## 4-9 Chemistry/5-9 Trilogy – Chemistry of the atmosphere

**1.0** This question is about fuels.

**1.1** There are two main types of diesel fuel used for cars:

- biodiesel, made from vegetable oils
- petroleum diesel, made from crude oil.

The table below gives information about the pollutants produced by cars using biodiesel or petroleum diesel as a fuel.

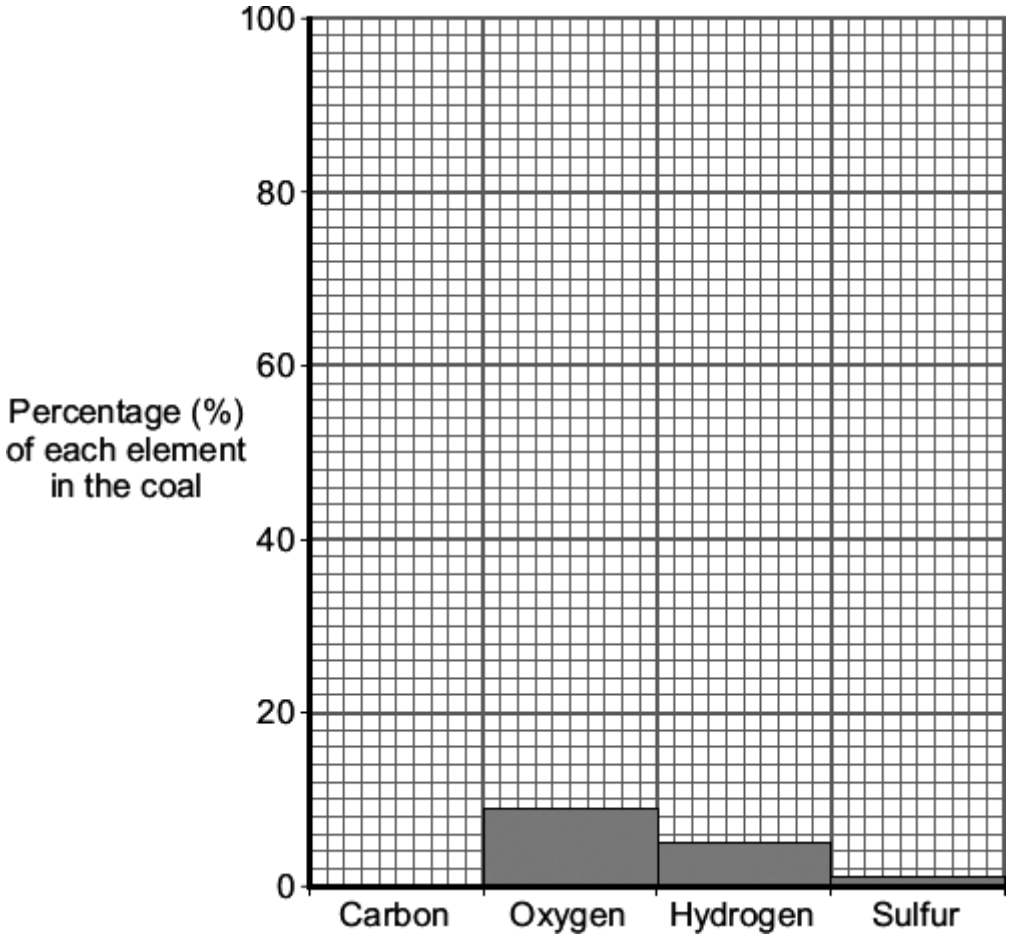
| Fuel | Relative amounts of pollutants | | |
|---|---|---|---|
| | Oxides of Nitrogen | Particulate matter | Carbon dioxide |
| Biodiesel | 108 | 44 | 26 |
| Petroleum diesel | 100 | 100 | 100 |

Compare the pollutants produced from cars using biodiesel with those from cars using petroleum diesel.

**[3 marks]**

**1.2** Coal is a fossil fuel.

The bar chart shows the percentage of some of the elements in a type of coal.




**1.2** Draw the bar for carbon on the chart

Assume all other elements are only found in trace amounts.

**[2 marks]**

**1.3** Coal is burned in the atmosphere to release energy.

Which gas is needed for burning to take place?

**[1 mark]**

_____

**1.4** Burning coal produces carbon dioxide, sulfur dioxide and water.

What is the environmental effect of sulfur dioxide on the atmosphere?

**[1 mark]**

Tick **one** box.

| | |
|---|---|
| Acid rain | ☐ |
| Flooding | ☐ |
| Global dimming | ☐ |
| Global warming | ☐ |

**2.0** Oxygen gas is critical to life on Earth.

**2.1** State the name of the process by which plants produce oxygen.

**[1 mark]**

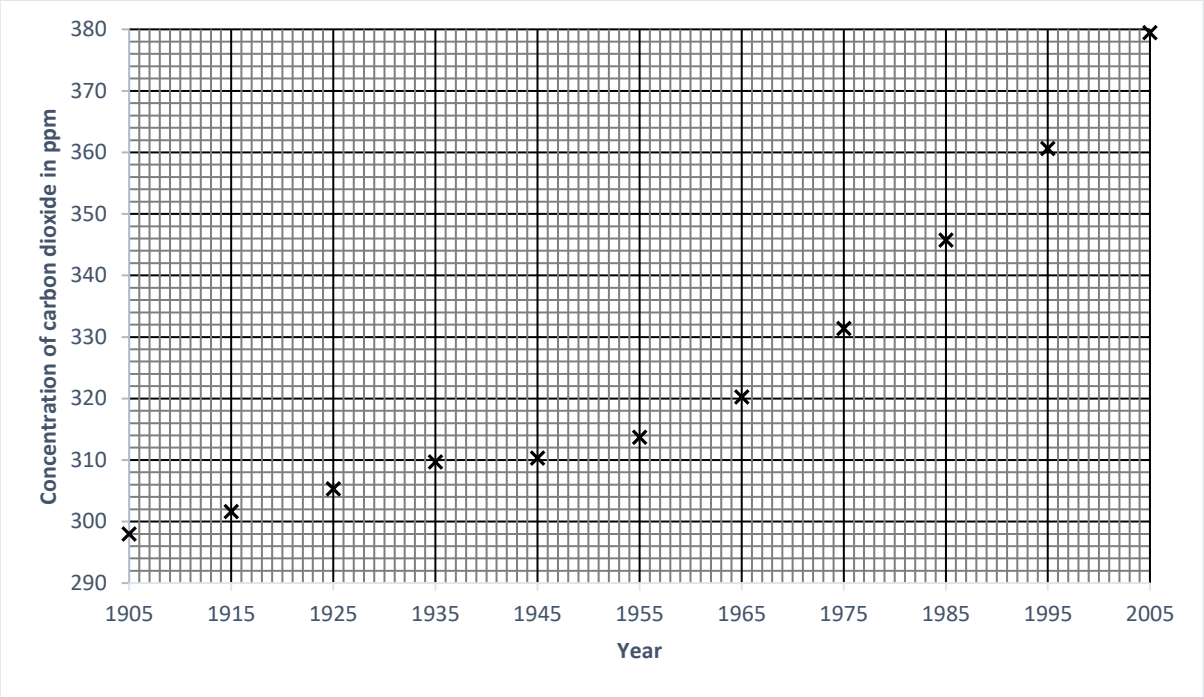
_____

**2.2** Complete the word equation for this process:

**[2 marks]**

_____ + _____ → _____ + oxygen

**3.0** The graph shows the concentration of carbon dioxide in the air from 1905 to 2005.




**3.1** Draw a curved line of best fit through these points.

**[1 mark]**

**3.2** State the concentration of carbon dioxide in 1960.

**[1 mark]**

Concentration = ..... ppm

**3.3** Give two conclusions you can make from the graph.

**[2 marks]**

1. _____

_____

2. _____

_____

**3.4** State the main process responsible for the change in carbon dioxide concentration since the start of the 20th century.

**[1 mark]**

_____

**3.5** Calculate the percentage change in carbon dioxide concentration between 1955 and 2005.

Give your answer to 2 significant figures.

Show your working.

**[2 marks]**

Percentage change = _____ %

**4.0** This question is about the Earth's atmosphere

Scientists have been using data from the Kepler space telescope to look for planets in the Milky Way galaxy which might be similar to Earth. They have spotted a planet that they think is like the early Earth. The atmosphere is mainly carbon dioxide.

**4.1** Which process was responsible for producing gases in the early atmosphere?

**[1 mark]**

**4.2** Water vapour was one of the gases produced in the early atmosphere.

Describe what scientists think happened to the water vapour as the Earth cooled.

**[2 marks]**

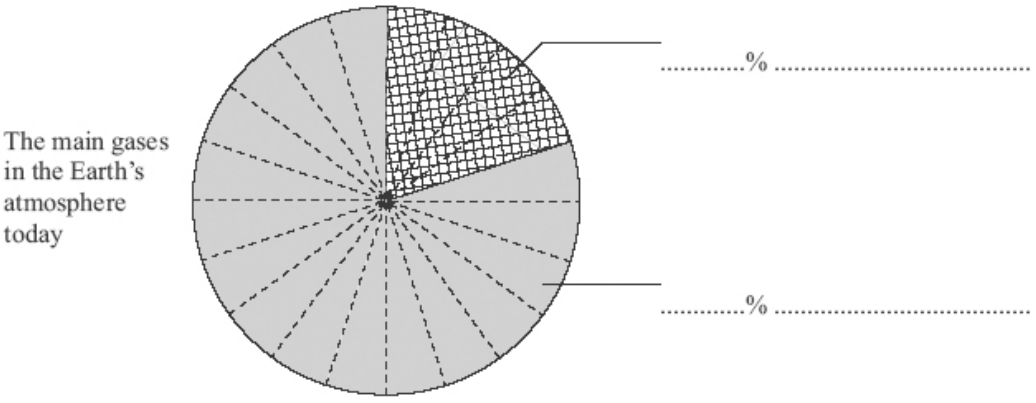
**4.3** There are many different theories about what the Earth's early atmosphere was made of and how it formed.

Give **one** reason why scientists can find it hard to agree on one theory.

**[1 mark]**

**4.4** For the last 200 million years, the amounts of the gases in the Earth's atmosphere have been much the same as they are today.

Label the pie chart below to show the percentages and names of the two main gases in the Earth's atmosphere today.




**[3 marks]**

**5.0** Heptane is a compound in petrol.

**5.1** Balance the equation for heptane burning in air.

**[1 mark]**

**Reaction 1** $C_7H_{16}$ + _____ $O_2$ → _____$CO_2$ + _____$H_2O$

**5.2** Heptane can also burn in air to form different products.

**Reaction 2** $2C_7H_{16} + 15O_2 \rightarrow 14CO + 16H_2O$

The second reaction produces different carbon products to the first reaction.

Name the products formed in **reaction 2**

**[1 mark]**

_____

_____

**5.3** Give a reason why the products produced in **reaction 2** are different from those in **reaction 1**.

**[1 mark]**

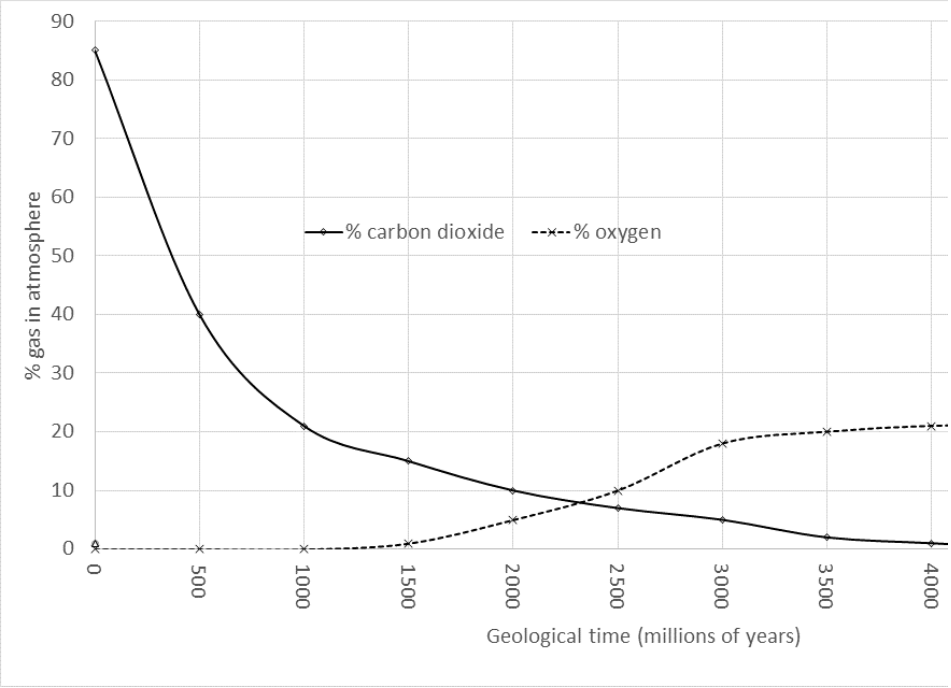
_____

_____

**6** Earth is approximately 4500 million (4.5 billion) years old.

The graph below shows how the percentages of carbon dioxide and oxygen in the atmosphere changed over the first 4000 million years.

It is known that the early atmosphere also contained a lot of water vapour.




It is thought the first oceans appeared at approximately 500 million years.

The earliest undisputed evidence for life on Earth dates back to about 1000 million years.

The earliest evidence for air breathing land animals dates from about 4000 million years.

**6.1** Between which years was the rate of change of carbon dioxide concentration greatest?

**[1 mark]**

_____ and _____

**6.2** Describe **and** explain the changes in both oxygen and carbon dioxide levels in the atmosphere from when the Earth formed until a few thousand years ago.

**[6 marks]**

**6.3** Many scientists believe that an increased level of carbon dioxide in the atmosphere is now causing global warming.

Describe how carbon dioxide causes global warming.

**[3 marks]**

**6.4** What is meant by carbon footprint?

**[1 mark]**

**6.5** Describe **two** changes that a company could make to reduce its carbon footprint.

**[2 marks]**

**6.6** In 2015, 196 countries agreed to reduce climate change by lowering the emission of greenhouse gases.

Suggest **two** reasons why countries may find it difficult to cut emissions of greenhouse gases.

**[2 marks]**

**MARK SCHEME**

| Qu No. | | Extra Information | Marks |
|---|---|---|---|
| 1.1 | *Biodiesel*<br>Produces less carbon dioxide<br>Produces less particulates<br>Produces more oxides of nitrogen | Accept reverse for petroleum diesel for each marking point. | <br>1<br>1<br>1 |
| 1.2 | Bar drawn between 84 and 86 | Allow one mark for bar drawn to a height that corresponds to any given calculation of percentage with a maximum of one mistake (eg missing one element or misreading one bar) | 2 |
| 1.3 | Oxygen | | 1 |
| 1.4 | Acid rain | | 1 |

| Qu No. | | Extra Information | Marks |
|---|---|---|---|
| 2.1 | Photosynthesis | | 1 |
| 2.2 | Carbon dioxide + water →<br>→ glucose (+ oxygen) | | 1<br>1 |

| Qu No. | | Extra Information | Marks |
|---|---|---|---|
| 3.1 | Curve of best fit drawn through all of the points | Do not accept “lumpy” curve or curve with multiple strokes for line | 1 |
| 3.2 | 318 (ppm) | Allow values in range 317 – 319<br>Allow ecf from drawn line of best fit | 1 |
| 3.3 | The later the year, the greater the concentration of carbon dioxide<br>The rate of increase in carbon dioxide concentration is increasing | | 1<br>1 |
| 3.4 | Combustion of fossil fuels | Allow burning | 1 |
| 3.5 | Change in concentration<br>380 – 313 = 67<br>Percentage change<br>67/313 × 100 = 21% | <br><br>Allow 1 mark for 18% (from 67/380)<br>Allow 1 mark for 0.21<br>Allow 1 mark for correct answer to more than 2 significant figures | 1<br><br>1 |

| Qu No. | | Extra Information | Marks |
|---|---|---|---|
| 4.1 | Volcanic eruptions | Allow volcanoes | 1 |
| 4.2 | Condensed<br>To form the oceans | <br>Allow sea for oceans | 1<br>1 |
| 4.3 | Any **one** from:<br>• There is not enough proof or evidence<br>• The Earth was created millions of years ago | <br>Allow no evidence/proof<br>Allow a long time ago<br>Ignore reference to no one being there | 1 |
| 4.4 | Percentages correctly worked out as 20 % and 80%<br>20 % oxygen<br>80 % nitrogen | <br>Allow values in range 20 – 21 %<br>Allow values in range 78 – 80 %<br>If no marks obtained from MP2 and MP3, but gases are correctly named as nitrogen and oxygen, allow 1 mark | 1<br>1<br>1 |

| Qu No. | | Extra Information | Marks |
|---|---|---|---|
| 5.1 | $C_7H_{16} + 11O_2 \rightarrow 7CO_2 + 8H_2O$ | | 1 |
| 5.2 | Carbon monoxide **and** water | | 1 |
| 5.3 | Because of partial / incomplete combustion (in reaction 2) **or** complete combustion (in reaction 1) | Allow because there is less / insufficient oxygen (in reaction 2) **or** sufficient oxygen (in reaction 1)<br>Allow different amounts of oxygen used (in the reactions)<br>Ignore air | 1 |

| Qu No. | | Extra Information | Marks |
|---|---|---|---|
| 6.1 | 0 and 500 (million years) | Both required for the mark | 1 |
| 6.2 | | | |
| **Level 3:** | A detailed and coherent explanation is given, which demonstrates a broad understanding of the key scientific ideas. The response makes logical links between the points raised and uses sufficient specific facts to support these links. | | 5-6 |
| **Level 2:** | An explanation is given which demonstrates a reasonable understanding of the key scientific ideas. Links are made but may not be fully articulated and / or precise. Statements may lack detail or include a few mistakes such as incorrect dates. | | 3-4 |
| **Level 1:** | Simple statements are made which demonstrate a basic understanding of some of the relevant ideas. The response may fail to make logical links between the points raised. | | 1-2 |
| | No relevant content | | 0 |
| **Indicative content** | | | |
| Carbon dioxide; description<br>• level drops rapidly over 1st billion years<br>• drops steadily, but more slowly to present day<br>Carbon dioxide; explain<br>• dissolved in oceans<br>• reacted to form carbonate rocks<br>• plants evolve so photosynthesis uses / takes in carbon dioxide<br>• plants die and are converted to fossil fuels locking up $CO_2$ (for millions of years)<br>Oxygen; description<br>• no significant level until 1 to 1.5 billion years<br>• rises steadily until 3,000-3,500 million years<br>• stays (approximately) same until 4,500 million years<br>Oxygen; explain<br>• plants evolve and photosynthesis releases oxygen | | | |
| 6.3 | Energy / radiation from the sun warms the earth's surface<br>(Infra-red) radiation from the earth's surface is absorbed / trapped by carbon dioxide causing an increase in temperature | | 1<br>1<br>1 |
| 6.4 | The total amount of carbon dioxide (and other greenhouse gases) emitted (in a process/by a person/organisation) | | 1 |
| 6.5 | Any **two** from:<br>• increased use of alternative/renewable energy supplies<br>• energy conservation<br>• carbon capture and storage<br>• carbon taxes and licences<br>• carbon off-setting, including through tree planting<br>• carbon neutrality – zero net release | | 2 |
| 6.6 | Any **two** from:<br>• expensive to invest in the equipment<br>• insufficient renewable energy resources<br>• difficult to provide for transport systems<br>• lack of political resolve | | 2 |