

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.

B samples

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B 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 all transfers and transformations, including waste heat. | Provides accurate and insightful scientific arguments, considering all data and evidence. Supports the evaluation and proposal of hypotheses with valid interpretations of evidence. Gives reasoned evidence about the validity of hypotheses. | Displays fluency in the use of scientific terminology when drawing conclusions, making predictions and constructing arguments. Uses accepted formats when constructing formulas for chemical compounds and when writing and constructing arguments. |
| A | B | C | D |

Overall grade

Although this response demonstrates a very high level of achievement in drawing conclusions and making predictions, the high level of achievement and in Knowledge and understanding, Communicating, and using evidence and scientific argument suggest an on-balance judgment of an overall B.

Investigating

Consistently and accurately interpreted data and evidence when making predictions and drawing conclusions.

Knowledge and understanding

Word equations did not correctly identify reactants and products but made use of balanced chemical equations to explain combustion of carbon and methane. Energy diagrams illustrated energy forms and transfers/transformations, including waste heat.

Investigating

Made valid interpretations of evidence to evaluate hypotheses, but did not offer a clear alternative hypothesis in Question 7. Considered and referred to all valid evidence to provide a scientific argument about climate change and its effects.

Communicating

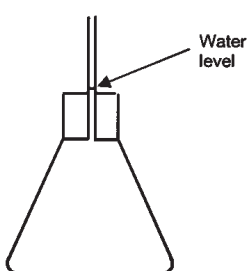
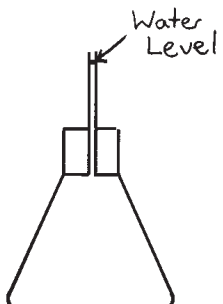
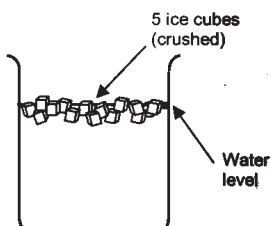
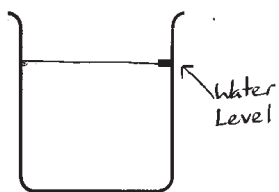
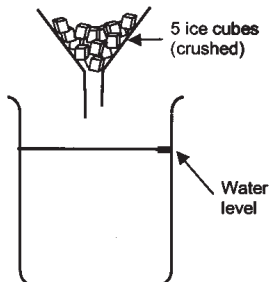
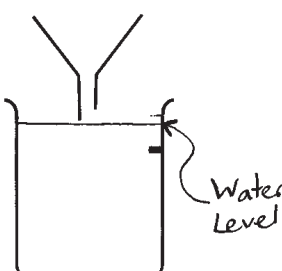
Used scientific terminology accurately when drawing conclusions and constructing an argument. Used accepted formats when writing formulas and equations, but not when balancing equations. Energy diagrams are clearly drawn and fully labelled.

Feedback

B 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  |
| 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  |

B 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>- In experiment 1, water level rose when the water was heated.</p> <p>- Something similar should happen to oceans.</p> <p>- Since there's so much ocean, even a small change in temp. would alter sea levels.</p> |
| Warming of <u>ice</u> in the Arctic Ocean The Arctic ocean is <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 experiment 2, floating ice melting had no effect on water levels.</p> <p>- Floating ice in the Arctic should have no effect on sea levels.</p> |
| Warming of <u>ice</u> in Antarctica The continent of Antarctica is <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>- In experiment 3, land ice was shown to increase water levels dramatically.</p> <p>- Ice in Antarctica should have similar effect.</p> <p>- Since the amount of ice in Antarctica is large, melting would dramatically alter sea levels.</p> |

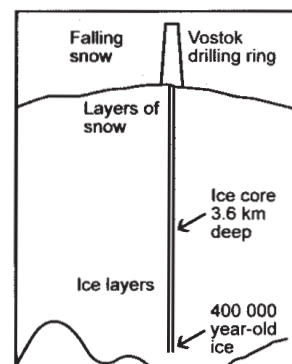
B sample: Response 1

Use the evidence below to answer questions 2 to 5.

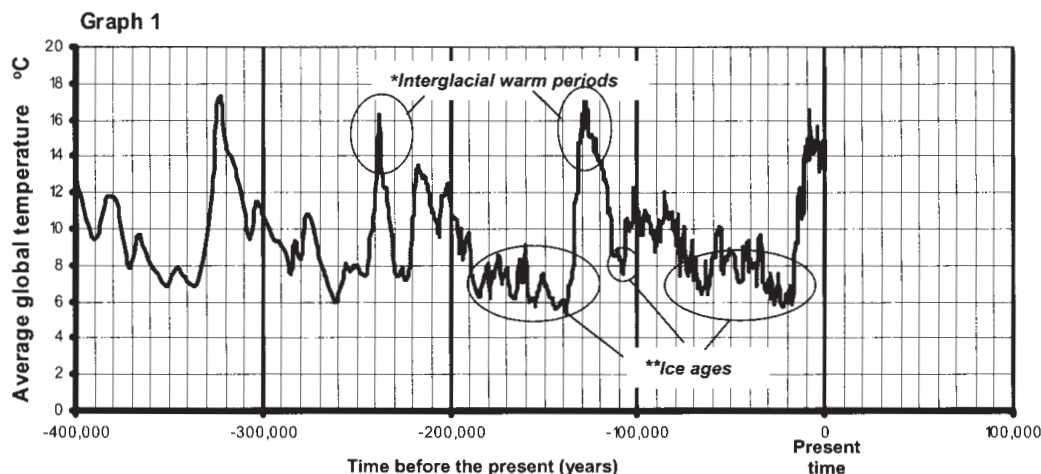
In 1995, scientists at Vostok Station in Antarctica drilled down 3.6 kilometres and retrieved ice cores containing air bubbles which have become trapped in snow over the past 400 000 years.

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.

Over the last 400 000 years, global temperature has risen and fallen by as much as 10°C . Usually, a 50 000 year long ice age is followed by a rapid spike in temperature for about 10 000 years then slowly returns to an ice age.

B sample: Response 1

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

I think the (like in the other interglacial warm periods) the temperature will drop again within 10 000 years and possibly go into an ice age.

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.

In question 1 I answered that rises in temperature will create an overall increase in water levels. Graph 1 shows that in the past 20 000 years global temperature has risen dramatically. This means that sea levels would have risen with the temperature.

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. When Aboriginals were living here 50 000 years ago, the temperature was far lower than it is today, so the sea levels would been lower too. While they were like this for about 30 000 years, the Moreton Bay islands would have been connected to the mainland.

B 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"

Yes. The average global temperature and CO₂ has been rising for the last 100 or so years. Both are rising so that suggests that there is a connection between the two. Also, in the 1940's the CO₂ in the atmosphere stopped rising. In the same year, global temperature dropped by 0.4°C. Then as CO₂ levels started rising again, so did the global temperature.

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

Just because CO₂ levels and global temperature are rising together, it doesn't mean the cause of the temperature increase is caused by CO₂. The graphs show that global temperature fluctuates without any change in CO₂ levels. This means there are probably other factors effecting climate change.

B 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 CO_2 into the atmosphere.

For example, heating water for use in homes can produce CO_2 .

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.

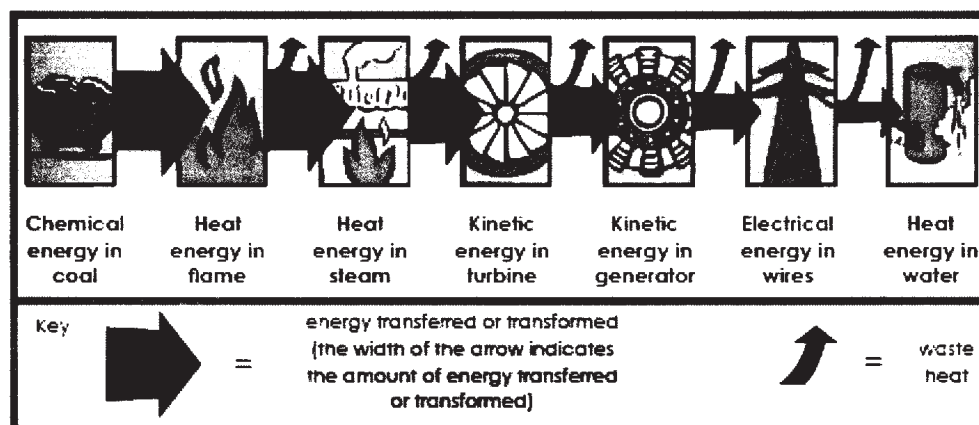
Electric hot water systems

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 + fire \Rightarrow heat + kinetic energy \Rightarrow heat + electric energy

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

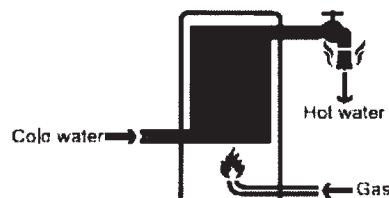
$\text{C} + \text{O}_2 \Rightarrow \text{CO}_2 (\text{gas})$

B sample: Response 1

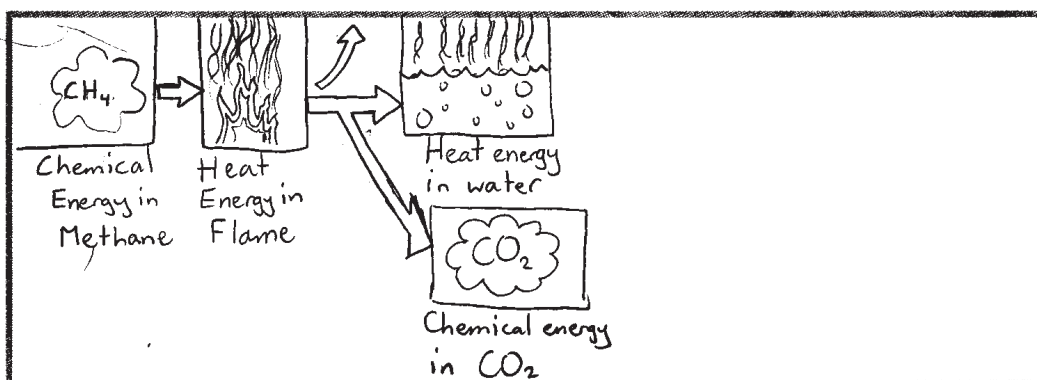
Gas hot water systems

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 + fire \Rightarrow heat + CO_2 + water

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

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

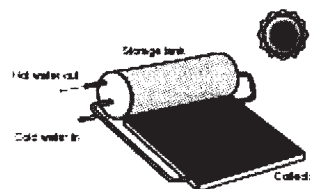
11. Does using a gas hot water system produce more or less CO_2 than using an electric hot water system? Explain by referring to the energy diagrams.

An electric hot water system produces more CO_2 because although in the chemical equation the CO_2 output is the same, heat energy is lost during the transformation of energy, so more coal has to be burned to produce the same heat.

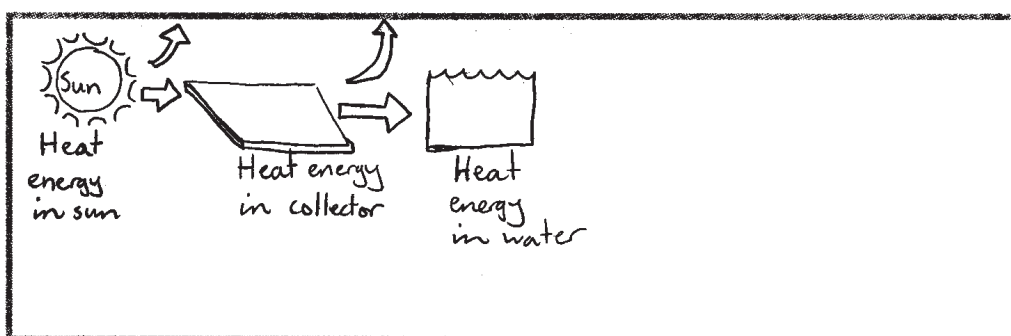
B sample: Response 1

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.

No. CO_2 is not emitted because carbon is not used in any part of the cycle. Therefore, 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."

Yes. Using high CO_2 emitting products will increase the amount of CO_2 in the atmosphere. Using low CO_2 emitting products will only slightly increase CO_2 in the atmosphere while using non CO_2 emitting products will not increase CO_2 levels at all.

B 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

I agree with the part of the statement that says 'Global temperature changes occur naturally'. Questions 2-8 and the historic temperature graph shows that global temperature does change naturally on a regular basis. But I disagree with 'there's nothing we can do about it'. The recent temperature and CO₂ data graphs show there is a link between CO₂ levels and global temperature. Questions 9-13 then answered that using low or non CO₂ emitting products reduce CO₂ emissions, therefore reducing global temperature. There is a problem with being a few degrees warmer. Even a slight change in temperature can drastically increase sea levels as shown in the model prediction from the model in question 1.

B sample: Response 2

Overall grade

As this response demonstrates a high level of achievement in Knowledge and Understanding, Communicating and Investigating, it is judged to be an overall B.

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, including waste heat. | Provides accurate and insightful scientific arguments, considering all data and evidence. Supports the evaluation and proposal of hypotheses with valid interpretations of evidence. Gives a reasoned opinion about climate change and its effects based on a | Displays fluency in the use of scientific terminology when drawing conclusions, making predictions and constructing arguments. Uses accepted formats when constructing formulas for chemical compounds and when writing and balancing equations. Draws clear, fully labelled energy diagrams. |
| A | B | C | D |

Investigating

Interpreted data and evidence to make accurate predictions. Drew valid conclusions, though the responses to Questions 2 and 3 lacked detail, Question 5 indicated a misconception and Question 11 was not well explained.

Knowledge and understanding

Used correct word equations and balanced chemical equations to explain combustion of carbon and methane. Energy diagrams correctly identified energy forms and transfers/transformations but solar hot water diagram did not include energy flow arrows.

Investigating

Made valid interpretations of evidence to evaluate hypotheses, though Question 14 lacked detail. Did not propose an alternative hypothesis in Question 7. Offered an opinion about climate based on an incomplete analysis of the evidence.

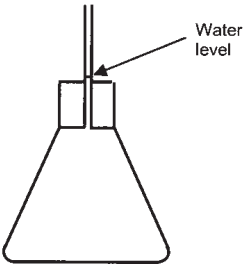
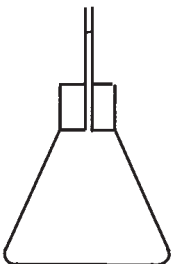
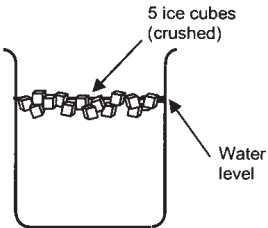
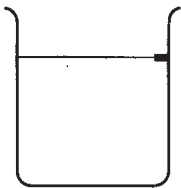
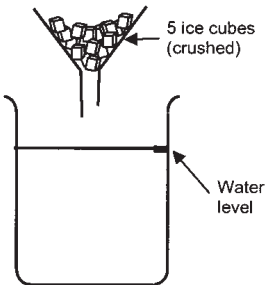
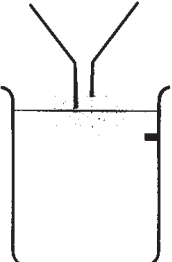
Communicating

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.

B 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  |

B 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 <u>water</u> in the oceans <ul style="list-style-type: none"> The oceans cover about two thirds of the Earth's surface. | <div style="text-align: center;"> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px; display: flex; align-items: center; justify-content: center; margin: 0 auto;">rise</div> <div style="margin-top: 5px;">fall</div> <div style="margin-top: 10px;">no effect</div> </div> | <p>...The observations from experiment 1 showed that the water level rose when the water was heated</p> <p>.....</p> <p>.....</p> |
| Warming of <u>ice</u> in the Arctic Ocean The Arctic ocean is <ul style="list-style-type: none"> about twice the size of Australia mostly covered by floating ice about 3 metres thick. | <div style="text-align: center;"> <div style="margin-bottom: 5px;">rise</div> <div style="margin-bottom: 5px;">fall</div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px; display: flex; align-items: center; justify-content: center; margin: 0 auto;">no effect</div> </div> | <p>...From observing experiment 2, it showed that the ice that floats on the water had displaced the water and once it melted, it had no effect on the water level.</p> |
| Warming of <u>ice</u> in Antarctica The continent of Antarctica is <ul style="list-style-type: none"> about twice the size of Australia covered with a layer of ice about 2 kilometres thick. | <div style="text-align: center;"> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px; display: flex; align-items: center; justify-content: center; margin: 0 auto;">rise</div> <div style="margin-top: 5px;">fall</div> <div style="margin-top: 10px;">no effect</div> </div> | <p>...In experiment 3, the observations made were that the ice that is not floating in water, when it melts, it causes the water level to rise.</p> |

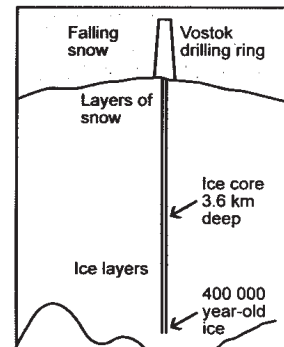
B sample: Response 2

Use the evidence below to answer questions 2 to 5.

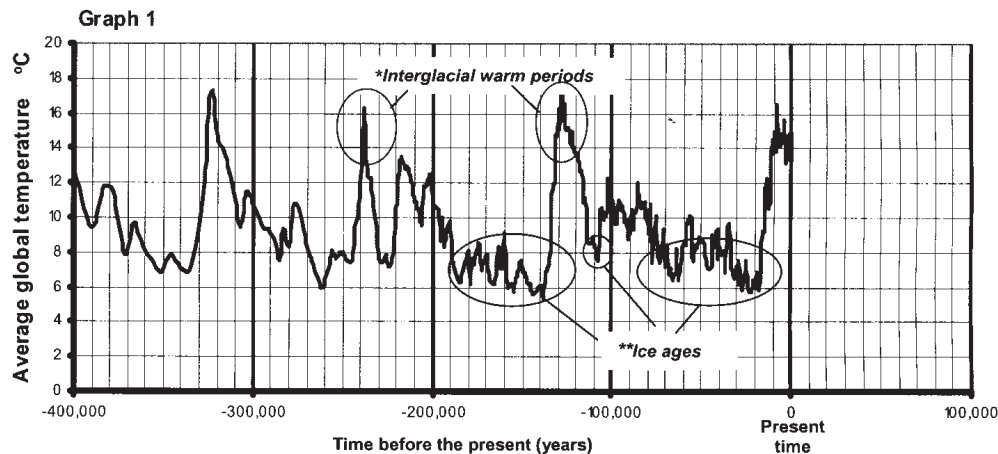
In 1995, scientists at Vostok Station in Antarctica drilled down 3.6 kilometres and retrieved ice cores containing air bubbles which have become trapped in snow over the past 400 000 years.

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 would slowly increase and slowly decrease throughout hundreds of years.

B sample: Response 2

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

From the patterns in the graph, it suggests that in the next 20 000 years the temperature will decrease at a steady pace.

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.

In the past 20 000 years, it would have been warmed, as the temperature has been increasing, as indicated by Graph 1. This would in turn cause a rise in sea levels as the ice on land would melt and the sea water would be heated, which causes rise in sea levels, as indicated by the observations made in question 1.

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.

No, because it indicates that the time that Aboriginal people lived in Australia was around the time of ice ages, where polar ice caps expanded, so there wouldn't be enough water on the earth to cover the low areas.

B 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 evidence presented in the graphs do support the hypothesis that the earth is becoming warmer due to the increase of carbon dioxide in the atmosphere, as Graph 3 indicates that over the past few decades the amount of carbon dioxide is increasing quite significantly and the average global temperature has also been increasing over that period of time, as shown in Graph 2.

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

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B 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 CO_2 into the atmosphere.

For example, heating water for use in homes can produce CO_2 .

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.

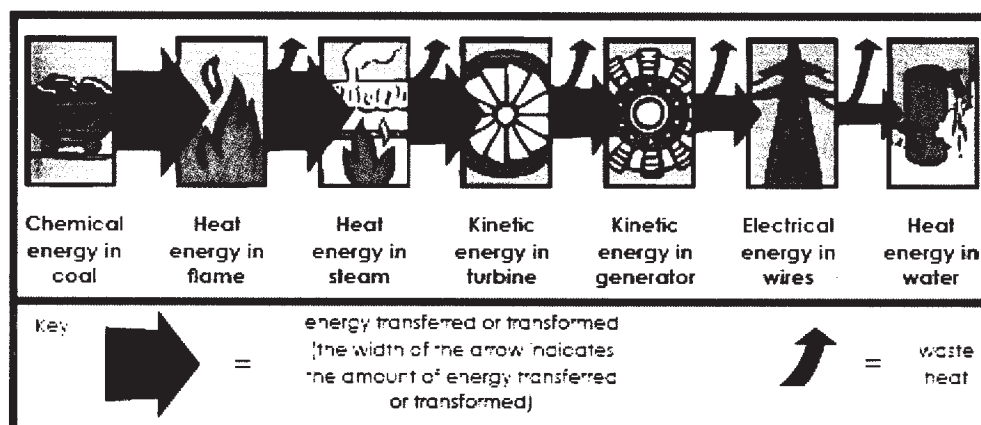
Electric hot water systems

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).

carbon + oxygen → carbon dioxide

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

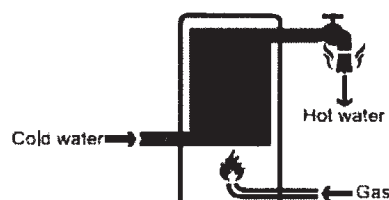
$\text{C} + \text{O}_2 \rightarrow \text{CO}_2$

B sample: Response 2

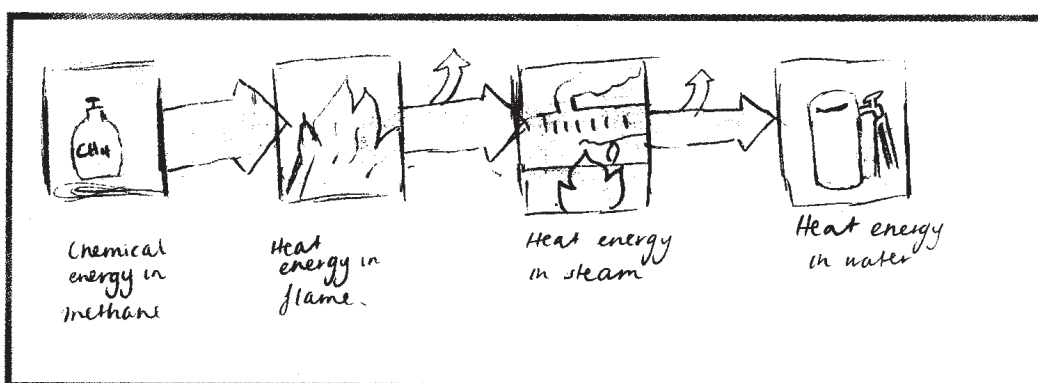
Gas hot water systems

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.

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

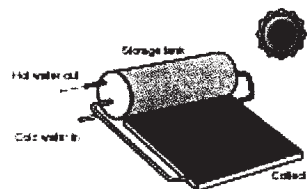
11. Does using a gas hot water system produce more or less CO_2 than using an electric hot water system? Explain by referring to the energy diagrams.

In the energy diagram of an electric hot water system there is more energy being used and more waste heat given off and in the energy diagram a gas hot water system doesn't need kinetic or electrical energy, therefore it produces less CO_2 .

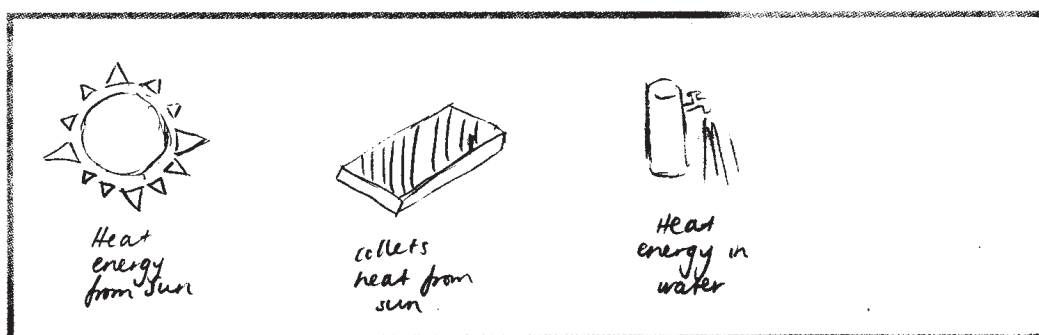
B sample: Response 2

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.

No because the sun heating up water does not have any carbon in the process of heating it up, therefore it would not emit 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."

The answers to the questions do support the hypothesis in that each energy diagram gives off different amounts of CO_2 , therefore our energy choices can affect the amount released into the atmosphere.

B 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

Some of the change are due to us humans who have advanced in technology and that has caused greater emissions of CO₂ in the air, which has caused a rise in global temperature by referring to questions 2 to 8. By referring to questions 9 to 13, it tells us that by choosing the correct energy choices, we can change the global temperature, as less CO₂ is emitted, therefore, there is something that can be done. But as global temperatures do rise, the ice on land will melt and sea levels will rise. Also the warming of the ocean causes the sea levels to rise as well, this is due to the prediction from the model in question 1.