C9: Chemistry of the Atmosphere 1

ANSWER KEY

21.1	What is the approximate proportion of nitrogen in Earth's current atmosphere?	78%
21.2	What is the approximate proportion of oxygen in Earth's current atmosphere?	21%
21.3	What does the other 1% of the atmosphere consist of?	Mainly noble gases like argon, with traces of water vapour and carbon dioxide
21.4	When Earth was formed which planets was its atmosphere similar to?	Venus and Mars
21.5	What does the atmosphere on Mars and Venus mainly consist of?	Carbon dioxide, with little or no oxygen
21.6	Which gases were present in Earth's early atmosphere?	 carbon dioxide water vapour nitrogen (with very small amounts of methane and ammonia)
21.7	What happened to most of the water vapour as the early earth cooled?	Condensed and formed the oceans
21.8	What happened to the atmosphere once green plants eventually evolved?	Photosynthesis used up carbon dioxide (atmospheric levels decreased), and released oxygen (levels increased)
21.9	Write the word equation to represent photosynthesis	carbon dioxide + water \rightarrow oxygen + glucose
21.10	How else were levels of carbon dioxide in the atmosphere reduced?	Dissolved in the oceans and was eventually locked up (trapped) in fossils fuels and sedimentary rocks
21.11	Why have theories about Earth's early atmosphere developed and changed over time?	Evidence is limited and it was billions of years ago

C9: Chemistry of the Atmosphere 2

ANSWER KEY

22.1	Through which process did algae and plants reduce levels of carbon dioxide in Earth's early atmosphere?	Photosynthesis	
22.2	What was formed when shells of organisms made using dissolved carbon dioxide, fell to the bottom of the ocean and were covered and compressed?	Sedimentary rock	
22.3	Which fossil fuel is formed from dead plants and trees over millions of years?	Coal	
22.4	Which fossil fuels are formed from dead plankton over millions of years?	Crude oil and natural gas	
22.5	Name three greenhouse gases	 carbon dioxide methane water vapour 	
22.6	How is the wavelength of radiation from the sun changed as it is reflected by the Earth	Wavelength increases	
22.7	What happens to the longer wavelength radiation that is reflected from the Earth?	It is absorbed by the greenhouse gases in the atmosphere	
22.8	What is the name given to the process that warms the surface of the Earth?	The greenhouse effect	
22.9	What human activities increase carbon dioxide levels?	Deforestation and burning fossil fuels	
22.10	What human activities increase methane levels?	Farming animals, and rice, and landfill sites	
22.11	What is the name given to the increasing average temperature of the Earth?	Climate change	
22.12	State 3 effects of climate change	 melting ice caps rising sea level increased flooding more extreme weather/storms drought and famine 	

C9: Chemistry of the Atmosphere 3

ANSWER KEY

23.1	What is the name given to the total amount of carbon dioxide and other greenhouse gases emitted over the lifetime of a product, service or event?	Carbon footprint
23.2	What is a hydrocarbon?	Molecule made from hydrogen and carbon atoms <u>only</u>
23.3	Which gas from the air is essential for combustion?	Oxygen
23.4	What is produced from the complete combustion of a hydrocarbon fuel?	Carbon dioxide and water
23.5	Under what conditions might incomplete combustion occur?	In a poor (limited) supply of oxygen
23.6	Which products could be produced from the incomplete combustion of a hydrocarbon fuel?	Carbon monoxide, carbon particulates (soot) and water
23.7	Which gas is produced when fuels are burned and contain sulfur impurities?	Sulfur dioxide
23.8	Why do nitrogen and oxygen react together to form nitrogen monoxide in a car engine?	Very high temperature
23.9	What are the effects of carbon monoxide?	Toxic (poisonous)
23.10	Why is carbon monoxide difficult to detect?	It is colourless and odourless
23.11	What are the effects of sulfur dioxide?	Causes respiratory problems and acid rain
23.12	What are the effects of the oxides of nitrogen?	Causes respiratory problems and acid rain
23.13	What are the effects of carbon particulates (soot)?	Causes global dimming
23.14	How to we ensure that data and research on global warming is valid and unbiased?	Peer review (by other Scientists)

Q1. An increase in greenhouse gases in the Earth's atmosphere causes an increase in global temperature.

(a) An increase in global temperature is a major cause of climate change.

Give **two** effects of global climate change.

1
2

Carbon dioxide is a greenhouse gas.

The graph below shows the percentage of carbon dioxide in the Earth's atmosphere from 1750.



Use th	e graph above.
000	
Determ from 19	ine the change in the percentage of carbon dioxide in the Earth's atmosphere 950 to 2000.
Use th	e graph above.
Percer	itage of carbon dioxide in 1950
Percer	itage of carbon dioxide in 2000
	Change in percentage of carbon dioxide =
Give o changi	ne reason why the percentage of carbon dioxide in the atmosphere is na.
j.	
Predict	the percentage of carbon dioxide in the Earth's atmosphere in 2050.
	ould extend the graph line on the graph above.
You sh	

Q2. This question is about the atmospheres of Earth and Mars.

(a) Earth's early atmosphere may have been like the atmosphere of Mars today.

What was formed from the water vapour	in the Earth's early atmosphere?	
Tick (✔) one box.		
Crude oil		
Limestone		
Natural gas		
Oceans		
	What was formed from the water vapour Tick (✓) one box. Crude oil Limestone Natural gas Oceans	What was formed from the water vapour in the Earth's early atmosphere? Tick (√) one box. Crude oil Limestone Natural gas Oceans The Earth's atmosphere today consists mainly of nitrogen and oxygen.

Draw **one** line from each gas to what produced the gas.

Gas	What produced the gas
	Algae
Nitrogen	Animals
	Fossils
Oxygen	Oceans
	Volcanoes

The table below shows the percentage of some gases in the atmospheres of Earth and Mars.

Gas	Percentage of gas in atmosphere (%)		
	Earth	Mars	
Argon	0.9	1.9	
Carbon dioxide	0.04	95	
Nitrogen	78	2.6	
Oxygen	21	0.2	

(d) Why are animals **not** able to live on Mars?

Tick (\checkmark) one box.

The atmosphere of Mars does not contain enough argon.

The atmosphere of Mars does not contain enough nitrogen.

The atmosphere of Mars does not contain enough oxygen.

(e) There is more carbon dioxide on Mars than on Earth.

Which other gas is found in larger quantities on Mars than on Earth?

(f) Calculate how many times more nitrogen than oxygen there is in the atmosphere of Earth.

Use the table above.

Give your answer to 2 significant figures.

Number of times more nitrogen than oxygen (2 significant figures) = _____

(3) (Total 9 marks)

(1)

(1)

Q3. Human activities can affect our ecosystem.

The graph shows information about how the area of ocean with sea ice in the arctic has changed between 1979 and 2016.



(a) Give **two** conclusions you can make from the data shown in the graph.



(b) The area of ocean with sea ice in the arctic has changed.

Most scientists believe this is due to the activities of humans.

Explain the activities of humans that have led to the changes in sea ice from 1979 to 2016.



(Total 8 marks)

(6)

HIGHER TIER

Q4. The graph below shows recent changes in the methane concentration in the Earth's atmosphere.



(a) Determine the percentage increase in methane concentration in the Earth's atmosphere from January 2018 to January 2019.



(b) Methane is a greenhouse gas.

Scientists **cannot** make accurate predictions about the concentration of methane in the Earth's atmosphere in the future.

Give one reason why.

Use the graph above.

(c) Explain why protecting peat bogs may reduce global warming.

(d) Greenhouse gases maintain temperatures on Earth high enough to support life.

Describe the greenhouse effect in terms of the interaction of short-wavelength and long-wavelength radiation with matter.

(2)

(e) The Earth is estimated to be 4.6 billion years old.

The Earth's early atmosphere changed over time.

Describe the evidence scientists use to form theories about:

- how the Earth's atmosphere was formed
- how the composition of the Earth's atmosphere changed.

(Total 16 marks)

(6)

Q5. Atmospheric pollution is emitted by cars.

Some car emissions contain nitrogen dioxide.

(a) Describe how nitrogen dioxide (NO₂) is produced in the engine of a car that burns fossil fuels.

(3)

The table below shows the concentration of nitrogen dioxide in the air in three different areas for 1 week.

	Concentration of nitrogen dioxide in the air in micrograms per m ³		
Day	City centre	Countryside	Motorway
Monday	35	8	22
Tuesday	37	8	23
Wednesday	37	8	23
Thursday	34	8	23
Friday	37	8	23
Saturday	29	7	20
Sunday	x	6	17

(b) The mean value for nitrogen dioxide in the air for the whole week in the city centre is 33 micrograms per m³.

Calculate the value (\mathbf{X}) for the concentration of nitrogen dioxide in the air in the city centre on Sunday.

X = micrograms per m³

(c) Each value in the table above has an uncertainty of ± 2 micrograms per m³.

Explain why this uncertainty is **most** significant for countryside data.

(2)

Nitrogen dioxide is removed from car emissions by catalytic converters.

(d) In a catalytic converter nitrogen dioxide (NO₂) reacts to produce nitrogen and oxygen.

Complete the equation for the reaction.

You should balance the equation.

 $___ NO_2 \rightarrow ___ + ___$

(e) The catalyst in a catalytic converter contains platinum.

Platinum is a finite resource.

What is meant by a 'finite resource'?

(f) Emissions from cars contain carbon dioxide.

Explain why carbon dioxide emissions during use and operation are **not** the total carbon footprint for a car.

Refer to the stages of the life cycle assessment of a car in your answer.

(3) (Total 13 marks)

(2)

(1)

Q1.

- (a) any **two** from:
 - global warming
 - melting polar ice caps
 - rising sea levels
 - flooding
 - crop failure
 or

famine

- extremes of weather
- loss of habitats
 - do **not** accept acid rain do **not** accept global dimming do **not** accept references to ozone ignore temperature rise

(b) constant

allow no change	
allow stays same	

2

1

1

1

1

1

1

(then) increases ignore values if given

(c) (1950) 0.030 **and** (2000) 0.036

(0.036 – 0.030) = 0.006 (%) allow correct use of incorrectly determined percentage reading(s) ignore + or –

(d) any **one** from:

٠

- combustion of fuel allow any named activity which burns fuel
- deforestation
- population increase
- (e) extrapolation on graph

determine value from extrapolation at 2050 allow a value in the range 0.044 to 0.050 allow a tolerance of $\pm \frac{1}{2}$ a small square

[9]

1

1

1

1 1

1

Q2.

- (a) any **one** from:
 - occurred (4.6) billion years ago
 - Iimited evidence
 ignore nobody was there ignore no proof
- (b) oceans



(d) the atmosphere of Mars does not contain enough oxygen

(e)	argon	allow Ar	
			1
(f)	78 21		1
	0.744		-
	= 3./14		
		do not accept a subsequent step in the	
		Carculation	1

= 3.7

Q3.

(b)

(a) any **two** from:

- the area of ocean with sea ice has reduced since 1979
- the amount of ice follows the same pattern during a year
 - allow ice reduces in the summer and increases in the winter
 - most ocean with sea ice in February / March
- least ocean with sea ice in September / October
- area of ocean with sea ice decreases from March to September each year
- area of ocean with sea ice increases from September to February / March each year
- decrease is greater between 1995 and 2016 compared with 1979 to 1995 allow other correct conclusions derived from the graph

Level 3: Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	5-6
Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logically linking. The resulting account is not fully clear.	3-4
Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1-2
No relevant content	0
Indicative content	
 deforestation has reduced the number of trees on the planet 	
• which has reduced the amount of carbon dioxide that can be removed from the atmosphere	
 increased combustion releases more carbon dioxide into the atmosphere 	
 therefore there is a build-up of carbon dioxide in the atmosphere 	
 (build up) allows short-wavelength radiation to pass into the Earth's atmosphere 	
 and absorbs long-wavelength 	
causing an increase in global	

2

1

[9]

 the increase in temperature causes ice to melt

[8]

6

1

1

1

Q4.

(a) (2018) 1854 (ppb) and (2019) 1865 (ppb)

> $\frac{1865 - 1854}{1854} \times 100$ allow $\frac{11}{1854} \times 100$

> > allow correct use of incorrectly determined concentration values

0.593 (%)

allow any answer that rounds to 0.593 (%)

- (b) any one from:
 - variation month to month (within a year) *ignore variation unqualified*
 - variations in changes between years
 - variation about the trend line

allow increasing awareness of climate change may cause reduced (increase in) methane emissions allow cannot predict if more livestock will be farmed allow may eat / produce less meat allow may eat / plant less rice

- allow methane (production) from landfill is unpredictable
- (c) less carbon dioxide released

ignore peat bogs release methane do **not** accept methane released when burnt

(because) less decomposition of peat (as compost) or (because) less burning of peat *allow peat absorbs carbon dioxide when photosynthesising (1) so more carbon dioxide would be removed from the atmosphere (1)*

1

1

1

(d)	short(er) wavelength radiation which enters the atmosphere (from the Sun) allow UV / ultraviolet / gamma radiation which	
	enters the atmosphere (from the Sun)	1
	(short(er) wavelength radiation) is absorbed by matter / materials / Earth and re-emitted	1
	as a longer wavelength radiation	
	allow as IR / infrared radiation	1
	(the longer wavelength radiation) is absorbed by a greenhouse gas which reduces radiation escaping (to space) or	
	(the longer wavelength radiation) is absorbed by a greenhouse gas so temperature increases	
	allow a named greenhouse gas or atmosphere for greenhouse gas(es)	
		1
(e)	Level 2: Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account.	4–6
	Level 1: Facts, events or processes are identified and simply stated but their relevance is not clear.	1_3
	No relevant content	0
	Indicative content	
	 Evidence from volcanoes (current) volcanic emissions release of carbon dioxide water <u>vapour</u> (from volcanoes) condensed (forming oceans) therefore decreased in atmosphere nitrogen (from volcanoes) (mostly) remained due to low reactivity of nitrogen methane / ammonia (from volcanoes) entered atmosphere 	
	 Evidence from plants / algae / photosynthesis (eventually) photosynthesis by algae / plants decreased carbon dioxide photosynthesis by algae / plants increased oxygen 	
	 Evidence from oceans / rocks carbon dioxide decreased in the atmosphere as it dissolved in the oceans carbon dioxide also decreased in formation of sedimentary rocks 	
	 Evidence from other planets the current atmospheres of Mars and Venus are mainly carbon dioxide which adds evidence for this theory For Level 2 responses must refer to detail of volcanoes and one other source 	

Q5.

(a)	at high temperatures (in the engine)	1	
	nitrogen	1	
	reacts with oxygen (to produce nitrogen dioxide)	1	
(b)	$(\mathbf{X} =)$ $(33 \times 7) - [(37 \times 3) + 35 + 34 + 29]$ <i>allow</i> $33 \times 7 = (37 \times 3) + 35 + 34 + 29 + \mathbf{X}$	1	
	= 22 (micrograms per m³)	1	
(c)	countryside data has smallest values	1	
	(so) 2 is a higher proportion / percentage of the value allow (so) countryside is ± 2 out of a value between 6 to 8	1	
(d)	$2 \text{ NO}_2 \rightarrow \text{N}_2 + 2 \text{ O}_2$ allow multiples or halves allow 1 mark for N ₂ and O ₂	2	
(e)	a resource which will run out allow a non-sustainable resource	1	
(f)	(because carbon dioxide is emitted in) extracting / processing raw materials	1	
	(and) manufacturing	1	
	(and) disposal at the end of its useful life	1	[13]