 2

Solar hot water systems

A solar hot water system heats water by absorbing heat from the sun



12. Draw a labelled energy diagram for a solar hot water system.



13. Does using a solar hot water system emit CO_2 ? Explain.

a solar hot water system does not emit CO_2 as no chemical reactions occur to emit CO_2 . the sun simply heats up the water, and does not burn with anything.

14. Do your answers to questions 8 to 13 support the following hypothesis? Explain.

"Our energy choices can affect the amount of CO_2 released into the atmosphere."

yes. the energy diagrams show that different forms of hot water systems can make a huge difference to the amount of CO_2 emitted.

A sample: Response 2

"Global temperature changes occur naturally, so there's nothing we can do about it. Anyway, there's no problem being a few degrees warmer."

15. What is your opinion of the statement above?

agree

disagree

partially agree

(circle one)

Justify your opinion by referring to:

- historic and recent temperature and CO₂ data in questions 2 to 8
- information about energy choices in questions 9 to 13
- your predictions from the model in question 1

I partially agree with the statement as global temperature changes do occur naturally as shown by the historic and recent temperature data. Yet the data about the average global temperature and amount of carbon dioxide in the atmosphere supports the hypothesis that the Earth is becoming warmer due to the increased amounts of carbon dioxide in the atmosphere. The information about energy choices concludes that our energy choices can affect the amount of CO₂ released into the atmosphere. This proves that the part of the statement which states that there is nothing we can do about it is wrong. If this continues, the water level in the ocean will rise.