1(a). **Extreme Weather Events**

Extreme weather events make big news all over the world. Floods and storms have killed and injured many people around the world and caused massive damage to poplulated cities in recent years. People are looking to try to explain these events and to predict what will happen in the future.

Scientists have collected data about changes to our climate and our weather and about global carbon emissions. They use data such as this to identify correlations about factors that may affect our climate and to predict likely changes in the future.

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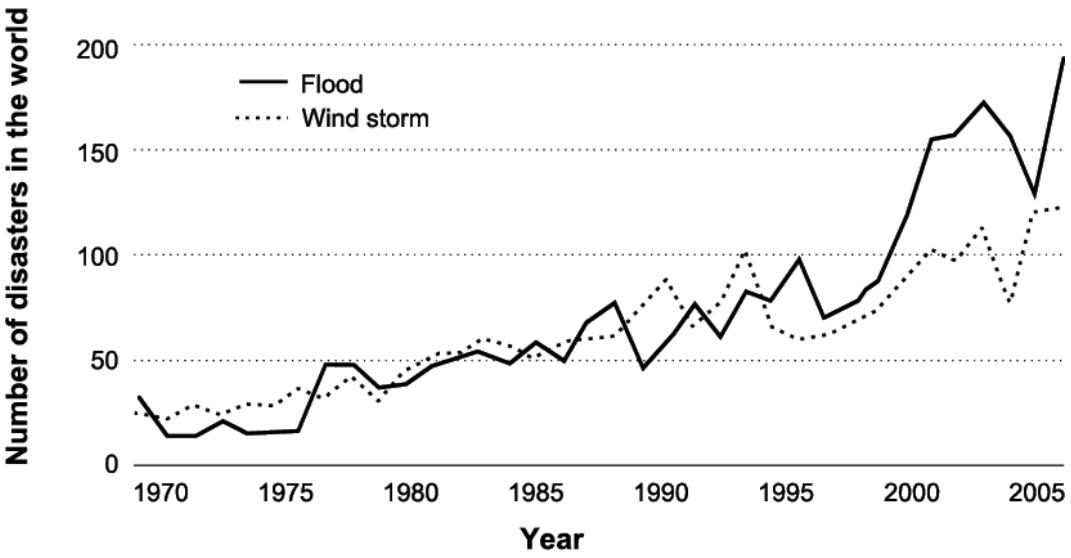
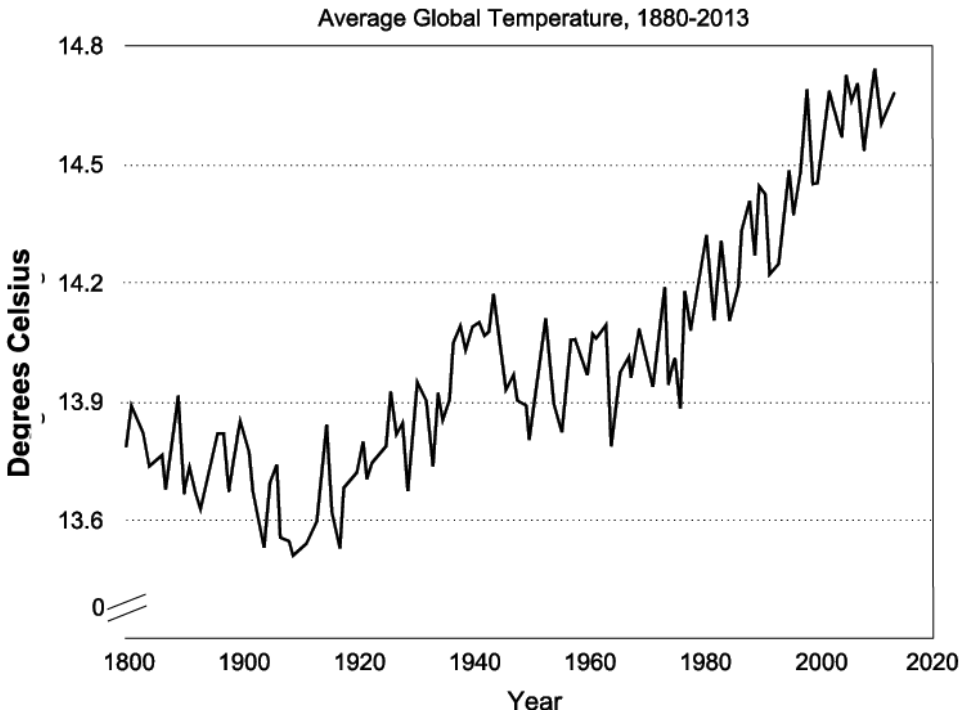
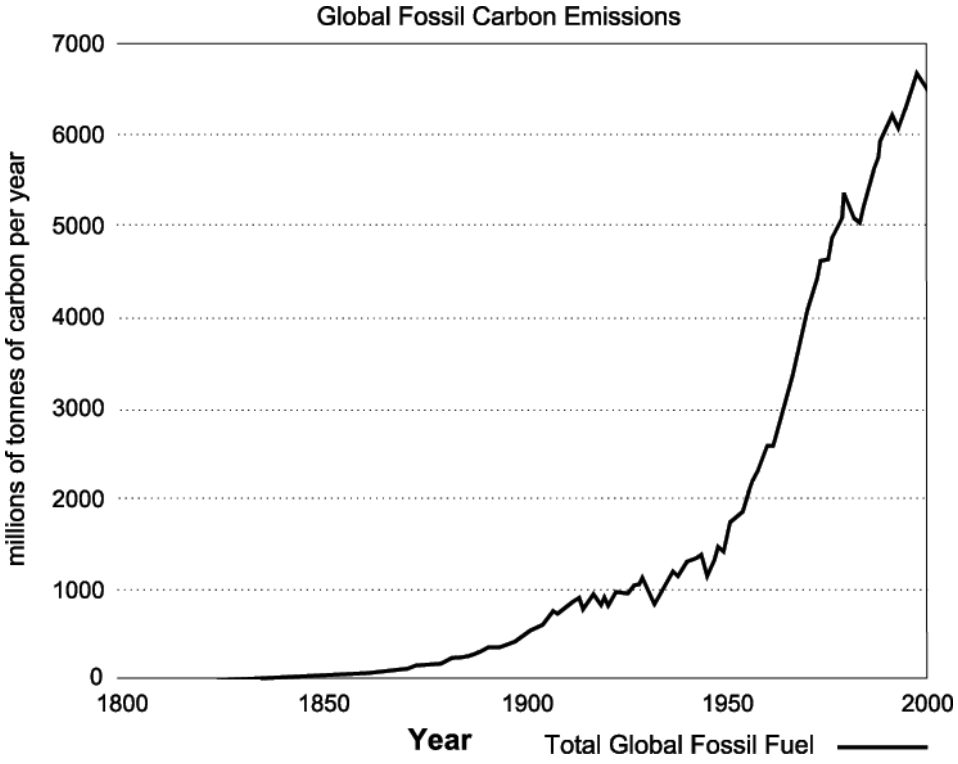
Trend in extreme weather events 1970-2005







Computer simulations have been developed to predict how our weather and climate may change in the future. These simulations give very accurate predictions about temperature, but they rely on using known values of global carbon emissions. However, scientists say that it is very difficult to make reliable long term predictions for the future.

Scientists have identified correlations about factors which may affect our climate.

Describe the correlations that the graphs show.

[3]

(b). Explain why it is difficult to make reliable predictions about changes to global temperatures in the future.

[2]

(c). Ray looks at the graphs and makes this comment:

'There is a much greater percentage increase in the number of floods than in the global temperatures.

The future risks from floods will get bigger and bigger. In the future, people will be at much greater risks from floods than the risks from rising temperatures.'

(i) Ray says there is a much greater percentage increase in the number of floods than in the global temperature.

Explain why Ray thinks this.

Use values from the graphs to support your answer.

---

[3]

(ii) Ray thinks that in the future, people will be at much greater risks from floods than the risks from rising temperatures.

Explain why Ray may not be right.

---

[3]

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(d). Read the information about a new way to reduce the problems caused by fossil fuels.

Scientists in Poland have developed a new method of making old CDs into a material that can absorb carbon dioxide. Carbon dioxide can be 'captured' from the air and stored in the material. Now that consumers download music and store it electronically, more and more CDs will be thrown away and can be recycled to make this new material.

Toxic gases from industrial processes can also be stored in the material.

Scientists hope to be able to make the same material from other waste plastics. However, further development of these ideas will have a high cost. To raise the necessary funding, scientists will need to show that this new idea will have a significant impact on the problems caused by fossil fuels.

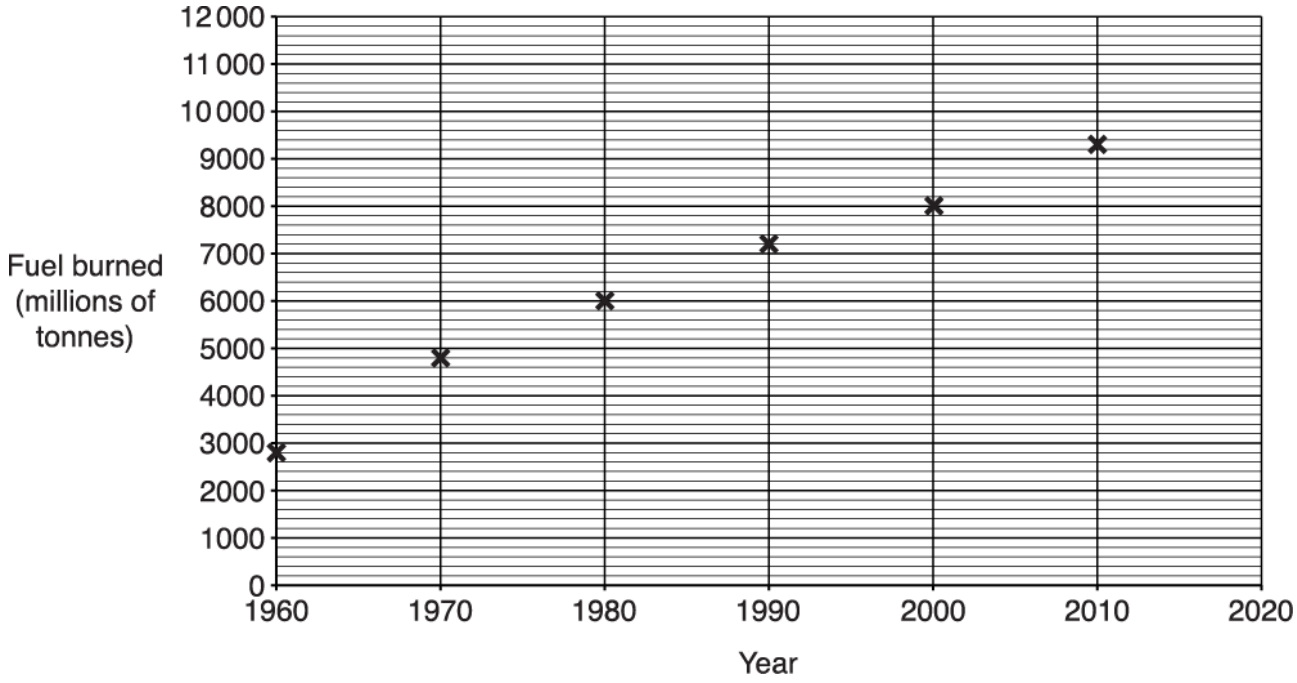
Do you think benefits of this process are likely to outweigh the costs in the long term?

Explain your reasoning.

---

[4]

2(a). John looks at a graph that shows the amount of fossil fuels burned in the world from 1960 to 2010.



(i) Estimate the amount of fossil fuels that will be burned in 2020.

_____ millions of tonnes

[1]

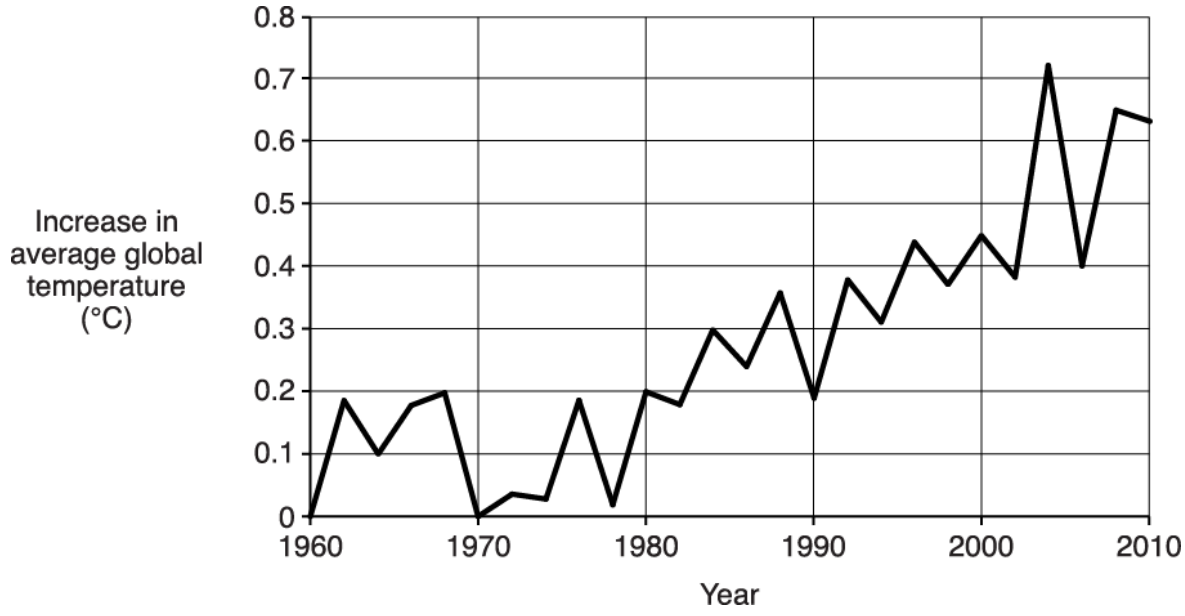
(ii) John says that it is very difficult to estimate the amount of fossil fuel we will use in 100 years' time.

Suggest reasons John could give to justify this statement.

---

[2]

(b). John looks at the changes in average global temperature from 1960 to 2010.



Some scientists think there is a link between the trends shown in this graph and the previous graph.

Describe the link between the trends shown in the graphs.

---

[2]

3. Diesel cars may be banned in some large cities.

Here is some data on the exhaust gases of petrol and diesel cars.

The cars are the same except for the fuel they use.

	Pollutant (grams per km travelled)			Nitrogen monoxide
	Carbon monoxide	Carbon particulates	Fuel used (litres per 100 km)	
Petrol car	12.0	none	6.0	5.5
Diesel car	0.5	0.5	9.0	4.5

Use your knowledge of these pollutants to discuss the **advantages** and **disadvantages** of diesel cars over petrol cars. Suggest reasons why diesel cars may be banned from large cities.

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

[6]

4. During the last 100 years, the burning of fossil fuels has released a large quantity of carbon dioxide into the atmosphere.

Despite this, the percentage of carbon dioxide in the atmosphere has risen only from approximately 0.03% to approximately 0.04%.

Explain why the percentage of carbon dioxide has not risen higher.

[2]

5. Millions of tonnes of hydrogen are made every year.

The hydrogen is usually made from methane.

The process starts with methane and steam, and makes hydrogen and carbon dioxide.

A new process for making hydrogen is by heating wood from trees.
Both processes for making hydrogen make carbon dioxide.
Suggest why this new process might be greener than the old one.

---

[2]

6. Coal-fired power stations pollute the air with solid particles. Which of these statements explains why solid carbon particles may be made when coal burns?

Put ticks (?) in the boxes next to the **two** correct answers.

Sulfur in the coal reacts with carbon. ☐

Coal is mainly carbon atoms. ☐

Coal is made up of carbon and hydrogen atoms. ☐

There is not enough oxygen for all the carbon to react. ☐

Carbon dioxide is reduced by nitrogen in the air. ☐

The hydrogen atoms react more slowly than the carbon atoms. ☐

[2]

7(a). Dom and Kate live in a town that has bus lanes.

Only buses can drive in bus lanes.

This means that at busy times buses travel faster than cars.

Buses and cars make carbon dioxide and other pollutants when they burn fuel.

Dom says there will be **less** air pollution as more people will travel by bus.

Kate says there will be **more** air pollution as a bus burns more fuel than a car.

Who is correct and why?

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

---

[6]

(b). Biofuels may be used to run buses instead of fuels from crude oil.

Suggest a reason for using biofuel. Explain your answer.

---

[2]

(c). A fuel is burned to make **only** carbon dioxide and water.

What does this tell you about the elements in the fuel and the conditions in which the fuel burns?

---

[2]

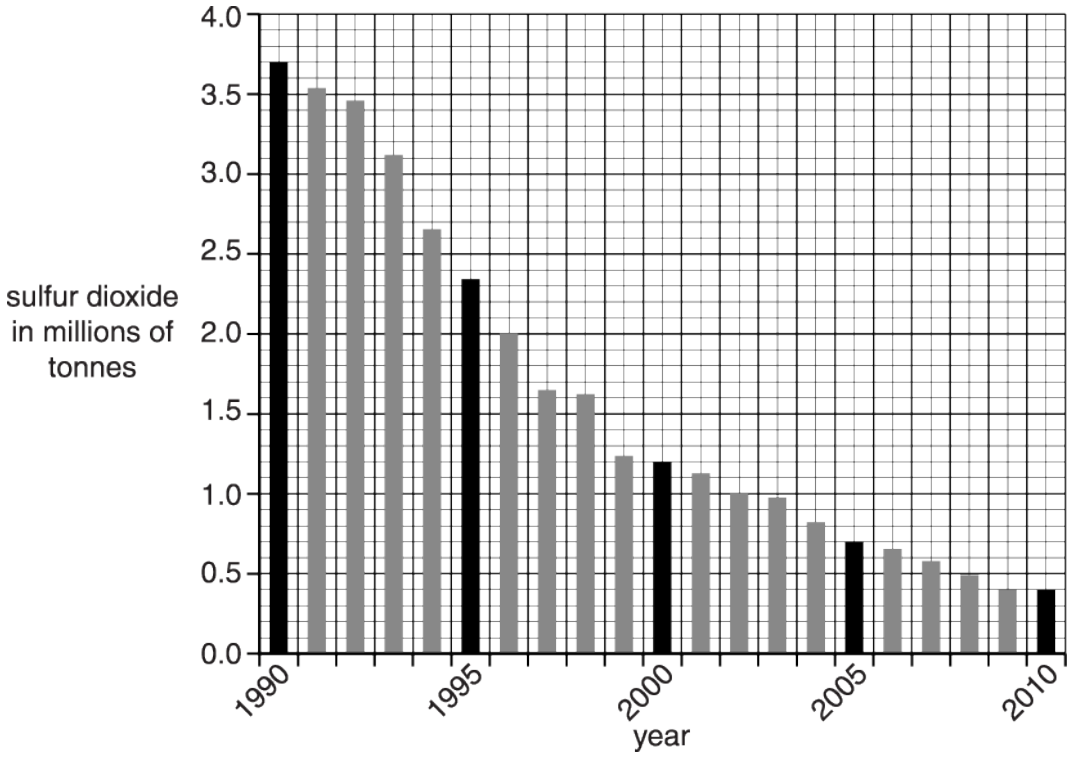
(d). Which term describes the changes to the elements in fuel as it burns?

Put a ring around the correct answer.

carbonised electrolysed neutralised oxidised reduced [1]

8(a). Sulfur dioxide is an air pollutant.

The graph shows the amount of sulfur dioxide put into the air from 1990 to 2010 in the UK.



(i) What was the amount of sulfur dioxide put into the air in 2010 as a fraction of that in 2000?

answer = _____ [1]

(ii) The Government says that the amount of sulfur dioxide put into the air falls to a third every 10 years since 1990.

Is this true? Justify your answer.

_____

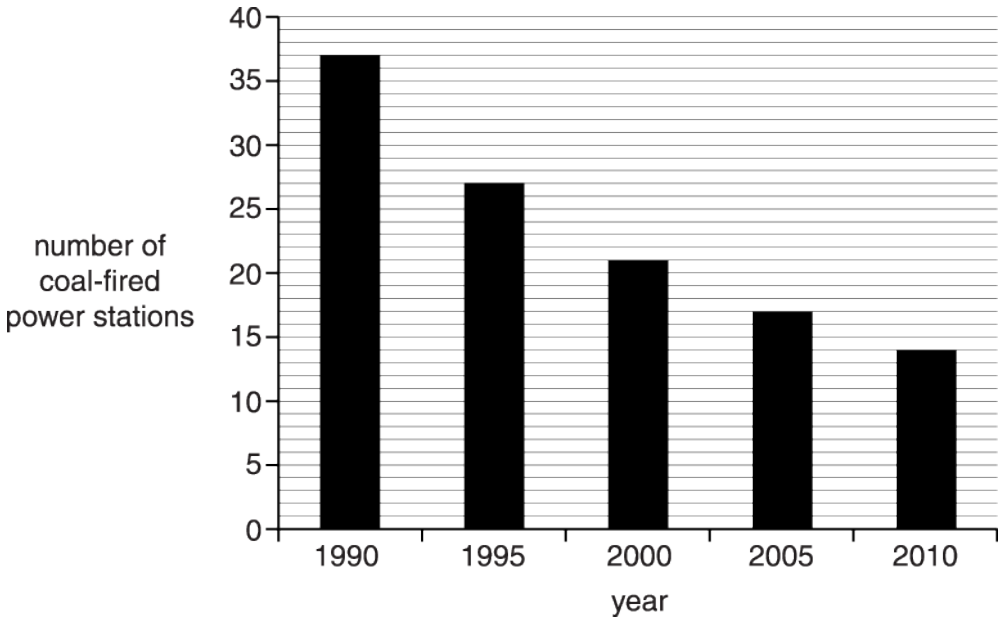
_____

---

[2]

Most sulfur dioxide in the air comes from power stations.

This graph shows the number of coal-fired power stations in the UK between 1990 and 2010.



(b). Look at the **two** graphs.

What is the correlation shown by the data?

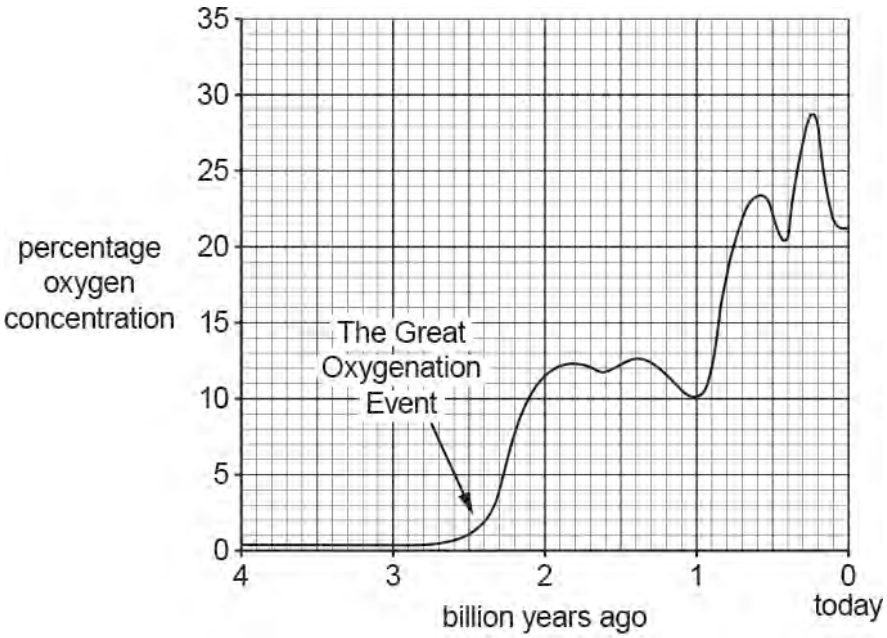
---

[2]

9.

(i) The percentage of oxygen gas in the Earth's atmosphere has generally increased over time.

This graph shows the percentage oxygen concentration in the Earth's atmosphere over the last 4 billion years.



Describe how the oxygen content of the Earth's atmosphere has changed during the last four billion years.

--- [2]

(ii) The concentration of oxygen has increased from two billion years ago to today.

By what factor has it increased?

Factor = ---------- [1]

(iii) Explain what caused the sudden increase in oxygen concentration 2.5 billion years ago and explain why the concentration did not continue to rise.

---

[2]

END OF QUESTION PAPER

Question			Answer/Indicative content	Marks	Guidance
1	a		floods, storms, global temperatures or carbon emissions show an increase ✓ idea of similar or same pattern in increase in storms and carbon emissions ✓ identifies similarity in rate of changes / since 1950 far greater increase in carbon emission and global temperature ✓	3	
	b		future global carbon emissions are not definite / not known ✓ idea that predictions are uncertain from extrapolated data / cannot be certain about factors in the future / cannot be certain about a named factor e.g. atmospheric composition / effect of increased water vapour or other ✓	2	
	c	i	gives an approximation of increase in floods / quotes numbers from graph of floods / less than 50 to almost 200 / about 400% ✓ during same period (since 1970) only about 1°C temperature increase / about 3.5% ✓ (conclusion) Idea that floods percentage increase is in multiples / much greater than 100% and that percentage increase in temperature is small ✓	3	
		ii	risk from floods is increasing more / faster than global temperature ✓ (don't agree because) overall risk of harm from floods is still small ✓ (don't agree because) idea that risk of increased temperature is far greater / names issue such as crop failure / weather pattern changes ✓	3	

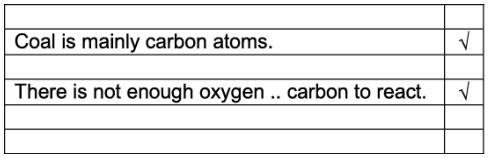
Question			Answer/Indicative content	Marks	Guidance
	d		explains positive benefits: **Any two points from** uses waste CDs ✓ carbon dioxide from burning fossil fuels can be stored ✓ also can be used to absorb toxic gases ✓ in the future other plastic waste may be used ✓ saves space in landfills ✓ idea of recycling / saves using crude oil to make material ✓ explains costs / drawbacks: **Any two points from** cost of development is high ✓ may be other developments which would have a bigger effect ✓ not enough CDs / idea that this is a small scale process / will run out ✓ judges overall outcome: makes a decision (yes / no) and justifies it in terms of relative size of benefit and cost ✓ acknowledges uncertainty at judging future benefits and costs / cannot be sure of future outcomes ✓	4	**must be clearly linked to idea of benefit or cost**. copied statements from question alone do not score. for two benefits award one mark for two drawbacks award one mark
			Total	**15**	

Question			Answer/Indicative content	Marks	Guidance
2	a	i	Value between 10000 and 11000	1	
		ii	Any 2 from: More renewable / alternative forms of energy; Fossil fuels running out / are non-renewable; Use of nuclear energy not known; More efficient power stations; increased industry/population new sources of fossil fuels;	2	Accept named renewables such as solar/wind turbines/biofuels Allow: other examples of better efficiency reducing fossil fuel usage. ORA Examiner's Comments In part (i) candidates were able to extrapolate a graph and give the correct result. Part (ii) asked about the difficulty in extrapolating further. Most gained marks by stating that fossil fuels were a finite resource and other sources of renewable energy would be used. Few marks were awarded for population increase, nuclear energy and more efficient power stations.
	b		As the amount of fossil fuels burned increases the average global temperatures increase; (2)	2	Factors must be named and linked directly for 2 marks Factors linked with time = 1 mark only One goes up / increases. The other goes up (1) If given only as a causal link 1 mark Examiner's Comments Many gained 1 mark by describing an increase in both graphs, but few seemed able to describe the correlation shown by these graphs. They should be encouraged to think about what happens in the second graph as the first one changes; i.e. as fuel burned increases, what happens to the increase in global temperature? Some were confused between correlation and cause.

Question			Answer/Indicative content	Marks	Guidance
			Total	5	

Question			Answer/Indicative content	Marks	Guidance
3			[Level 3] Gives 1 advantage **and** 2 disadvantages or 2 advantages **and** 1 disadvantages of diesel **and** states harmful effects of 2 pollutants **and** relates these to why diesel cars may be banned in cities. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks) [Level 2] Gives 1 advantage **and** 2 disadvantages or 2 advantages **and** 1 disadvantages of diesel **and** states harmful effect of 1 pollutant. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks) [Level 1] Gives 1 advantage **and** 1 disadvantage of diesel cars. 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 A* Indicative scientific points may include: Advantages • diesel cars emit less carbon monoxide than petrol cars. • diesel cars burn less fuel than petrol cars (so less carbon **monoxide** produced). / Diesel cars travel further for the same amount of fuel Disadvantages • diesel cars emit more carbon particulates than petrol cars. • diesel cars emit more nitrogen monoxide than petrol cars. Effects • carbon monoxide emissions are toxic to humans. • carbon monoxide emissions lower the amount of oxygen the blood can carry. • carbon particulates cause breathing problems and make buildings dirty. • carbon particulates contribute to global dimming • nitrogen monoxide causes breathing problems and causes acid rain • nitrogen monoxide contributes to photochemical smog and global dimming Reason why banned Diesel banned because of effects of **carbon particulates and/or NO only**. eg breathing problems, smog, dirt **Ignore** catalytic convertors **Reject** ‘using’ pollutants **Use the L1, L2, L3 annotations in Scoris; do not use ticks.**

Question			Answer/Indicative content	Marks	Guidance
					Examiner's Comments This first level of response question was answered well with good differentiation between the levels. Most used the data to achieve level 1. Some were vague about the effects of the pollutants, repeating ideas of fatal, harmful and polluting. More failed to comment on banning from cities or just wrote they were banned because of pollution or harmful gases which did not gain marks. Another common problem was that candidates were uncertain about the difference between using something and producing something. It was not uncommon to read that petrol cars use more carbon monoxide than diesel cars.
			Total	6	
4			carbon dioxide is removed from the air by: photosynthesis (1) dissolving in water (1)	2	**ignore** reference to people using less petrol / fossil fuels / "increase in use of alternative energy sources" **do not allow** "absorbed by plants" unqualified **do not allow** "by sea" unqualified **allow** "formation of acid rain / absorbed by oceans / sea" Examiner's Comments Most candidates gained at least one mark, usually for mention of photosynthesis. Fewer described the dissolving of carbon dioxide in the sea.
			Total	2	

Question			Answer/Indicative content	Marks	Guidance
5			**Any two from** **comment about trees** trees renewable / can plant more; **detail about new process** total CO_2 output zero / trees use CO_2 / carbon neutral / trees photosynthesise; **comment about methane** methane a fossil fuel / finite / non-renewable;	2	Unspecified 'it / they' = trees **Ignore** sustainable **Ignore** atom economy **Ignore** reference to energy **Ignore** less CO2 produced / released **Examiner's Comments** Most could suggest that trees are a renewable resource, and many realised that methane is a finite resource.
			Total	**2**	
6				2	**Examiner's Comments** This was a discriminating question with good candidates able to pick out the correct statements to explain the formation of solid carbon particles when coal burns.
			Total	**2**	

Question			Answer/Indicative content	Marks	Guidance
7	a		[Level 3] Makes a choice and justifies this choice. Statements that discuss the amount of fuel burned **and** the amount of air pollution for cars and buses. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks) [Level 2] Makes a choice and justifies this choice. Answer gives comparison between buses and cars in terms of air pollution **or** fuel burned. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks) [Level 1] Simple statement about benefit of using a type of transport. 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 C Indicative scientific points may include: • choice of Dom or neither or both • fewer cars make less pollution / burn less fuel • if people travel on a bus rather than in cars then less fuel is burned overall / per person • one bus burns less fuel / makes less pollution than a number of cars • faster journey by bus linked to less fuel burned / less pollution • cars stuck in traffic burn extra fuel / make more pollution • pollution increases as more fuel burned. Simple statements: • each bus carries more people than each car • if people travel on buses there will be fewer cars • journey time is longer in a car / shorter in a bus • some buses may not be full Only credit these statements if qualified or linked • more people travel by bus • bus burns more fuel • bus travels faster Use the L1, L2, L3 annotations in Scoris; do not use ticks. Examiner's Comments This six mark question was a common question with the foundation tier. Most were able to reach level 2 by comparing the pollution caused by buses and cars, but few linked pollution to the amount of fuel burned, which would have raised them

Question			Answer/Indicative content	Marks	Guidance
					to level 3.
	b		Biofuels do not change the amount of CO_2 in the air overall / carbon neutral; (1) ORA they are renewable; (1) ORA	2	**ignore** sustainable or reusable **ignore** bland statements such as environmentally friendly **Examiner's Comments** Knowledge of biofuels was weak. Candidates gave vague comments about pollution which failed to score. Some candidates believed that biofuels do not emit polluting gases when they burn. Also there was a common misconception that biofuels do not release carbon dioxide when they burn.
	c		Fuel contains hydrogen and carbon / is a hydrocarbon; (1) complete combustion / burned in plenty of air / oxygen; (1)	2	accept 'it is a carbohydrate / alcohol' / contains hydrogen, carbon and oxygen **Examiner's Comments** A discriminating question with most able candidates gaining both marks. Some weaker candidates were confused by the terms 'complete' and 'incomplete combustion' and linked these terms to the incorrect amount of oxygen or the incorrect products of combustion.
	d		oxidised	1	**Examiner's Comments** This was well known. Those who gave an incorrect answer often chose 'carbonised'.
			Total	**11**	

Question			Answer/Indicative content	Marks	Guidance
8	a	i	1/3	1	**Examiner's Comments** This question was well answered. Almost all candidates were able to take data from the graph, but some were unable to process this data. A common error in the calculation was to subtract instead of divide. Some candidates did not read the instruction and gave the answer as a decimal.
		ii	(Almost always equal to 1/3 or very near because) Any two of: Reference to (ai) 2000 - 2010; ref to calculation over a different 10 years; ref to calculation over another different 10 years;	2	**Examiner's Comments** Most candidates scored on this question. Some only gave one piece of evidence for their answer so limited their mark. Some, who did not read the question carefully, discussed the fall in sulfur dioxide per year or per 5 years. Candidates should be aware that if they write answers such as 'the graph clearly shows it falls to a third every ten years' no marks are awarded. They need to show how they came to this conclusion.
	b		identifies number of power stations decreases and amount of sulfur dioxide decreases (2)	2	idea of 'as one (graph) goes down the other (graph) goes down' is 1 mark **ignore** positive and negative correlation **Examiner's Comments** Many candidates were able to describe the correlation shown by the two graphs. Again, weaker candidates did not read the rubric correctly and just described the second graph. Candidates should be discouraged from using 'positive' and 'negative' when writing about correlations in science. Their use of these words was often wrong, although their descriptions of the correlation were correct. Descriptions are much more relevant in a scientific context.
			Total	**5**	

Question			Answer/Indicative content	Marks	Guidance
9		i	No/very little/<1% oxygen until 2.5 billion years ago/for about (first) 1.5 billion years AW ✓ Fluctuations but overall increase / up and down but overall rise ✓	2 (AO 2 × 3.1a)	ALLOW any number in range 2.8 – 2.5 for 'about 2.5 / 1.2-1.5 for 'about 1.5' IGNORE 'increases and decreases' or 'up and down' alone Examiner's Comments The main point about this question is 'Describe how……'. Candidates sometimes tried to 'Explain why….' (which overlaps with a later question). The best answers discussed that the oxygen content was low until (approximately) 2.5 billion years ago, and showed a fluctuating increase since then. This type of question is best tackled by describing the overall trend, and adding important values (for example the timing of the start of the increase). Answers such as 'it increases' do not give the necessary detail of description that the pattern on the graph shows.
		ii	1.7 – 2(.0)	1 (AO 3.1a)	Examiner's Comments The word 'factor' was difficult for some candidates. Some wrote 'photosynthesis'. The word 'factor' has a mathematical meaning and is often applied to increases, particularly those which can be read from graphs.

Question			Answer/Indicative content	Marks	Guidance
		iii	Plants/bacteria evolved / photosynthesis✓ plants/bacteria established / number of plants or bacteria stayed the same / animals evolved / animals use up oxygen / respiration AW ✓	2 (AO 2 × 1.1)	<u>Examiner's Comments</u> Most candidates knew that photosynthesis was the important factor in the increase. Some also identified respiration as the main 'balancing' factor. Some confused the two processes, either thinking respiration produced oxygen or that it was respiration of plants themselves which eventually created a balance.
			Total	5	