2.29 Climate Change and Atmospheric Pollutants: 1-hour Pack

Total Marks

AQA 8464 · Calculator allowed · about 60 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

Figure 1: Global Carbon Dioxide and Temperature Data (illustrative)

Original data table written for Revision Library.

Year	Atmospheric CO_2 concentration (ppm)	Global mean temperature anomaly (°C, relative to a 1850-1900 baseline)
1960	315	+0.0
1990	355	+0.5
2020	415	+1.1

Note: these figures are simplified and illustrative for teaching purposes; they show the same overall trend reported in published international climate data.

1 Many fossil fuels, such as coal, contain small amounts of sulfur as an impurity.

(a) Explain how burning a fossil fuel that contains sulfur impurities produces sulfur dioxide. **(2)**

(b) Write a word equation for this reaction. **(1)**

(c) Explain how sulfur dioxide released into the atmosphere leads to acid rain. **(2)**

(d) State one problem caused by acid rain. **(1)**

(Total for Question 1 is 6 marks)

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2 Table 2 shows the mean concentration of oxides of nitrogen (NOx) measured at two monitoring stations over one year.

Table 2

Location	Mean NOx concentration (micrograms/m^3)
Busy road	120
Rural area	30

(a) Calculate how many times greater the mean NOx concentration was at the busy road compared with the rural area. **(2)**

.....

(b) Suggest one reason for the difference in NOx concentration between the two locations. **(1)**

.....

(c) A newspaper claimed that this data proves traffic is the only cause of the higher NOx levels at the busy road. Evaluate this claim. **(2)**

.....

(Total for Question 2 is 5 marks)

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3 Global climate change is linked to rising sea levels and more frequent extreme weather events.

(a) Describe how rising global temperatures can lead to a rise in sea level. **(2)**

.....

.....

(b) State two effects that more frequent extreme weather events, caused by climate change, could have on the UK. **(2)**

(Total for Question 3 is 4 marks)

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4 Evaluate the methods that could be used, at a personal, national and international level, to reduce the negative effects of climate change caused by increased greenhouse gas emissions. In your answer, you should refer to the limitations of the evidence and methods you discuss.

(Total for Question 4 is 6 marks)

5 The Earth's surface is kept warm by the natural greenhouse effect, which has been enhanced by human activity since the industrial revolution.

(a) Explain how greenhouse gases in the atmosphere cause the Earth's surface to be warmer than it would otherwise be. **(2)**

(b) Name one greenhouse gas, other than carbon dioxide, that occurs naturally in the atmosphere. **(1)**

(Total for Question 5 is 3 marks)

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6 A local council is deciding between two projects to help reduce the area's carbon footprint.
Project A: a tree-planting programme costing £2,000,000, saving 40,000 tonnes of CO_2 per year.
Project B: an offshore wind farm costing £150,000,000, saving 2,500,000 tonnes of CO_2 per year.

(a) Calculate the cost per tonne of CO_2 saved per year for each project. **(2)**

.....

(b) Using your answers to part (a) and one other factor, evaluate which project the council should choose. **(2)**

.....

(Total for Question 6 is 4 marks)

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7 Since the industrial revolution, human activities have increased the concentration of greenhouse gases in the atmosphere.

(a) Name the greenhouse gas released in the largest quantities by burning fossil fuels. **(1)**

(b) Name a human activity, other than burning fossil fuels, that releases significant amounts of methane into the atmosphere. **(1)**

(c) Explain why cutting down large areas of forest (deforestation) increases the concentration of carbon dioxide in the atmosphere. **(2)**

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(Total for Question 7 is 4 marks)

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8 The Ahmed family are calculating the carbon footprint of a weekend trip.

(a) They drive 150 km to visit relatives. Their car produces 0.16 kg of CO_2 equivalent (CO_2e) per km. Calculate the CO_2e produced by the car journey. **(2)**

.....

(b) Two family members also take a return domestic flight, and each passenger's flight produces 105 kg of CO_2e. Calculate the total carbon footprint of the whole trip (the car journey plus both flights). **(2)**

.....

(Total for Question 8 is 4 marks)

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9 Individuals, as well as governments, can take action to reduce greenhouse gas emissions.

(a) Define the term 'carbon footprint'. **(1)**

.....

(b) State one way an individual could reduce their personal carbon footprint. **(1)**

.....

(Total for Question 9 is 2 marks)

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10 National governments can take action to reduce a country's total carbon footprint.

(a) Explain how carbon capture and storage (CCS) reduces the amount of carbon dioxide released into the atmosphere from power stations. **(2)**

.....

.....

(b) Explain how increasing the proportion of electricity generated from renewable sources, such as wind or solar power, reduces a country's carbon footprint. **(2)**

.....

.....

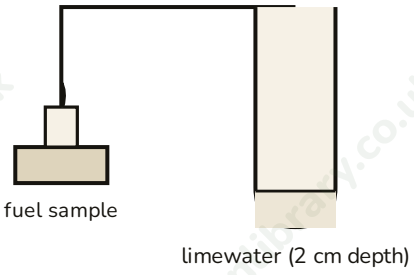
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(Total for Question 10 is 4 marks)

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11 Tomasz wanted to find out whether the gas produced when a hydrocarbon fuel burns is carbon dioxide.



(a) Describe a method, using limewater, that Tomasz could use to test whether the gas produced is carbon dioxide. **(3)**

(b) Suggest one variable that should be controlled when comparing the amount of carbon dioxide produced by burning different fuels, to make it a fair test. **(1)**

(c) Tomasz timed how long it took the limewater to turn cloudy for each fuel, and used this time to compare how much carbon dioxide each fuel produced. He noticed the limewater took longer to turn cloudy when a smaller sample of gas was collected. Explain why this is a problem for the reliability of his comparison. **(2)**

(d) State one safety precaution Tomasz should take when carrying out this experiment. **(1)**

(Total for Question 11 is 7 marks)

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12 Use the information in Figure 1 above to answer this question.

(a) Describe the trend in atmospheric CO_2 concentration shown in Figure 1 between 1960 and 2020. **(2)**

(b) Calculate the percentage increase in atmospheric CO_2 concentration between 1960 and 2020. Give your answer to 1 decimal place. **(2)**

(Total for Question 12 is 4 marks)

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Mark scheme · 2.29 Climate Change and Atmospheric Pollutants: 1-hour Pack

Question 1

(a) the sulfur impurities in the fuel react with oxygen in the air during combustion oe **B1**

(a) forming sulfur dioxide gas (SO_2) oe **B1**

(a) Answer: Sulfur impurities in the fuel react with oxygen during combustion, forming sulfur dioxide gas

(b) sulfur + oxygen -> sulfur dioxide cao **B1**

(b) Answer: sulfur + oxygen -> sulfur dioxide

(c) sulfur dioxide dissolves in atmospheric water droplets (in clouds/rain) and reacts with oxygen oe **B1**

(c) forming (dilute) sulfuric acid, which falls as acid rain oe **B1**

(c) Answer: Sulfur dioxide dissolves in atmospheric water and reacts with oxygen, forming dilute sulfuric acid, which falls as acid rain

(d) any valid problem, e.g. damages/kills trees and plants; acidifies lakes and rivers, harming aquatic life; erodes limestone buildings and statues; corrodes metal structures oe **B1**

(d) Answer: Any valid problem, e.g. damage to trees and plants, or acidification of lakes and rivers

Question 2

(a) 120 / 30 oe **M1**

(a) 4 (times greater) cao **A1**

(a) Answer: 4 times greater

(b) there is more traffic/more vehicles burning fuel at the busy road, releasing more oxides of nitrogen oe **B1**

(b) Answer: There is more traffic at the busy road, so more fuel is burned in vehicle engines, releasing more NOx

(c) the data shows a correlation/association between traffic and higher NOx levels but does not, on its own, prove traffic is the (only) cause oe **B1**

(c) other factors could contribute, e.g. nearby industry or weather conditions affecting how the gas disperses, so further evidence would be needed to establish a causal link oe **B1**

(c) Answer: The data shows a correlation but does not, on its own, prove traffic is the only cause; other factors (e.g. nearby industry, weather affecting dispersion) could contribute, so more evidence would be needed to prove causation

Question 3

(a) higher temperatures cause polar ice caps and glaciers to melt, adding water to the oceans oe **B1**

(a) higher temperatures also cause thermal expansion of sea water (water expands as it warms), both increasing sea level oe **B1**

(a) Answer: Melting ice caps and glaciers add water to the oceans, and thermal expansion of warming sea water also increases its volume; both raise sea level

(b) any one effect, e.g. increased risk/frequency of flooding from heavier rainfall or storms oe **B1**

(b) any second, different effect, e.g. damage to homes, infrastructure and agriculture, or increased risk of heatwaves/drought oe **B1**

(b) Answer: Any two of: increased flooding from heavier rainfall/storms; damage to homes, infrastructure and agriculture; increased risk of heatwaves or drought

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Question 4

Level 3 A detailed and coherent evaluation, referring to methods at more than one scale (personal/national/international) with clear explanation of how each reduces greenhouse gas emissions, together with a discussion of at least one limitation (e.g. cost, scientific uncertainty, need for international cooperation) and a reasoned conclusion. The answer is logically structured throughout. **5-6**

Level 2 Relevant methods are described at one or more scales with some explanation of how they reduce emissions. Some limitations may be mentioned but are not fully linked to a conclusion. The answer has some structure. **3-4**

Level 1 Basic or isolated statements about reducing climate change are given, with little or no explanation or evaluation, and limited use of scientific terminology. **1-2**

Level 0 No relevant content. **0**

Indicative content:

- Personal: reduce car use by walking, cycling or using public transport; take fewer flights; improve home insulation and use energy-efficient appliances; eat less meat and dairy, which reduces methane from farming; reduce, reuse and recycle to lower personal carbon footprint.
- National: increase the proportion of electricity generated from renewable or low-carbon sources such as wind, solar or nuclear power; use carbon capture and storage at power stations and industrial sites; government taxation or incentives, e.g. taxing high emitters or subsidising renewables and electric vehicles; tree-planting and reforestation programmes to increase carbon sinks.
- International: international agreements or targets to limit greenhouse gas emissions; carbon trading or carbon pricing schemes between countries; sharing or funding low-carbon technology with developing countries.
- Limitations: many methods are expensive to implement, e.g. carbon capture and storage or renewable infrastructure; they require international cooperation and agreement, which can be difficult to achieve or enforce; scientific models used to predict the effects of climate change and of interventions have uncertainties, due to incomplete data and simplifying assumptions about complex systems; changes may take a long time to have an effect, e.g. trees take years to grow and behaviour change is slow; some methods have their own drawbacks, e.g. land use for wind farms or tree planting, or costs passed on to consumers.

Question 5

(a) the Earth's surface absorbs (short-wavelength) radiation from the Sun and re-radiates it as longer-wavelength infrared radiation oe **B1**

(a) greenhouse gases absorb this infrared radiation and re-radiate it in all directions, including back towards the surface, keeping the lower atmosphere warmer oe **B1**

(a) Answer: The Earth's surface absorbs radiation from the Sun and re-radiates it as infrared radiation; greenhouse gases absorb this infrared radiation and re-radiate it in all directions, including back to the surface, keeping it warmer

(b) water vapour oe (accept methane) **B1**

(b) Answer: Water vapour (methane is also accepted)

Question 6

(a) Project A: 2,000,000 / 40,000 = £50 per tonne oe **M1**

(a) Project B: 150,000,000 / 2,500,000 = £60 per tonne cao (both values correct) **A1**

(a) Answer: Project A: £50 per tonne. Project B: £60 per tonne

(b) correct comparison based on part (a), e.g. Project A is more cost-effective per tonne of CO_2 saved (lower cost per tonne), ft from (a), but Project B saves a far greater total mass of CO_2 per year oe **B1**

(b) valid reference to at least one additional factor, e.g. permanence (trees can be lost to disease, fire or felling, whereas a wind farm provides consistent generation for its lifetime), land use, or the timescale before benefits are realised (trees take years to mature) oe, with a justified conclusion **B1**

(b) Answer: Accept either project if justified: e.g. Project A is more cost-effective per tonne (£50 vs £60), but Project B saves a much greater total mass of CO_2 and is more permanent/reliable than trees, which take years to mature and can be lost to disease or fire

Question 7

(a) carbon dioxide cao **B1**

(a) Answer: Carbon dioxide

(b) livestock farming/cattle rearing oe (accept rice growing/paddy fields, or landfill sites) **B1**

(b) Answer: Livestock farming (rice growing and landfill sites are also accepted)

(c) fewer trees means less photosynthesis, so less carbon dioxide is removed from the atmosphere oe **B1**

(c) cleared trees are often burned or left to decompose, releasing the carbon they had stored as carbon dioxide oe **B1**

(c) Answer: Fewer trees means less photosynthesis removing CO_2 from the air, and cleared trees are often burned or decompose, releasing stored carbon as CO_2

Question 8

(a) 150 x 0.16 oe **M1**

(a) 24 kg CO_2e cao **A1**

(a) Answer: 24 kg CO_2e

(b) 2 x 105 (= 210) added to their answer to part (a) oe, ft **M1**

(b) 234 kg CO_2e cao, ft from (a) **A1**

(b) Answer: 234 kg CO_2e

Question 9

(a) the total amount of greenhouse gases released, directly or indirectly, by an activity, product, individual or organisation, usually measured as CO_2 equivalent, over a given period oe **B1**

(a) Answer: The total amount of greenhouse gases (measured as CO_2 equivalent) released directly or indirectly by an activity, product, individual or organisation

(b) any valid method, e.g. walk/cycle/use public transport instead of driving; take fewer flights; use energy-efficient appliances/insulate the home; eat less meat and dairy oe **B1**

(b) Answer: Any valid method, e.g. walking or cycling instead of driving, taking fewer flights, or improving home insulation

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Question 10

(a) carbon dioxide produced by burning fossil fuels is captured before it is released into the atmosphere oe **B1**

(a) the captured CO_2 is transported and stored, e.g. pumped into depleted oil and gas fields underground, so it cannot enter the atmosphere oe **B1**

(a) Answer: CO_2 produced by burning fossil fuels is captured before release, then transported and stored underground (e.g. in depleted oil and gas fields) so it cannot enter the atmosphere

(b) renewable sources do not burn fossil fuels, so they release little or no carbon dioxide when generating electricity oe **B1**

(b) replacing fossil-fuel power stations with renewables therefore reduces the total CO_2 released for the same amount of electricity generated oe **B1**

(b) Answer: Renewables do not burn fossil fuels, so they release little or no CO_2 when generating electricity; replacing fossil-fuel power stations with renewables reduces total emissions

Question 11

(a) collect the gas produced by the burning fuel, e.g. using a delivery tube leading into a test tube/boiling tube oe **M1**

(a) bubble the collected gas through (or shake it with) limewater oe **M1**

(a) if the gas is carbon dioxide, the limewater turns cloudy/milky cao **A1**

(a) Answer: Collect the gas produced using a delivery tube into a boiling tube, then bubble it through limewater; if the gas is CO_2, the limewater turns cloudy/milky

(b) any one sensible control variable, e.g. mass/volume of fuel burned; time the fuel is burned for; volume of limewater used; distance of the fuel from the apparatus oe **B1**

(b) Answer: Any one of: mass or volume of fuel burned, time the fuel burns for, or volume of limewater used

(c) the time taken depends on how much gas is collected, not only on which fuel produced it, so results will only be comparable if the volume of gas collected is controlled/kept the same oe **B1**

(c) a fuel could appear to produce less CO_2 simply because less gas was collected, not because it actually produces less CO_2 per unit of fuel, making the comparison unreliable oe **B1**

(c) Answer: The time taken depends on the volume of gas collected as well as the fuel used, so unless this is controlled a fuel could wrongly appear to produce less CO_2 simply because less gas was collected

(d) any valid precaution, e.g. wear eye protection; keep flammable materials away from the flame; ensure good ventilation; tie back long hair oe **B1**

(d) Answer: Any valid precaution, e.g. wearing eye protection or keeping flammable materials away from the flame

Question 12

(a) the CO_2 concentration increased/rose throughout the period oe **B1**

(a) with a supporting figure, e.g. it rose by 100 ppm, from 315 ppm to 415 ppm oe **B1**

(a) Answer: It rose steadily throughout the period, increasing by 100 ppm from 315 ppm in 1960 to 415 ppm in 2020

(b) (415 - 315) / 315 x 100 oe **M1**

(b) 31.7% cao (accept 31.6-31.8%) **A1**

(b) Answer: 31.7%

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