Atmosphere 4

Name: _____

Class: _____

Date: _____

Time: **66 minutes**

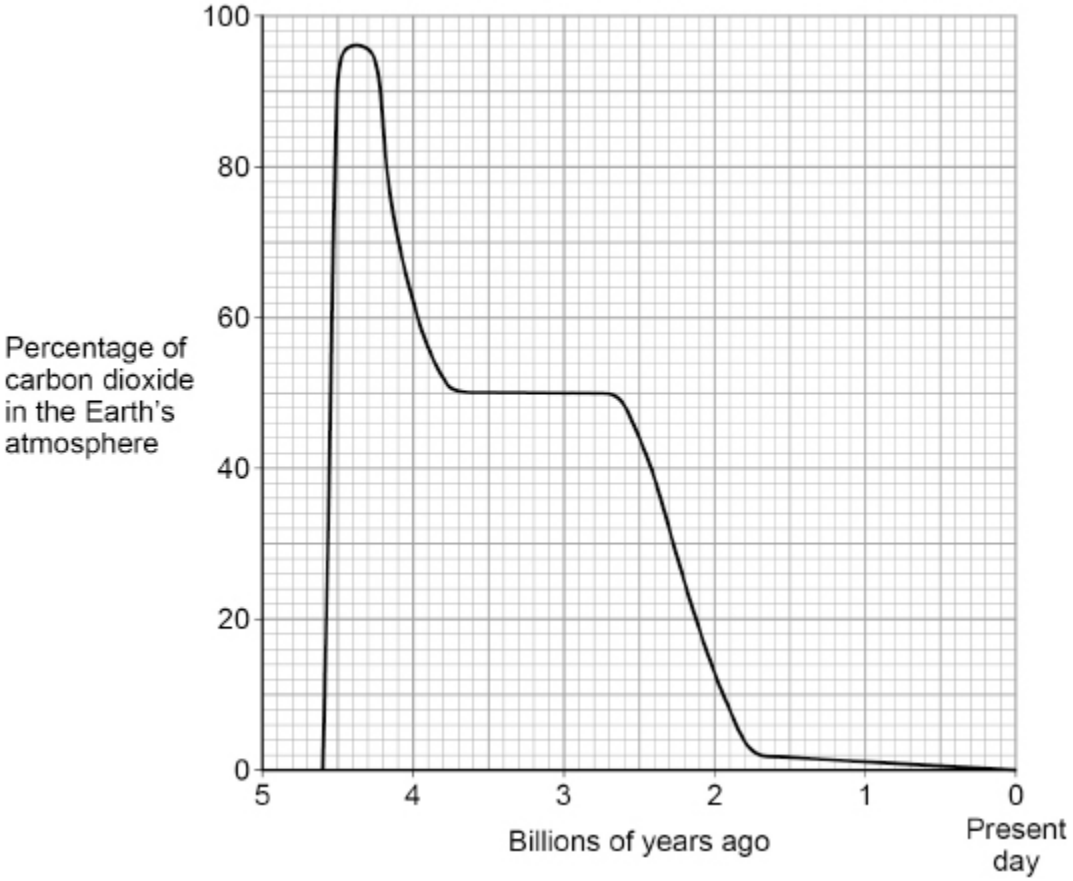
Marks: **61 marks**

Comments:

1. This question is about carbon dioxide in the Earth's atmosphere.

Figure 1 shows how the percentage of carbon dioxide in the Earth's atmosphere has changed over 4.6 billion years.

Figure 1



(a) What was the highest percentage of carbon dioxide in the Earth's atmosphere?

Use **Figure 1**.

Highest percentage = _____%

(1)

(b) The percentage of carbon dioxide in the atmosphere has decreased since Earth's early atmosphere.

Which **two** processes have decreased the percentage of carbon dioxide in the Earth's atmosphere?

Tick (✓) **two** boxes.

Combustion of fuels	☐
Formation of sedimentary rocks	☐
Photosynthesis	☐
Volcanic activity	☐

(2)

(c) The total amount of carbon dioxide emitted over the life cycle of a product can be measured.

What name is given to the total amount of carbon dioxide emitted during the life cycle of a product?

Tick (✓) **one** box.

Carbon footprint ☐

Global dimming ☐

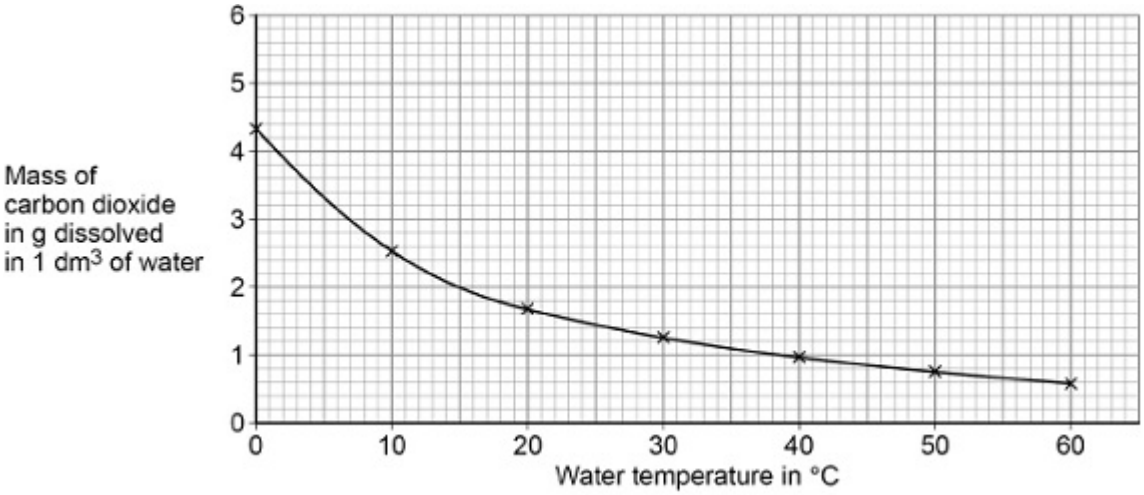
Greenhouse effect ☐

(1)

Carbon dioxide dissolves in water.

Figure 2 shows the mass of carbon dioxide dissolved in water at different temperatures.

Figure 2



(d) Complete the table below.

Use **Figure 2**.

Water temperature in °C	**Mass of carbon dioxide in g dissolved in 1 dm^3 of water**
5	
15	

(2)

(e) Calculate the difference in the mass of carbon dioxide dissolved in 1 dm^3 of water at 5 °C and at 15 °C

Use the table above.

_____

Mass = _____ g

(1)

(f) Carbon dioxide is a greenhouse gas.

The greenhouse effect happens in four stages.

The four stages are:

Stage **A**	Carbon dioxide stops longer wavelength radiation escaping
Stage **B**	Radiation is absorbed by the Earth
Stage **C**	Longer wavelength radiation is emitted
Stage **D**	Shorter wavelength radiation enters the atmosphere.

What is the correct order of stages **A**, **B**, **C** and **D**?

Tick (✓) **one** box.

C, **A**, **B**, **D** ☐

C, **D**, **B**, **A** ☐

D, **B**, **C**, **A** ☐

D, **C**, **B**, **A** ☐

(1)

(g) Changes in the percentage of carbon dioxide in the Earth's atmosphere cause climate change.

Give **two** effects of climate change.

1. _____

_____

2. _____

_____

(2)

(Total 10 marks)

2. Atmospheric pollution is emitted by cars.

Some car emissions contain nitrogen dioxide.

(a) Describe how nitrogen dioxide (NO_2) 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 m^3.

Calculate the value (**X**) for the concentration of nitrogen dioxide in the air in the city centre on Sunday.

_____

_____

_____

_____

X = _____ micrograms per m^3

(2)

(c) Each value in the table above has an uncertainty of ± 2 micrograms per m^3.

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 (NO_2) reacts to produce nitrogen and oxygen.

Complete the equation for the reaction.

You should balance the equation.

_____ NO_2 → _____ + _____

(2)

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

Platinum is a finite resource.

What is meant by a 'finite resource'?

_____

_____

(1)

(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)

3. This question is about hydrocarbons and crude oil.

(a) Hydrocarbon fuels are produced from crude oil.

Describe how crude oil is separated into fractions.

(4)

Butane is a hydrocarbon.

(b) Two equations for the combustion of butane are:

- $2\ C_4H_{10} + 13\ O_2 \longrightarrow 8\ CO_2 + 10\ H_2O$
- $2\ C_4H_{10} + 5\ O_2 \longrightarrow 8\ C + 10\ H_2O$

Why are different products formed?

_____

_____

_____

(1)

(c) One other product of the combustion of butane is carbon monoxide.

Balance the equation.

$$\_\_\_\_\ C_4H_{10} + \_\_\_\_\ O_2 \rightarrow \_\_\_\_\ CO + \_\_\_\_\ H_2O$$

(1)

(d) Carbon dioxide is a greenhouse gas.

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

(4)

(Total 10 marks)

4. (a) What percentage of the Earth's atmosphere is nitrogen?

Tick **one** box.

5% ☐ 20% ☐ 50% ☐ 80% ☐

(1)

(b) During the first billion years of the Earth's existence the amount of nitrogen in the atmosphere increased.

Give **one** source of this nitrogen.

(1)

(c) Nitrogen is used to make ammonia.

The word equation for the reaction is:

nitrogen + hydrogen _____ ammonia

Write the correct symbol in the equation to show that it is a reversible reaction.

(1)

(d) A reversible reaction can reach equilibrium.

Complete the sentence.

Equilibrium is reached when the forward reaction and the reverse reaction happen at the same _____ .

(1)

(e) Fertilisers are formulations containing nitrogen.

What is a formulation?

_____

_____

(1)

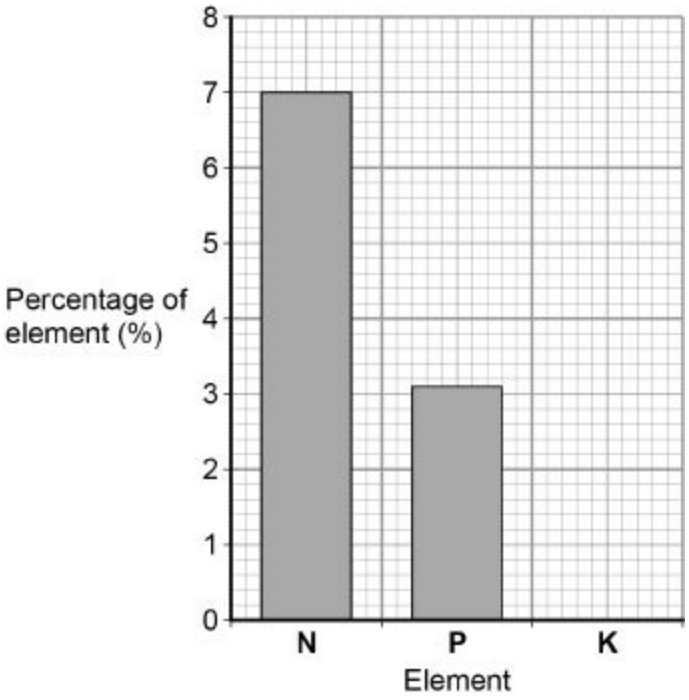
(f) The table below shows percentages of chemical elements in a fertiliser.

Element	**Percentage (%)**
Nitrogen (N)	7.0
Phosphorus (P)	3.1
Potassium (K)	5.8

Draw the bar for potassium on **Figure 1**

Use the information in the table above.

Figure 1



(1)

(g) A fertiliser contains 0.225 g of iron per 3.0 g of fertiliser.

Which calculation gives the percentage of iron in the fertiliser?

Tick **one** box.

$\frac{0.225}{3.0 \times 100}$ ☐

$\frac{3.0 \times 100}{0.225}$ ☐

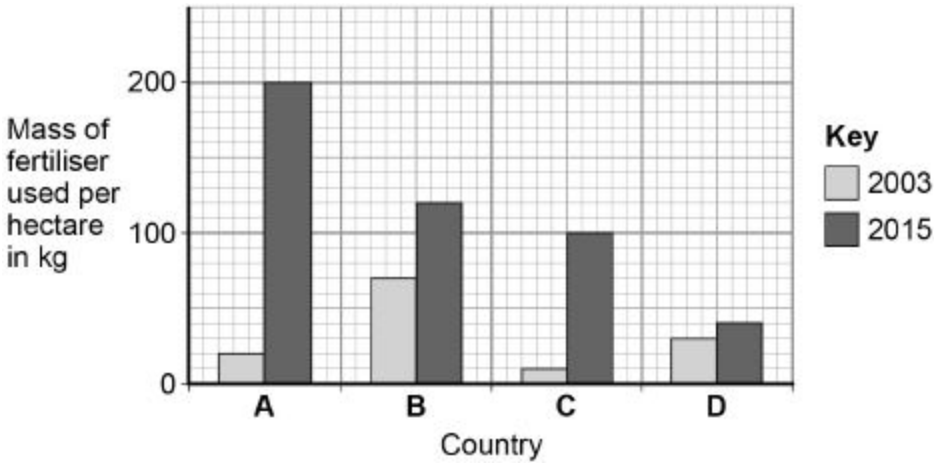
$\frac{0.225 \times 3.0}{100}$ ☐

$\frac{0.225 \times 100}{3.0}$ ☐

(1)

(h) **Figure 2** shows the use of fertiliser in four different countries, **A**, **B**, **C** and **D**, in 2003 and 2015

Figure 2



A student said:

‘ **much** more fertiliser was used in 2015 than in 2003’

Is the student correct?

Use data from **Figure 2** to justify your answer.

_____

_____

_____

_____

_____

_____

(3)

(Total 10 marks)

5. There is less carbon dioxide in the Earth's atmosphere now than there was in the Earth's early atmosphere.

(a) The amount of carbon dioxide in the Earth's early atmosphere decreased because it was used by plants and algae for photosynthesis, dissolved in the oceans and formed fossil fuels.

Give **one** other way that the amount of carbon dioxide in the Earth's early atmosphere decreased.

_____

_____

(1)

(b) Carbon dioxide is a greenhouse gas.

Describe the greenhouse effect.

_____

_____

_____

_____

_____

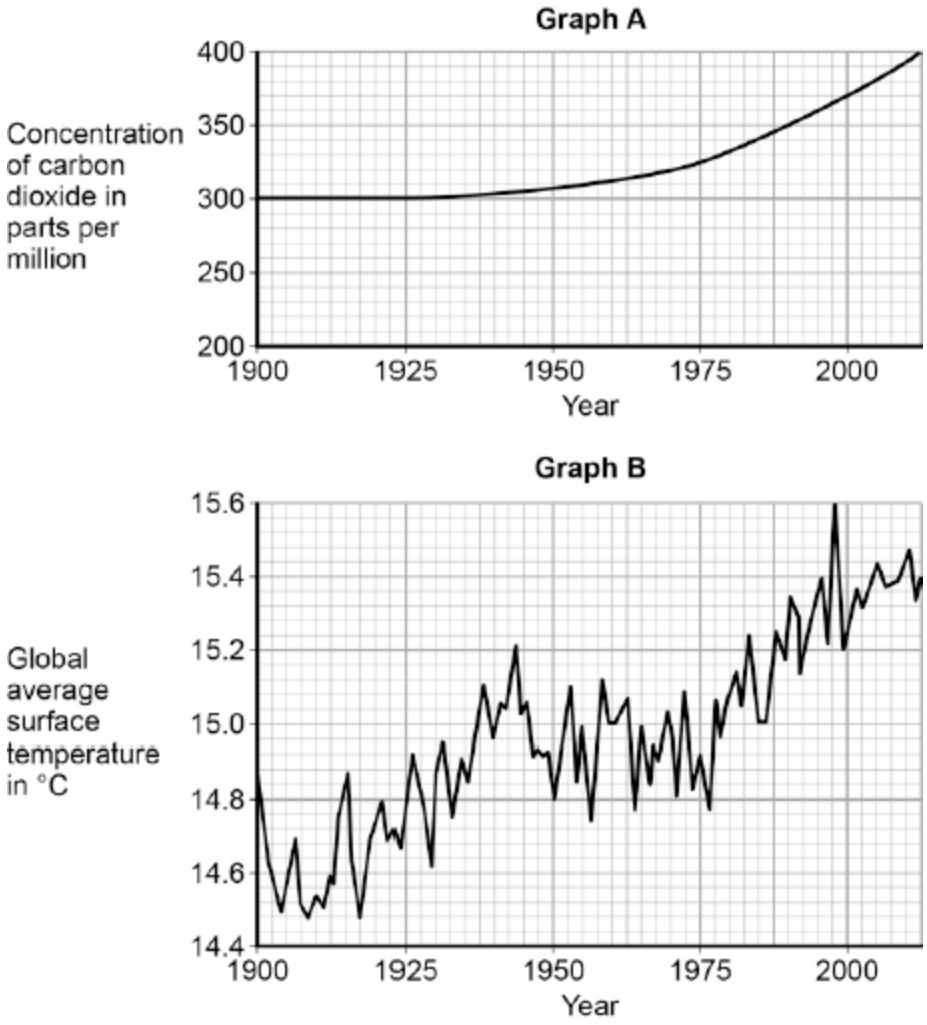
_____

_____

(4)

(c) The graphs in **Figure 1** show the concentration of carbon dioxide in the atmosphere and global average surface temperature since 1900.

Figure 1



Calculate the percentage increase in the concentration of carbon dioxide from 1975 to 2000.

_____ %

(1)

(d) What was the global average surface temperature in 1980?

Global average surface temperature = _____ °C

(1)

(e) A student stated: ‘The graphs show that increasing the concentration of carbon dioxide in the atmosphere causes global temperature increases.’

Discuss why this statement is only partially true.

(4)

(Total 11 marks)

6. This question is about life, the Earth and its atmosphere.

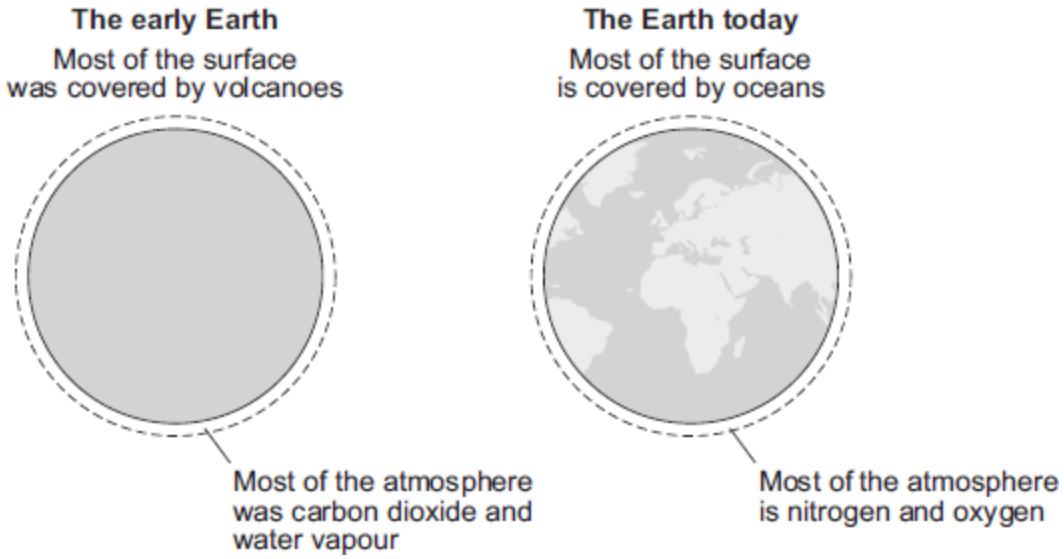
(a) There are many theories about how life was formed on Earth.

Suggest **one** reason why there are many theories.

(1)

(b) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

This Earth and its atmosphere today are not like the early Earth and its atmosphere.



Describe and explain how the surface of the early Earth and its atmosphere have changed to form the surface of the Earth and its atmosphere today.

(6)

(Total 7 marks)

1.

(a) 96 (%)

allow a value in the range 95–97 (%)

1

(b) formation of sedimentary rocks

1

photosynthesis

1

(c) carbon footprint

1

(d) 3.3 (g)

allow a value in the range 3.2 – 3.4 (g)

1

2 (g)

allow a value in the range 1.9 − 2.1 (g)

1

(e) (3.3 – 2 =) 1.3 (g)

*allow ecf from question **(d)***

1

(f) **D B C A**

1

(g) any **two** from:

- rising sea levels
- melting ice (caps) / glaciers
- agricultural problems
- extremes of weather
- (coastal) flooding / erosion
- drought
- forest fires
- animal habitats change / lost

allow extinction of species

allow global warming

2

[10]

2.

(a) at high temperatures (in the engine)

1

nitrogen

1

reacts with oxygen (to produce nitrogen dioxide)

1

(b) (**X** =)
(33 × 7) – [(37 × 3) + 35 + 34 + 29]

allow

*33 x 7 = (37 x 3)+ 35 + 34 + 29 +**X***

1

= 22 (micrograms per m^3)

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) $2\ NO_2 \rightarrow N_2 + 2\ O_2$

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]

3. (a)

*maximum of **3** marks if incorrect reference made to cracking*
ignore fractional distillation
ignore fracking

heat or vaporise (oil)

1

temperature gradient in column

allow column is cooler at the top
or
allow column is hotter at the bottom

1

(vapour) condenses (into fractions)

1

depending on boiling point of fraction

allow at different levels

1

(b) different amounts of oxygen available

*allow complete combustion **and** incomplete / partial combustion*

1

(c) $2\ C_4H_{10} + 9\ O_2 \longrightarrow 8\ CO + 10\ H_2O$

allow correct multiples / halves

1

(d) short wavelength radiation which enters the atmosphere

because uv / ultra violet radiation which enters the atmosphere

1

is absorbed by materials **and** re-emitted

1

as a longer wavelength radiation

as ir / infrared radiation

1

(the longer wavelength radiation is trapped by) a greenhouse gas / carbon dioxide / methane which stops radiation escaping (from the atmosphere)

allow so temperature increases

1

[10]

4. (a) 80

1

(b) volcanoes

allow ammonia
allow meteorites

1

(c) ⇌

ignore any extra words

1

(d) rate

allow speed
allow pace

*do **not** accept time*
*do **not** accept amount*
*do **not** accept level*
*do **not** accept point*

1

(e) a mixture designed as a useful product

1

(f) bar for K to 5.8%

allow ± ½ a small square

1

(g) $\frac{0.225 \times 100}{3.0}$

1

(h) use has increased

1

(increase is) less in country B
or (increase is) less in country D

allow (increase is) more in country A
***or** (increase is) more in country C*

1

example of data

1

[10]

5. (a) sediment / limestone formation from carbonates

1

(b) short wavelength radiation

1

passes through atmosphere to Earth's surface

1

Earth's surface radiates different wavelengths

1

which are absorbed by greenhouse gases to produce temperature increase

allow CH_4 H_2O or CO_2

1

(c) 13.8 %

allow values in the range 13.0 to 15.0

1

(d) 15.08 (°C)

allow values in the range 15.05 – 15.10

1

(e) correlation between CO_2 levels and temperature

1

despite short-term variations of temperature

1

supported by values from graph which show correlation

1

cannot determine causality from this data or possible causality as increasing use of fossil fuels since 1900 has caused accelerated temperature increase

1

[11]

6. (a) any **one** from:

- not enough evidence or proof

  allow no evidence or no proof
- (life and the Earth were created) billions of years ago

  allow a long time ago

  ignore different beliefs or no one was there.

1

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking Guidance and apply a 'best–fit' approach to the marking.

0 marks
No relevant content

Level 1 (1−2 marks)
Statements based on diagrams

Level 2 (3−4 marks)
Description of how one change occurred

Level 3 (5−6 marks)
Descriptions of how at least two changes occurred

Examples of chemistry points made in the response could include:

Main changes

- oxygen increased because plants / algae developed and used carbon dioxide for photosynthesis / growth producing oxygen; carbon dioxide decreased because of this
- carbon dioxide decreased because oceans formed and dissolved / absorbed carbon dioxide; carbon dioxide became locked up in sedimentary / carbonate rocks and / or fossil fuels
- oceans formed because the Earth / water vapour cooled and water vapour in the atmosphere condensed
- continents formed because the Earth cooled forming a supercontinent / Pangaea which formed the separate continents
- volcanoes reduced because the Earth cooled forming a crust.

Other changes

- nitrogen has formed because ammonia in the Earth's early atmosphere reacted with oxygen / denitrifying bacteria.

6

[7]