# 2.10 Chemistry of the Atmosphere: Test Pack

AQA 8462 · Calculator allowed · about 55 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

**Answer ALL questions. Show all your working.**

**1** State the name of the gas that makes up about 78 percent of Earth's atmosphere.

**(Total for Question 1 is 1 mark)**

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**2** Name the greenhouse gas that is produced by growing rice in flooded fields and from cattle digestion, and give its chemical formula.

**(Total for Question 2 is 2 marks)**


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**3** The composition of the Earth's atmosphere has changed enormously since the planet formed about 4.6 billion years ago.

**(a)** Which of these is closest to the percentage of nitrogen gas in the Earth's atmosphere today? **(1)**

- ☐ A) 21%
- ☐ B) 78%
- ☐ C) 95%
- ☐ D) 0.04%

**(b)** Which of these is closest to the percentage of oxygen gas in the Earth's atmosphere today? **(1)**

- ☐ A) 78%
- ☐ B) 21%
- ☐ C) 60%
- ☐ D) 4%

**(c)** Which process released most of the gases that made up the Earth's very early atmosphere, about 4.6 billion years ago? **(1)**

- ☐ A) Photosynthesis by algae
- ☐ B) Volcanic activity
- ☐ C) Human industry
- ☐ D) Evaporation from oceans

**(Total for Question 3 is 3 marks)**

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**4** Complete the sentence. Sulfur dioxide is released when fuels that contain sulfur are burned. Sulfur dioxide dissolves in rain to form an acid. Name this acid, and state one effect of acid rain.

**(Total for Question 4 is 2 marks)**


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**5** A student measured the concentration of carbon dioxide in outside air at different times of day. Their results were: 08:00 - 420 ppm, 12:00 - 390 ppm, 18:00 - 430 ppm.

Suggest two reasons why the $CO_2$ concentration was lower at 12:00 than at 08:00 and 18:00, and explain one of them.

**(Total for Question 5 is 3 marks)**

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**6** Biofuels, made from plant material, are sometimes described as 'carbon neutral'.

**(a)** Explain why biofuels are sometimes described as carbon neutral. **(3)**

**(b)** Give one limitation of describing biofuels as fully 'carbon neutral'. **(2)**

**(Total for Question 6 is 5 marks)**

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**7** Human activities that release greenhouse gases contribute to a person's or organisation's 'carbon footprint'.

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

**(b)** A family's car releases 0.24 kg of carbon dioxide for every kilometre travelled. Calculate the total mass of carbon dioxide released for a return car journey of 45 km. **(3)**

**(Total for Question 7 is 4 marks)**


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**8** Scientists have recorded the concentration of carbon dioxide in the atmosphere continuously since 1950, alongside global average surface temperature.

**(a)** Describe the trend shown by a graph of atmospheric carbon dioxide concentration plotted against time from 1950 to the present day. **(2)**

**(b)** A rise in atmospheric carbon dioxide concentration correlates with a rise in global average temperature over the same period. Evaluate why this correlation alone does not prove that carbon dioxide causes the temperature rise. **(3)**

**(Total for Question 8 is 5 marks)**


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**9** Oxides of nitrogen (NOx) formed in car engines can produce acid rain. A catalytic converter reduces NOx by converting NO to harmless $N_2$ and $O_2$. Suggest why catalytic converters are less effective at very low temperatures, and give one practical change an engineer could make to improve cold-start performance of the converter, explaining how it helps and one trade-off or consequence of making it.

**(Total for Question 9 is 5 marks)**

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**10** Hard question: A power station burns methane (natural gas) to generate electricity. Complete combustion of methane is described by the equation: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$.

**(a)** Explain, using the equation, why burning methane increases the concentration of the greenhouse gas carbon dioxide in the atmosphere and describe how this contributes to the greenhouse effect. **(4)**

**(b)** The power station burns $4.00 \times 10^4$ kg of methane in one day. (Mr: $CH_4 = 16$, $CO_2 = 44$) Calculate the mass of carbon dioxide released that day. A carbon capture system is then fitted that removes $8.80 \times 10^4$ kg of $CO_2$ per day from the exhaust gas. Calculate the percentage decrease in the mass of $CO_2$ released to the atmosphere as a result of the carbon capture system. Show working. **(6)**

**(Total for Question 10 is 10 marks)**


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# Mark scheme · 2.10 Chemistry of the Atmosphere: Test Pack

## Question 1

nitrogen cao **B1**

**Answer: Nitrogen.**

## Question 2

methane cao **B1**

$CH_4$ cao **B1**

**Answer: Methane ($CH_4$).**

## Question 3

(a) B) 78% **B1**

**(a) Answer: B) 78%**

(b) B) 21% **B1**

**(b) Answer: B) 21%**

(c) B) Volcanic activity **B1**

**(c) Answer: B) Volcanic activity**

## Question 4

sulfuric acid or $H_2SO_4$ (accept sulfurous acid or $H_2SO_3$) cao **B1**

one effect of acid rain, e.g. damage to buildings, statues or plants, oe **B1**

**Answer: Sulfuric acid ($H_2SO_4$); sulfurous acid ($H_2SO_3$) is also accepted. Acid rain damages buildings and plants.**

## Question 5

identifies increased photosynthesis around midday as a reason, oe **M1**

links daytime higher light intensity to more $CO_2$ uptake by plants, reducing atmospheric $CO_2$ at 12:00, oe **A1**

alternatively mentions that traffic emissions are lower at midday than at rush hour (and so fewer emissions), oe **B1**

**Answer: More photosynthesis at midday (more light) so plants remove more $CO_2$; also midday traffic emissions can be lower than rush hour.**

## Question 6

(a) as the biofuel crop grows, it absorbs carbon dioxide from the atmosphere through photosynthesis (oe) **B1**

(a) this absorbed carbon dioxide roughly balances/is approximately equal to the carbon dioxide released when the biofuel is later burned (oe) **B1**

(a) so there is little or no net increase in atmospheric carbon dioxide over the fuel's life cycle (oe) **B1**

**(a) Answer: Biofuel crops absorb carbon dioxide from the atmosphere as they grow, which roughly balances the carbon dioxide released when the fuel is burned, so there is little or no net increase in atmospheric carbon dioxide overall.**

(b) growing, harvesting, processing and transporting the biofuel crop itself releases carbon dioxide, e.g. from fossil-fuelled machinery, fertiliser production or transport (oe) **B1**

(b) these additional emissions are not accounted for by the simple 'carbon neutral' balance, so biofuels are not truly/fully carbon neutral in practice (oe, alternative valid point: land-use change, e.g. clearing forest to grow biofuel crops, releases stored carbon) **B1**

**(b) Answer: Growing, processing and transporting biofuel crops itself releases carbon dioxide (e.g. from machinery, fertiliser production or transport, or from land-use change such as deforestation), which is not accounted for by the simple carbon-neutral balance, so biofuels are not truly carbon neutral in practice.**

## Question 7

(a) the total amount of carbon dioxide (and other greenhouse gases) released into the atmosphere, e.g. over the life cycle of a product, service or activity (oe) **B1**

**(a) Answer: The total amount of greenhouse gases (mainly carbon dioxide) released into the atmosphere as a result of an individual's, organisation's or product's activities.**

(b) 45 x 2 = 90 km (recognising a return journey is double the one-way distance) **M1**

(b) 90 x 0.24 (dependent on first mark) **M1**

(b) 21.6 kg (cao, allow awrt 21.6 kg) **A1**

**(b) Answer: 21.6 kg**


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## Question 8

(a) carbon dioxide concentration has risen/increased throughout the period (oe) **B1**

(a) the rate of increase has itself become greater in more recent decades (oe, accept 'increasing at an increasing rate') **B1**

**(a) Answer: The graph shows a continuous rise in carbon dioxide concentration from 1950 to the present day, with the rate of increase becoming steeper in more recent decades.**

(b) a correlation only shows that two variables change together/at the same time (oe) **B1**

(b) it does not show which variable, if either, is causing the change in the other, or whether both are caused by a third factor (oe) **B1**

(b) scientists need additional evidence, e.g. testing the physical mechanism by which carbon dioxide absorbs infrared radiation, or ruling out other explanations, before concluding causation (oe) **B1**

**(b) Answer: A correlation only shows that two variables change together, not that one causes the other; the change could be coincidental or caused by a third factor. Scientists need further evidence, such as demonstrating the physical mechanism of $CO_2$ absorbing infrared radiation, before concluding causation.**

## Question 9

at low temperature reaction rates on the catalyst surface are slower because molecules have less kinetic energy **B1**

the catalyst surface may be partially poisoned or less active when cold, reducing conversion efficiency, oe **B1**

practical change: fit a close-coupled converter nearer the engine so it heats up faster or use electrically heated catalyst, oe **B1**

practical change explanation: nearer engine or heating raises temperature quickly so converter reaches operating temperature faster **B1**

gives a realistic engineering trade-off or consequence such as increased cost or packaging complexity **B1**

**Answer: Converters are less effective when cold because surface reaction rates are slower and the catalyst may be less active; fitting the converter closer to the engine or using an electrically heated catalyst warms it faster so it reaches operating temperature sooner, though this increases cost or packaging complexity.**

## Question 10

(a) burning methane (a fossil fuel) releases carbon dioxide, a greenhouse gas, into the atmosphere, oe **B1**

(a) this carbon was previously locked away in the fossil fuel, so burning fossil fuels increases the concentration of $CO_2$ in the atmosphere, oe **B1**

(a) the increased $CO_2$ absorbs infrared (long-wave) radiation re-radiated from the Earth's surface, oe **B1**

(a) this traps more energy in the atmosphere, causing an enhanced greenhouse effect and global warming, oe **B1**

**(a) Answer: Burning methane releases $CO_2$ that was previously locked in the fossil fuel, increasing atmospheric $CO_2$ concentration. $CO_2$ absorbs infrared radiation re-radiated from the Earth's surface, trapping more energy in the atmosphere; this enhanced greenhouse effect causes global warming.**

(b) uses the 1:1 mole ratio ($CH_4$:$CO_2$) and the Mr ratio to find mass of $CO_2$: mass $CO_2$ = mass $CH_4$ x (44/16) **M1**

(b) mass of $CO_2$ released before capture = $4.00 \times 10^4 \times 2.75 = 1.10 \times 10^5$ kg cao **A1**

(b) uses consistent units (kg) throughout **B1**

(b) sets up percentage decrease = (mass $CO_2$ captured / mass $CO_2$ originally released) x 100 = $(8.80 \times 10^4 / 1.10 \times 10^5) \times 100$ **M1**

(b) = 80.0 % cao **A1**

(b) includes the % unit with the final answer **B1**

**(b) Answer: Mass of $CO_2$ released before capture = $4.00 \times 10^4 \times (44/16) = 1.10 \times 10^5$ kg. Percentage decrease = $(8.80 \times 10^4 / 1.10 \times 10^5) \times 100 = 80.0$ %.**


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