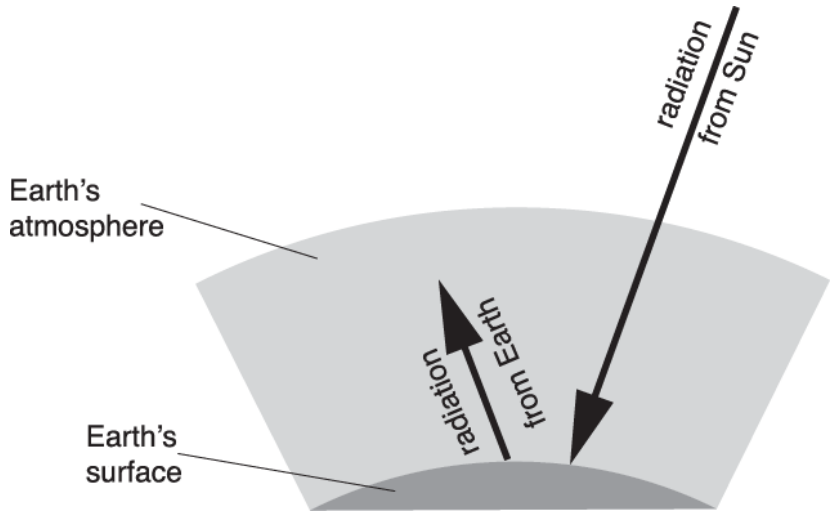
1. This question is about the greenhouse effect. The diagram below shows radiation from the Sun reaching the Earth and radiation leaving the Earth's surface.



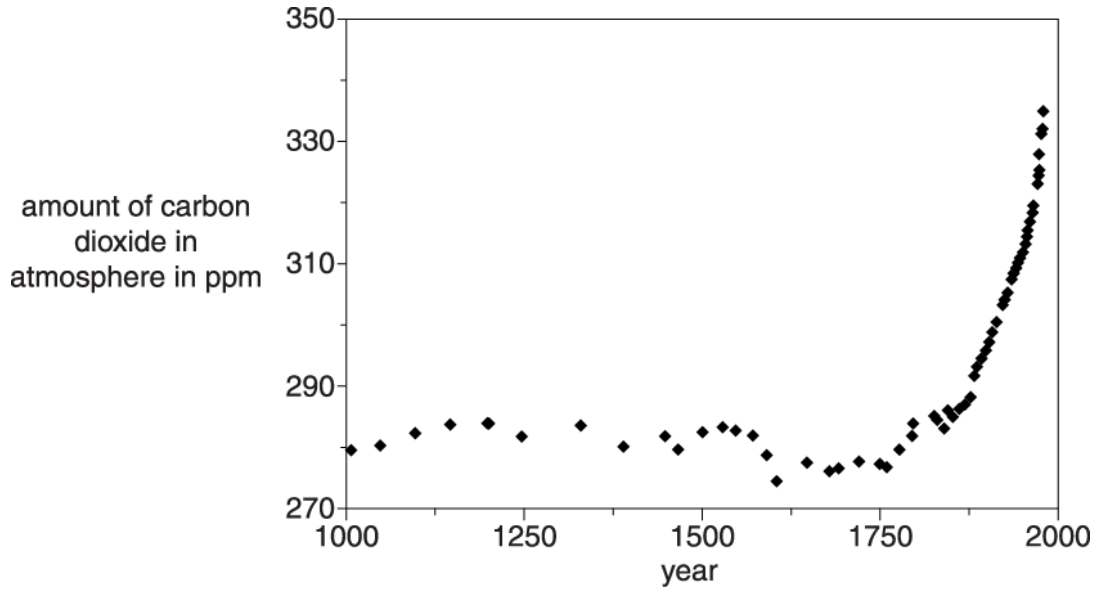
The Earth's atmosphere affects these two radiations differently.

Describe how the radiation from the Sun is different from the radiation from the Earth, and explain how the atmosphere is responsible for the greenhouse effect.

The quality of written communication will be assessed in your answer.

[6]

2(a). This graph shows the amount of carbon dioxide in the atmosphere over a 1000 year period.



Many scientists think this is evidence that human activity has had an effect on the amount of carbon dioxide in the atmosphere.

Explain how the graph supports this idea.

---

[4]

(b). One of the effects of increasing carbon dioxide in the atmosphere is global warming and climate change.

Suggest some groups of people who are most at risk from global warming. For each group describe the risk.

group _____

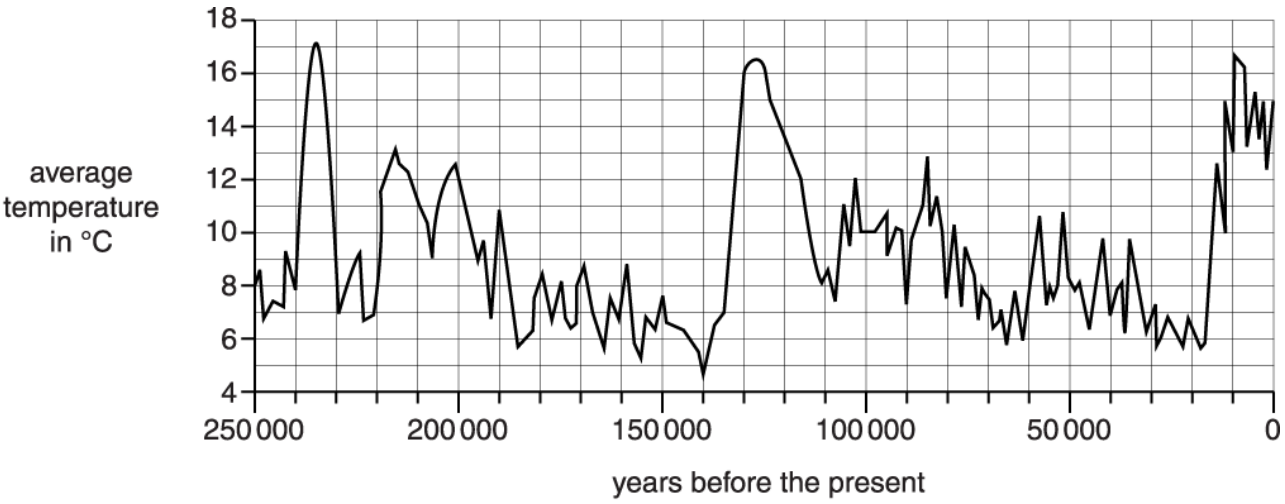
risk _____

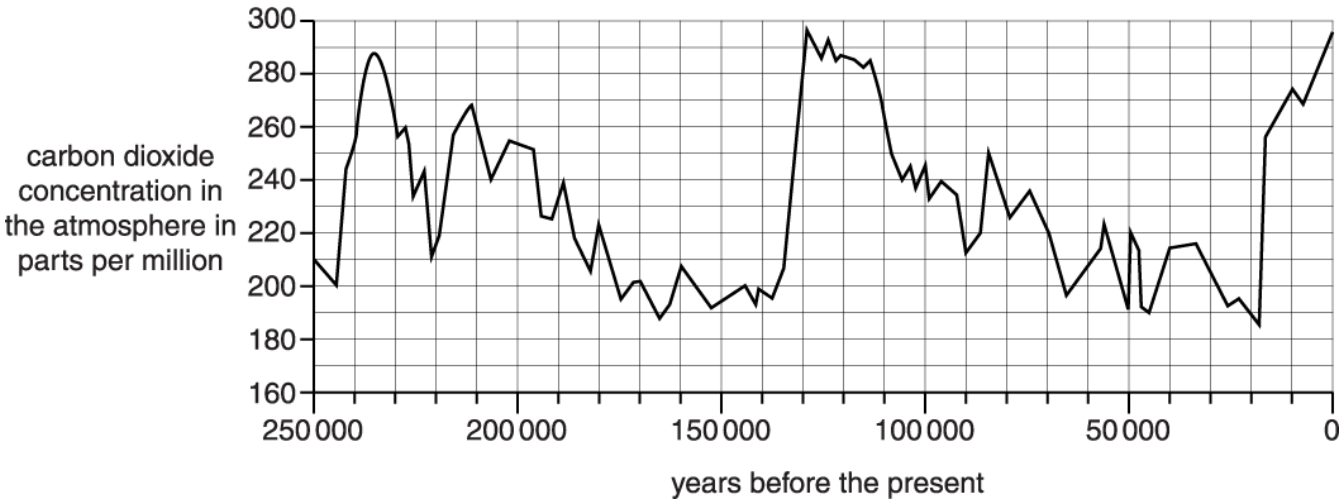
group _____

risk _____

[4]

3. The two graphs show changes in the Earth's atmosphere over the past 250 000 years.





The graphs show that there is a **correlation** between average temperature and carbon dioxide concentration.

How can you tell there is a correlation, and what is the **cause** of this correlation?

The quality of written communication will be assessed in your answer.

---

[6]

4. Margaret runs a small transport company.

She decides to review the possible fuel sources for her delivery trucks.

At present all her vehicles use petrol.

She finds the following table of information on the internet.

Fuel	Energy efficiency	CO_2 equivalent emission units	Cost of fuel per tonne
biogas	22%	20	similar for all three fuels
diesel	35%	750	
petrol	27%	740	

The data are given for equal masses of fuel.

She wants to take into account economic factors, sustainability and environmental impact.

Use the information in the table and your knowledge of energy sources to discuss the three fuel sources and make a recommendation about which one Margaret should use.

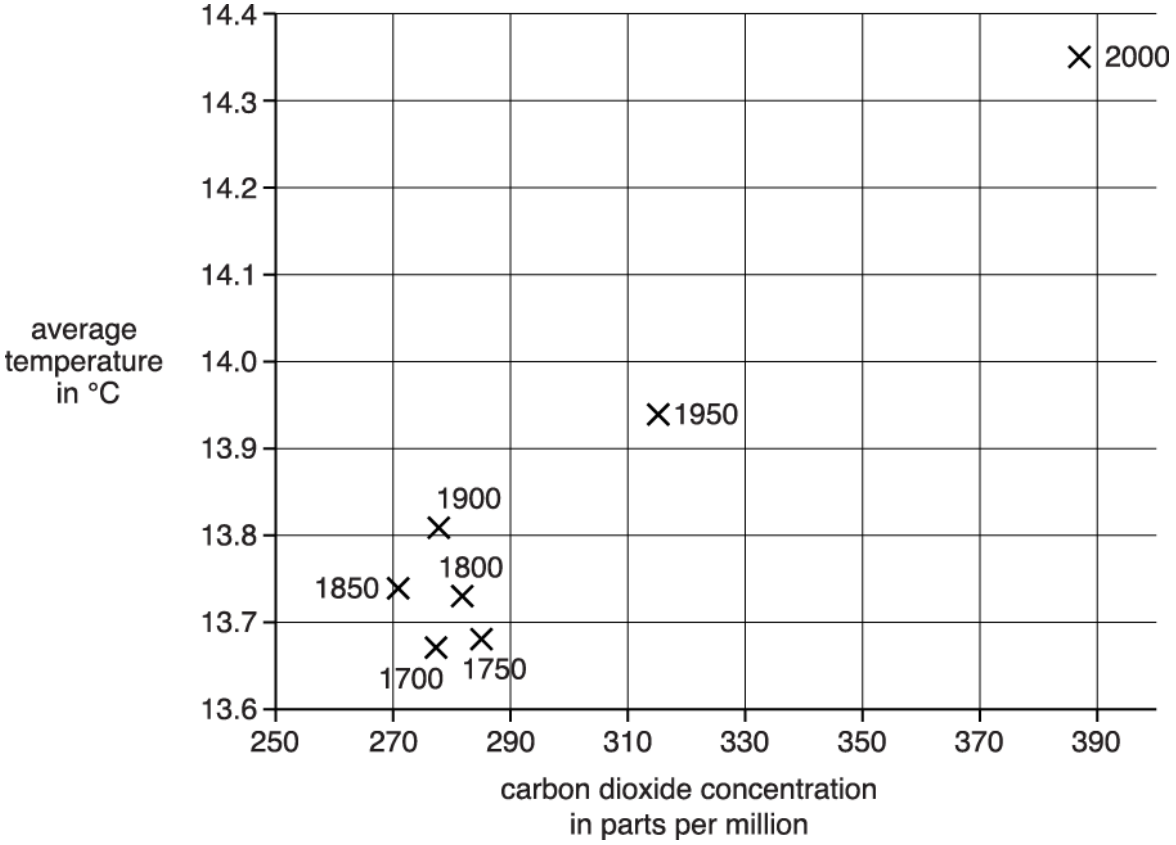
The quality of written communication will be assessed in your answer.

---

[6]

5(a). The graph below shows how the average temperature of the Earth and the concentration of carbon dioxide in the atmosphere have changed over the last 300 years.

Each point is marked with the year the readings were taken.



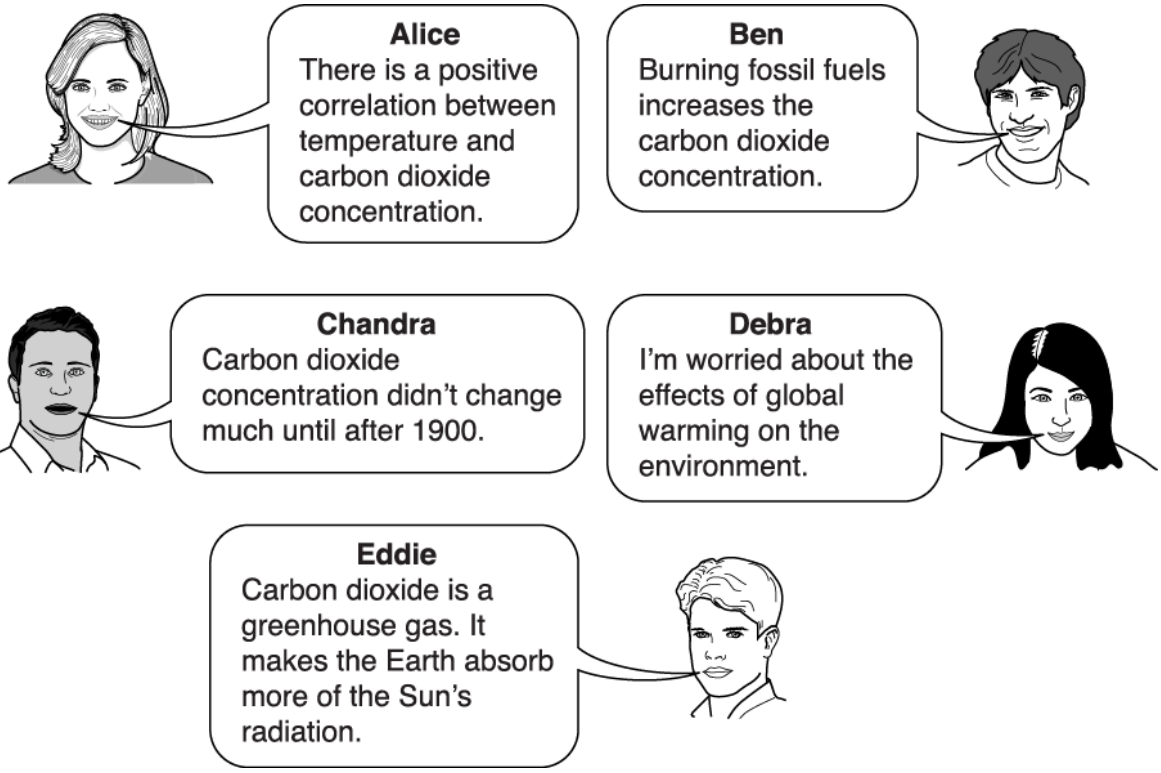
(i) In which **two** years was the carbon dioxide concentration greater than 300 parts per million?

_____ and _____ **[2]**

(ii) In which years was the average temperature less than 13.8 °C?

_____ **[2]**

(b). Five friends have been looking at the graph on the opposite page.



(i) Which two friends are **describing** the data shown in the graph?

Put ticks (✓) in the boxes next to the **two** correct names.

Alice ☐

Ben ☐

Chandra ☐

Debra ☐

Eddie ☐

[2]

(ii) Which two friends are **explaining** the data shown in the graph?

Put ticks (✓) in the boxes next to the **two** correct names.

Alice ☐

Ben ☐

Chandra ☐

Debra ☐

Eddie ☐

[2]

6(a). The amount of carbon dioxide in the atmosphere stayed constant for a very long time.

Use the correct scientific terms to explain why the amount of carbon dioxide did not change.

---

[2]

(b). Over the last two hundred years, the amount of carbon dioxide in the atmosphere has increased steadily.

Write down **two** reasons for this increase.

1

2

---

[2]

[Total: 4]

END OF QUESTION PAPER

Question			Answer/Indicative content	Marks	Guidance
1			**(Level 3)** States at least one point describing either radiation from Earth or radiation from the Sun. **AND** states at least one relevant point about the greenhouse effect **AND** includes the idea that energy or radiation is trapped (in the atmosphere) Quality of written communication does not impede communication of the science at this level. (5 – 6 marks) **(Level 2)** States a relevant point about the greenhouse effect **AND** includes the idea that energy or radiation is trapped (in the atmosphere) **OR** States at least one point describing either radiation from Earth or radiation from the Sun **AND** includes the idea that energy or radiation is trapped (in the atmosphere) **OR** States at least one point describing either radiation from Earth or radiation from the Sun **AND** states a relevant point about the greenhouse effect Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks) **(Level 1)** States at least one point describing either radiation from Earth or radiation from the Sun. **OR** States a relevant point about the greenhouse effect **OR** Includes the idea that energy or radiation is trapped (in the atmosphere) Quality of written communication impedes communication of the science at this level. (1 – 2 marks) **(Level 0)**	[6]	**This question is targeted at grades up to E** **Indicative scientific points related to difference in radiation from the Sun and Earth may include:** • Sun's radiation includes visible/UV/other types of EM radiation • radiation emitted by Earth is infrared • radiation from the Sun has more energy /power/ intensity/is more ionising than radiation from the Earth • atmosphere does not absorb (much) light/radiation from Sun • atmosphere/greenhouse gases absorb radiation from Earth • Sun's radiation/light gives energy for plants/photosynthesis **Indicative scientific points related to the greenhouse effect may include:** • If energy in > energy out Earth will heat up • Earth's radiation is absorbed. • Sun's radiation is transmitted • atmosphere/gases absorb infrared/radiation from Earth • these (greenhouse) gases include carbon dioxide (and methane & water) • this results in global warming **Example of ideas of energy/radiation is trapped** • 'Radiation from the Sun cannot escape' • 'Prevents radiation from the Sun leaving' • 'Heat is trapped' **Use the L1, L2, L3 annotations in Scoris; do not use ticks.** **Examiner's Comments** For the first part of the question many candidates offered the information that the Sun's radiation contained ultraviolet, some said that it contained more energy. Some

Question			Answer/Indicative content	Marks	Guidance
			Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)		candidates have the overall idea of the greenhouse effect – that this is an effect which traps some radiation, or heat – others can tell you that carbon dioxide is a greenhouse gas and that the Earth is warming up and there is some connection between the two – but they do not appear to have any idea what the connection is. Although this question was targeted at lower ability candidates, it was clear that this is an idea that is very poorly understood below C grade. A lot of candidates thought that the greenhouse gases were trapped in the atmosphere and could not escape. Some said that the Earth's radiation was carbon dioxide, or pollution, and some went on to say this was trapped by the ozone layer.
			Total	6	

Question			Answer/Indicative content	Marks	Guidance
2	a		graph shows (rapid) increase in CO_2 (1) human activity increased (around this time)/industrial revolution / more factories / population increase / (1); hence correlation (1) use of fossil fuels / deforestation (produces CO_2)(1)	4	**do not accept** increase before 1750 **ignore** named examples of human / industrial activity e.g. more cars / more technology must have described graph AND history of human activity for this mark ignore breathing out CO_2 Examiner's Comments This question was a good differentiator. The best responses linked the shape of the graph to a causal factor and went on to explain why. The weakest responses often did not state what the graph showed about carbon dioxide and often gave generic comments about more cars/technology without looking at the time frame to see if this was a sensible argument.
	b		1 mark for sensible risk and 1 mark sensible associated group (×2)	4	if no sensible risk is given then group cannot score acceptable examples group: people living on the coast risk: flooding due to rising sea levels group: farmers risk: crops not growing due to climate changes group: everyone risk: extreme weather events allow same group twice if two separate valid risks similarly allow same risk (eg flooding) if two separate reasons (eg damage crops / destroy low level housing) Examiner's Comments Many candidates did not appreciate the need to give a specific group of people or did not give a risk associated with global warming. Common errors were references to animals or breathing difficulties and asthma due to the carbon dioxide in the air or damage to the ozone layer.

Question			Answer/Indicative content	Marks	Guidance
			Total	8	
3			**(Level 3)** Describes a feature of the two graphs which show correlation and identifies the CO_2 mechanism. Quality of written communication does not impede communication of the science at this level. (5–6 marks) **(Level 2)** Describes a feature of the two graphs which show correlation OR identifies the CO_2 mechanism. Quality of written communication partly impedes communication of the science at this level. (3–4 marks) **(Level 1)** Refers to both graphs to attempt to describe correlation, OR may refer global warming. Quality of written communication impedes communication of the science at this level. (1–2 marks) **(Level 0)** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	**This question is targeted at grades up to E** **Indicative scientific points related to the data may include:** • graphs follow similar trends – have a similar shape • discusses graphs in more detail e.g. 'both had low points 150 000 years ago' • as CO_2 levels rise so does T • as T rises so does CO_2. **Indicative scientific points related to mechanism may include:** • the CO_2 is the cause of the correlation • the CO_2 causes the temperature rise • CO_2 is a cause of the greenhouse effect • CO_2 causes global warming. **Use the L1, L2, L3 annotations in Scoris; do not use ticks.** **Examiner's Comments** In answer to this six-mark extended writing question, it was pleasing to see that the majority explained how the graphs showed a correlation and achieved at least level 2. For level 3, some correctly identified the mechanism as the carbon dioxide in the atmosphere.
			Total	6	

Question			Answer/Indicative content	Marks	Guidance
4			**Level 3 (5–6 marks)** Considers all three fuels using all data from table and other information. Considers all three key factors. Draws a clear conclusion based on and consistent with the data considered. Quality of written communication does not impede communication of the science at this level. **Level 2 (3–4 marks)** Considers all three fuels using some data from table. Considers two key factors. Draws a conclusion based on the data considered. Quality of written communication partly impedes communication of the science at this level. **Level 1 (1–2 marks)** Considers two fuels using some data from table, considers one key factor. OR Considers one fuel and two factors. Draws a relevant conclusion which may not be based on the data. Quality of written communication impedes communication of the science at this level. **Level 0 (0 marks)** Insufficient or irrelevant science. Answer not worthy of credit.	6	**This question is targeted at grades up to C** **Indicative scientific points may include:** **key factor — sustainability** • biogas is renewable * • diesel and petrol are non-renewable. * **key factor — economics** • unit cost of fuel is the same for all • may be expensive to convert vehicles * • may be difficult to find supplies of biogas* • same amount of fuel diesel will go further • replacement costs to replace vehicles* • order of energy efficiency linked to amount used. **key factor — environmental impact** • order of CO_2 equivalent emissions • more CO_2 from diesel or / and petrol than biogas • CO_2 emissions contribute to global warming * • not clear what is meant by 'CO_2 equivalent emissions'. * These are examples of other information beyond that provided in the table. **Use the L1, L2, L3 annotations in Scoris; do not use ticks.** Examiner's Comments This was a six-mark extended writing question. It was fairly well answered with the majority of candidates understanding the importance of low emission of carbon dioxide and high efficiency of diesel and petrol. Fewer candidates understood the term sustainability and many interpreted it to mean viable. Candidates have obviously had practice at interpreting data and

Question			Answer/Indicative content	Marks	Guidance
					scored well, mentioning all three fuels and two of the factors using the data provided.
			Total	6	
5	a	i	1950 (1) 2000 (1)	2	any order
		ii	1700, 1750, 1800 and 1850	2	any order **ignore** all except 1900, 1950 and 2000 **ignore** 1700–1850 **ignore** below 1851 all correct = (2) one omission OR one extra OR one incorrect date (1)
	b	i	Alice (1) Chandra (1)	2	?Examiner's Comments?? These were well answered. Where candidates scored only one correct answer there was no one name that was commonly incorrect.
		ii	Ben (1) Eddie (1)	2	?Examiner's Comments?? These were well answered. Where candidates scored only one correct answer there was no one name that was commonly incorrect.
			Total	8	

Question			Answer/Indicative content	Marks	Guidance
6	a		Respiration and photosynthesis (1); these processes were balanced (1); OR Respiration put CO_2 into the atmosphere (at same rate as) photosynthesis removed it (2);	2	IGNORE label letters IGNORE Other processes for releasing CO_2 e.g. burning / decomposition / dissolving ALLOW same amount of carbon (dioxide) taken in & given out ALLOW max mark of 1 for idea that fossil fuels were not being burnt OR less deforestation if no other marks scored.
	b		i & ii (increased use of / burning) fossil fuels (1); deforestation (1)	2	ALLOW answers to i & ii given in either order ALLOW (use of / burning) a named fossil fuel ALLOW example of increased use e.g. cars / factories IGNORE more people / more pollution / CO_2 emissions
			Total	4	