2.10 Chemistry of the Atmosphere: 1-hour Pack

AQA 8462 · Calculator allowed · about 60 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 When fossil fuels are burned, nitrogen oxides (NOx) and carbon monoxide (CO) can be produced. State one harmful effect of each of these gases on human health or the environment.

(Total for Question 1 is 2 marks)

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2 Name two gases that were much more abundant in the Earth's early atmosphere than they are today.

(a) Give two gases that were much more abundant in the Earth's early atmosphere than they are today. **(2)**

(Total for Question 2 is 2 marks)

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3 Burning fossil fuels releases several pollutants in addition to carbon dioxide.

(a) Explain why carbon monoxide, produced by incomplete combustion, is toxic to humans. **(2)**

(b) Fossil fuels often contain sulfur impurities. Explain how burning these fuels leads to acid rain. Include a balanced symbol equation for the formation of sulfur dioxide from sulfur. **(4)**

(c) State two problems caused by acid rain. **(2)**

(Total for Question 3 is 8 marks)

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4 The table gives estimated percentages of carbon dioxide and oxygen in the Earth's atmosphere at different times in its history.

Time (billion years ago): 4.6	3.5	2.5	1.0	present day (0)
Carbon dioxide (%): 95	80	40	5	0.04
Oxygen (%): 0	0	5	15	21

(The remainder of the atmosphere was made up mainly of nitrogen and other gases.)

(a) Calculate the percentage decrease in atmospheric carbon dioxide concentration between 3.5 billion years ago and 1.0 billion years ago. **(2)**

(b) Suggest why the concentration of oxygen in the atmosphere began to increase noticeably after about 2.5 billion years ago. **(2)**

(c) Write a word equation for photosynthesis, the process responsible for this increase in oxygen. **(2)**

(Total for Question 4 is 6 marks)

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5 Governments, organisations and individuals can all take action to reduce carbon dioxide emissions.

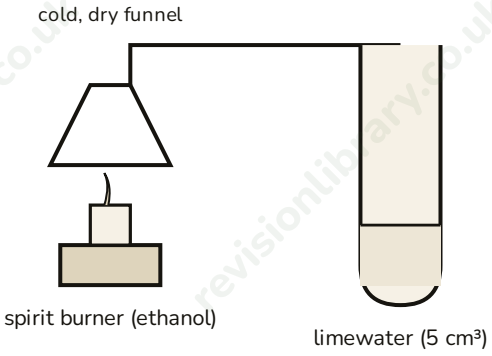
(a) Give three ways in which an individual could reduce their personal carbon footprint. **(3)**

(b) Describe the process of carbon capture and storage (CCS) and explain how it helps to reduce the amount of carbon dioxide entering the atmosphere. **(3)**

(Total for Question 5 is 6 marks)

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6 Required practical style question. A student investigates the products formed when ethanol (C_2H_5OH) is burned completely. A spirit burner containing ethanol is lit under a boiling tube, and a cold, dry glass funnel is held just above the flame. The funnel is connected by a delivery tube to a second boiling tube containing 5 cm^3 of limewater, so that combustion gases pass through it.



(a) Name the test used to detect carbon dioxide gas and describe the observation if carbon dioxide is present. **(2)**

(b) A colourless liquid collects on the cold funnel. Describe a chemical test the student could use to show that this liquid contains water. **(2)**

(c) Complete the balanced symbol equation for the complete combustion of ethanol: **(2)**

$C_2H_5OH + 3O_2$ -> ___ + ___

(d) The student's 2.3 g sample of ethanol should theoretically produce 2.7 g of water on complete combustion. The student actually collected 1.8 g of water. Calculate the percentage yield of water. **(3)**

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(e) Suggest two reasons, other than experimental error, why the percentage yield of water was less than 100%. **(2)**

(f) Evaluate this method, suggesting one improvement that would increase the reliability of the mass of water collected. **(2)**

(g) Explain why the glass funnel must be cold and dry before the experiment begins. **(2)**

(Total for Question 6 is 15 marks)

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7 Extended response (6 marks).

Explain how human activities have changed the composition of the atmosphere since the start of the industrial revolution, and describe two effects these changes have on the environment or human health. You should give reasons and link causes to effects.

(Total for Question 7 is 6 marks)

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Mark scheme · 2.10 Chemistry of the Atmosphere: 1-hour Pack

Question 1

NOx causes respiratory problems or contributes to acid rain or creates smog/photochemical ozone, oe **B1**

CO reduces the oxygen-carrying capacity of blood and can cause illness or death, oe **B1**

Answer: NOx can cause respiratory problems, acid rain or smog formation; CO reduces blood oxygen carrying capacity and can cause illness or death.

Question 2

(a) any one from: carbon dioxide, water vapour, methane, ammonia **B1**

(a) any other one from the same list, oe **B1**

(a) Answer: Any two from: carbon dioxide; water vapour; methane; ammonia.

Question 3

(a) carbon monoxide binds to haemoglobin in red blood cells, in place of oxygen (oe) **B1**

(a) this reduces the amount of oxygen that can be carried around the body/to cells, which can cause suffocation or death (oe) **B1**

(a) Answer: Carbon monoxide binds to haemoglobin in red blood cells instead of oxygen, reducing the amount of oxygen transported around the body, which can lead to suffocation or death.

(b) $S + O_2 \rightarrow SO_2$ (correctly balanced equation) **B1**

(b) sulfur impurities in the fuel react with oxygen during combustion, releasing sulfur dioxide gas (oe) **B1**

(b) sulfur dioxide dissolves in atmospheric water droplets/rainwater (oe) **B1**

(b) reacting to form (dilute) sulfurous/sulfuric acid, which falls to the ground as acid rain (oe) **B1**

(b) Answer: $S + O_2 \rightarrow SO_2$. Sulfur impurities in the fuel burn to form sulfur dioxide gas, which dissolves in rainwater/atmospheric water droplets and reacts to form dilute sulfurous or sulfuric acid, which falls as acid rain.

(c) any one from: damages/kills trees and plants; acidifies lakes and rivers, harming or killing aquatic life; corrodes/erodes buildings and statues, especially those made of limestone or marble (any two distinct points, max 2) **B1**

(c) second distinct valid point from the list above **B1**

(c) Answer: Any two from: damages trees and plants; acidifies lakes and rivers, harming aquatic life; corrodes buildings and statues, particularly limestone or marble structures.

Question 4

(a) (80 - 5) / 80 x 100 seen, or equivalent method **M1**

(a) 93.75% (accept awrt 94%) cao **A1**

(a) Answer: 93.75% (approximately 94%)

(b) photosynthesising organisms, such as algae (and later plants), evolved (oe) **B1**

(b) these organisms released oxygen as a product of photosynthesis, which built up in the atmosphere (oe) **B1**

(b) Answer: Photosynthesising organisms such as algae evolved and released oxygen as a waste product of photosynthesis, which gradually built up in the atmosphere.

(c) carbon dioxide + water on the reactants side (oe) **B1**

(c) glucose + oxygen on the products side (oe) **B1**

(c) Answer: carbon dioxide + water -> glucose + oxygen

Question 5

(a) any one from: using public transport, walking or cycling instead of car travel **B1**

(a) any one from: using renewable energy sources at home, or improving home insulation to reduce energy use **B1**

(a) any one from: eating less meat/reducing food miles, flying less, or recycling more (any three distinct valid points from the list, max 3) **B1**

(a) Answer: Any three from: using public transport/walking/cycling instead of driving; using renewable energy or improving home insulation; eating less meat or reducing food miles; flying less; recycling more.

(b) carbon dioxide produced by power stations/industrial processes is captured/separated from other waste gases (oe) **B1**

(b) the captured carbon dioxide is transported, e.g. by pipeline (oe) **B1**

(b) it is injected into and stored in porous rock or depleted oil/gas reservoirs (often deep underground or under the seabed), preventing it entering the atmosphere (oe) **B1**

(b) Answer: Carbon dioxide from power stations or industrial processes is captured before it is released, transported (e.g. by pipeline), and injected into porous rock or depleted oil/gas reservoirs for long-term storage, preventing it entering the atmosphere.

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Question 6

(a) bubble the gas through limewater **B1**

(a) the limewater turns cloudy/milky **B1**

(a) Answer: Bubble the gas through limewater; if carbon dioxide is present, the limewater turns cloudy (milky).

(b) add the liquid to white anhydrous copper sulfate (oe, cobalt chloride paper also accepted) **B1**

(b) the anhydrous copper sulfate turns blue (oe, cobalt chloride paper turns from blue to pink) if water is present **B1**

(b) Answer: Add the liquid to white anhydrous copper sulfate; if water is present it turns blue (or use cobalt chloride paper, which turns from blue to pink).

(c) products identified as carbon dioxide and water **M1**

(c) $2CO_2 + 3H_2O$, fully balanced cao **A1**

(c) Answer: $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$

(d) percentage yield = actual yield / theoretical yield x 100 identified **M1**

(d) 1.8 / 2.7 x 100 (dependent on first mark) **M1**

(d) 66.7% (accept awrt 66.7% or 67%) cao **A1**

(d) Answer: 66.7%

(e) any one from: incomplete combustion occurred, producing soot/carbon monoxide instead of full conversion to CO_2 and water (oe) **B1**

(e) any one from: some water escaped as vapour without condensing on the funnel, or heat/gas was lost to the surroundings (oe, max 2 for two distinct valid reasons) **B1**

(e) Answer: Any two from: incomplete combustion occurred (producing some soot/carbon monoxide rather than full conversion); some water vapour escaped without condensing on the funnel; heat or gas was lost to the surroundings.

(f) a valid improvement identified, e.g. repeat the experiment (with the same mass of ethanol) and calculate a mean mass of water collected, or use a larger/more effective condensing surface (oe) **B1**

(f) linked justification, e.g. this would reduce the effect of any one anomalous result, or would condense a greater proportion of the water vapour produced (oe) **B1**

(f) Answer: Repeat the experiment and calculate a mean mass of water collected, to reduce the effect of any anomalous result; or use a larger/colder condensing surface to condense a greater proportion of the water vapour produced.

(g) cold, so that water vapour produced by combustion condenses on the funnel and can be collected as a liquid (oe) **B1**

(g) dry, so that no water is already present on the funnel that would give a false/misleading result (oe) **B1**

(g) Answer: The funnel must be cold so that water vapour from combustion condenses on it and can be collected as liquid water; it must be dry so there is no water already present that would give a false result.

Question 7

Level 3 Detailed explanation. Links multiple human activities to specific changes in atmospheric composition and gives two developed effects with clear cause-effect links and relevant examples. **5-6**

Level 2 Some explanation. Mentions at least one human activity and one change in atmospheric composition plus one effect with some linking comment. **3-4**

Level 1 Simple statements. Limited link between activities and atmospheric change or only lists effects without explanation. **1-2**

Indicative content:

- Human activities such as burning fossil fuels for energy, transport and industry have increased CO_2 concentrations.
- Agriculture and waste produce methane from livestock and decomposition.
- Burning fuels and industry release nitrogen oxides and sulfur dioxide.
- These changes increase greenhouse gases, enhancing the greenhouse effect and causing global warming and climate change - give example such as sea level rise or changing weather patterns.
- Air pollutants like NOx, SO_2 and particulates cause respiratory illnesses and contribute to acid rain damaging buildings, rivers and soils.
- Link causes to effects: more fossil fuel burning -> more CO_2 -> more trapped infrared radiation -> higher global temperatures; more SO_2 -> acid rain -> damaged ecosystems and buildings.

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