Materials
For this paper you must have:

- Ruler
- Pencil, Rubber, Protractor and Compass
- Scientific calculator, which you are expected to use when appropriate

Instructions

- Answer all questions
- Answer questions in the space provided
- All working must be shown
- Do all rough work in this book. Cross out any rough work you don't want to be marked

Information

- The marks for the questions are shown in brackets
This question is about gases in the Earth’s atmosphere.

(a) The amount of carbon dioxide in the Earth’s atmosphere decreased during the first billion years of the Earth’s existence.

Complete the sentences. Use words from the box.

<table>
<thead>
<tr>
<th>carbonates</th>
<th>dissolved</th>
<th>evaporated</th>
<th>melted</th>
<th>nitrates</th>
<th>sulfates</th>
</tr>
</thead>
</table>

The amount of carbon dioxide in the Earth’s atmosphere decreased because

the carbon dioxide_________________________ in the oceans.

Sediments were formed when __________________________ were produced.

Algae and plants use carbon dioxide and water to produce oxygen.

(b) What is the name of this process?

Tick one box.

- Carbon capture
- Combustion
- Photosynthesis
- Polymerisation

(c) Complete the word equation for this process.

\[ \text{carbon dioxide} + \text{____________________} \rightarrow \text{glucose} + \text{____________________} \]
(d) Draw one line from each gas to the approximate percentage of the gas in the Earth’s atmosphere today.

<table>
<thead>
<tr>
<th>Gas</th>
<th>Approximate percentage of gas in the Earth’s atmosphere today</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>5</td>
</tr>
<tr>
<td>Oxygen</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>&gt;90</td>
</tr>
</tbody>
</table>

(e) Carbon dioxide is a greenhouse gas.

Why does increasing the amount of carbon dioxide change the global climate?

___________________________________________________________________
(f) How can countries reduce carbon dioxide emissions?

Tick one box.

- only burn methane
- use renewable energy supplies
- use waste plastic bags as fuel

(g) Give one reason why it is difficult for countries to reduce emissions of carbon dioxide.

___________________________________________________________________
___________________________________________________________________

(Total 10 marks)

Figure 1 represents an atom of sulfur.

Figure 1

\[ ^{32}_{16}S \]

(a) Complete the table below.

<table>
<thead>
<tr>
<th>Particle</th>
<th>Number of particles in a sulfur atom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electron</td>
<td>16</td>
</tr>
<tr>
<td>Neutron</td>
<td></td>
</tr>
<tr>
<td>Proton</td>
<td>16</td>
</tr>
</tbody>
</table>
(b) Sulfur is in Group 6 of the periodic table. Complete the electronic structure of the sulfur atom represented in Figure 2.

Figure 2

(c) Sulfur reacts with oxygen to produce sulfur dioxide. Complete the word equation for this reaction.

sulfur + ____________________________________________________________

(d) What effect is caused by sulfur dioxide? Tick one box.

Acid rain
Global dimming
Global warming
Sea levels rising

(1)
A student said:

‘the mass of sulfur dioxide in the atmosphere decreased every year between 1984 and 2014’

Is the student correct?

Use data from Figure 3 to justify your answer.
(f) **Figure 4** shows the percentage of sulfur dioxide released by human activities.

$$\text{Figure 4}$$

Calculate the percentage of sulfur dioxide released by industry.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

Percentage = ________________________ %

(2)
(Total 9 marks)
This question is about the Earth and its atmosphere.

(a) Figure 1 shows the Earth and its atmosphere billions of years ago.

![Figure 1](image)

The boiling point of water is 100 °C.

Suggest one reason why there was no liquid water on the Earth’s surface billions of years ago.

___________________________________________________________________
___________________________________________________________________

(1)

(b) The Earth’s atmosphere today contains nitrogen, oxygen, argon, carbon dioxide and other gases.

(i) Draw one line from each substance to a description of the substance.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Description of the substance</th>
</tr>
</thead>
<tbody>
<tr>
<td>air</td>
<td>compound</td>
</tr>
<tr>
<td>carbon dioxide</td>
<td>element</td>
</tr>
<tr>
<td>argon</td>
<td>hydrocarbon</td>
</tr>
<tr>
<td></td>
<td>metal</td>
</tr>
<tr>
<td></td>
<td>mixture</td>
</tr>
</tbody>
</table>
(ii) Which gas in the Earth's atmosphere is used when hydrocarbons burn?

Tick (✔) one box.

- carbon dioxide
- nitrogen
- oxygen

(iii) What percentage of the Earth's atmosphere is nitrogen?

Tick (✔) one box.

- about 40%
- about 60%
- about 80%

(c) Figure 2 shows the carbon dioxide percentage (%) in the Earth's atmosphere since the year 1800.

![Figure 2](image_url)

(i) What was the carbon dioxide percentage in 1900?

_______________________ %

(1)
(ii) Describe, in detail, how the carbon dioxide percentage changed from 1900 to 2015.

______________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________

(2)

(iii) Suggest two reasons for the change in the carbon dioxide percentage from 1900 to 2015.

1. ____________________________________________________________
   ____________________________________________________________

2. ____________________________________________________________
   ____________________________________________________________

(2)

(Total 11 marks)

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.

1. _________________________________________________________________
   _____________________________________________________________________

2. _________________________________________________________________
   _____________________________________________________________________

(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.

___________________________________________________________________

___________________________________________________________________

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(6)
(Total 8 marks)
Human activity contributes to pollution.

The concentration of particulate matter (PM) in the atmosphere is measured in different places across the world.

**Figure 1** shows the diameter of some different particles.

![Figure 1](image)

(a) **PM$_{2.5}$** are particles which are $2.5 \times 10^{-6}$ m in diameter or smaller.

What is the maximum diameter of PM$_{2.5}$ particles in millimetres?

Tick one box.

- 0.025
- 0.0025
- 0.000025
- 0.00000025

(1)
(b) Which **two** particles in **Figure 1** are included in the PM$_{2.5}$ measure of air pollution?

Tick **two** boxes.

- Beach sand
- Cement dust
- Pollen
- Soot
- Tobacco smoke

**Figure 2** shows how the concentration of PM$_{2.5}$ affects death rates.

**Figure 2**

```
Relative risk of death

Key
- Risk of death from lung cancer
- Risk of death from other lung diseases

Concentration of PM$_{2.5}$
```

(2)
(c) Compare the effect of PM$_{2.5}$ concentration on the death rate from lung cancer with the death rate from other lung diseases.

Use data from Figure 2 in your answer.

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

(d) Why do PM$_{2.5}$ particles cause these negative health effects?

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

(e) Figure 3 shows air pollution information collected in one city in 18 hours.

**Figure 3**

![Graph showing PM$_{2.5}$, SO$_2$, and NO$_x$ concentrations over the day]

Suggest two possible reasons for the rise in PM$_{2.5}$ concentration from 6 am to 2 pm.

1. _________________________________________________________________

___________________________________________________________________

2. _________________________________________________________________

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

(2)
(f)  Air Quality Index (AQI) is a measure of pollution in the atmosphere. When the AQI value reaches 201 it is judged to be 'very unhealthy'.

Suggest **one** precaution people should take if AQI rises above 201

___________________________________________________________________
___________________________________________________________________

(1)

(Total 9 marks)

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)
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.

___________________________________________________________________
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___________________________________________________________________
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(6)  
(Total 7 marks)
Sulfur is a non-metal.
Sulfur burns in the air to produce sulfur dioxide, $\text{SO}_2$

(a) Why is it important that sulfur dioxide is **not** released into the atmosphere?

Tick (✓) one box.

- Sulfur dioxide causes acid rain.
- Sulfur dioxide causes global dimming.
- Sulfur dioxide causes global warming.

(1)

(b) Sulfur dioxide dissolves in water.

What colour is universal indicator in a solution of sulfur dioxide?
Give a reason for your answer.
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
(2)

(c) Sulfur dioxide is a gas at room temperature.

The bonding in sulfur dioxide is covalent.

Explain, in terms of its structure and bonding, why sulfur dioxide has a low boiling point.
___________________________________________________________________
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(3)
Sulfur dioxide is produced when fossil fuels are burned.

It is important that sulfur dioxide is not released into the atmosphere.

Three of the methods used to remove sulfur dioxide from gases produced when fossil fuels are burned are:

- wet gas desulfurisation (W)
- dry gas desulfurisation (D)
- seawater gas desulfurisation (S).

Information about the three methods is given in the bar chart and in Table 1 and Table 2.

![Bar chart showing percentage of sulfur dioxide removed from waste gases for methods W, D, and S.]

<table>
<thead>
<tr>
<th>Method</th>
<th>Material used</th>
<th>How material is obtained</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>Calcium carbonate, CaCO₃</td>
<td>Quarrying</td>
</tr>
<tr>
<td>D</td>
<td>Calcium oxide, CaO</td>
<td>Thermal decomposition of calcium carbonate:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CaCO₃ → CaO + CO₂</td>
</tr>
<tr>
<td>S</td>
<td>Seawater</td>
<td>From the sea</td>
</tr>
</tbody>
</table>
Table 2

<table>
<thead>
<tr>
<th>Method</th>
<th>What is done with waste material</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>Solid waste is sold for use in buildings. Carbon dioxide is released into the atmosphere.</td>
</tr>
<tr>
<td>D</td>
<td>Solid waste is sent to landfill.</td>
</tr>
<tr>
<td>S</td>
<td>Liquid waste is returned to the sea.</td>
</tr>
</tbody>
</table>

Evaluate the three methods of removing sulfur dioxide from waste gases.

Compare the three methods and give a justified conclusion.

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(6) (Total 12 marks)