# The Morley Academy

# 9. Chemistry of the Atmosphere Mastery Booklet

(Chemistry Paper 2)

Name : _____

Teacher : _____

Date Given : _____

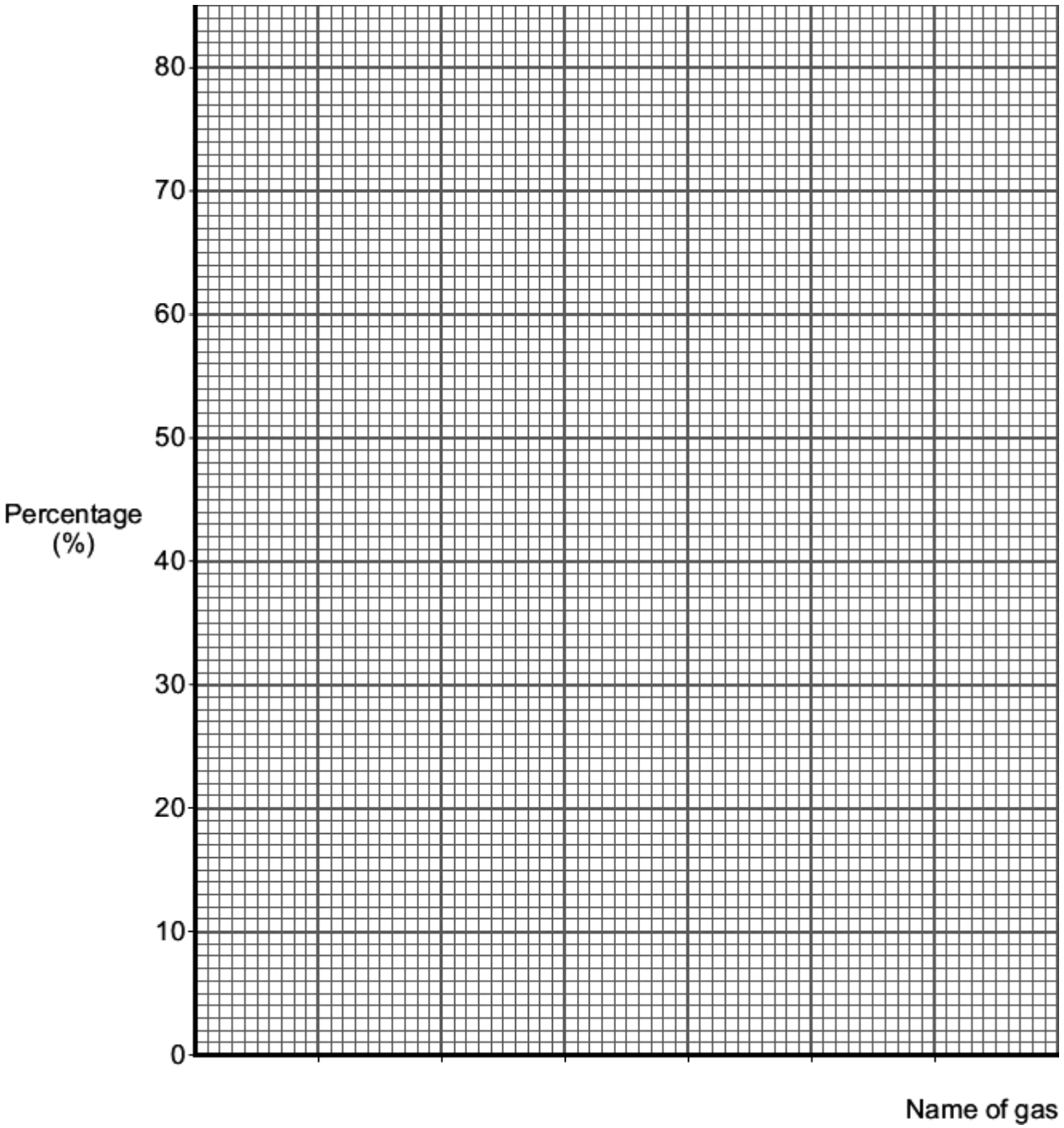
These booklets are a consolidation of your learning. They should be used in the following way - You should attempt the questions WITHOUT looking at the answers. Then mark your questions with **green pen** and add any missing marks you missed.

*THESE BOOKLETS WILL IMPROVE YOUR GRADES...!!*

**Q1.** (b) The data in the table shows the percentages of the gases in the Earth's atmosphere.

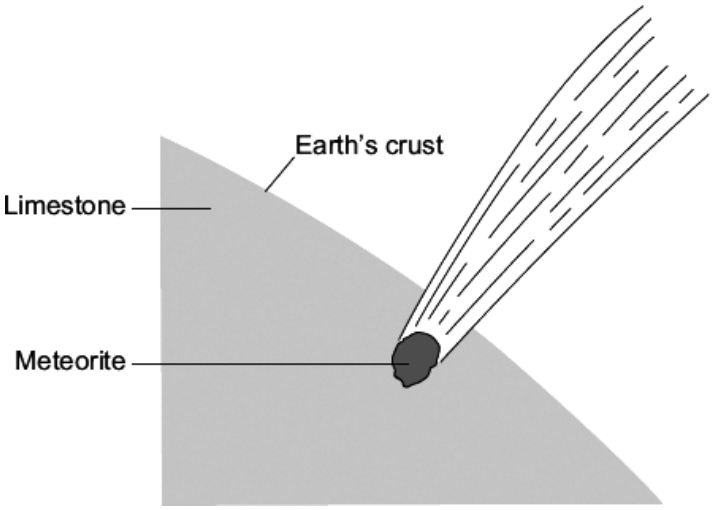
| Name of gas | Percentage (%) of gas |
|---|---|
| Nitrogen | 78 |
| Oxygen | 21 |
| Other gases | 1 |

Present the data in the table on the grid below.



**(3)**

(c) Millions of years ago a large meteorite hit the Earth.
The meteorite heated limestone in the Earth's crust to a very high temperature.
The heat caused calcium carbonate in the limestone to release large amounts of carbon dioxide.




Draw a ring round the correct answer to complete each sentence.

(i) Carbon dioxide was released because the calcium carbonate was

| |
|---|
| decomposed. |
| evaporated. |
| reduced. |

**(1)**

(ii) More carbon dioxide in the Earth's atmosphere causes

| |
|---|
| acid rain. |
| global dimming. |
| global warming. |

**(1)**
**(Total 7 marks)**

**Q2.** Coal is used as a fuel in power stations.

The table shows the percentage of carbon and sulfur in four different coal samples.

| Sample | Percentage (%) by mass in coal | |
|---|---|---|
| | Carbon | Sulfur |
| **A** | 22.1 | 0.4 |
| **B** | 46.8 | 0.6 |
| **C** | 66.3 | 0.9 |

| | | |
|---|---|---|
| **D** | 92.0 | 0.7 |

(a) Sulfur produces a gas that causes acid rain.

Name the gas.

_____

**(1)**

(b) Give **one** environmental effect caused by acid rain.

_____

**(1)**

(c) Which coal sample produces the most acid rain from 1 kg of coal?

Use the table above.

Give a reason for your answer.

Sample _____

Reason _____

_____

**(2)**

(d) Calculate the mass of coal sample **A** that would produce the same amount of carbon dioxide as 1 kg of coal sample **C**.

_____

_____

Mass of coal sample **A** = _____ kg

**(2)**

(e) Incomplete combustion of coal can produce carbon monoxide.

Carbon monoxide is a toxic gas.

Give **two** reasons why people may be unaware of the presence of carbon monoxide.

1. _____

_____

2. _____

_____

**(2)**

**(Total 8 marks)**

## Q3.

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.

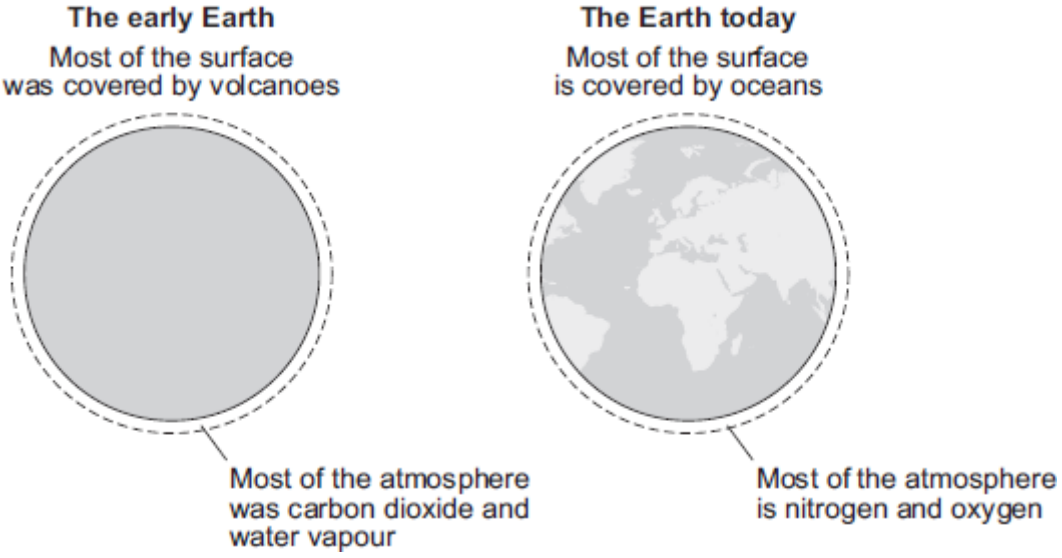
_____

_____

**(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)**

## Q4.

Scientists study the atmosphere on planets and moons in the Solar System to understand how the Earth's atmosphere has changed.

(a) Millions of years ago the Earth's atmosphere was probably just like that of Mars today.

The table shows data about the atmosphere of Mars and Earth today.

| **Mars today** | | **Earth today** | |
|---|---|---|---|
| nitrogen | 3% | nitrogen | 78% |
| oxygen | trace | oxygen | 21% |
| water | trace | water | trace |
| Carbon dioxide | 95% | Carbon dioxide | trace |
| Average surface temperature −23°C | | Average surface temperature 15°C | |

The percentages of some gases in the Earth's atmosphere of millions of years ago have changed to the percentages in the Earth's atmosphere today.

For **two** of these gases describe how the percentages have changed **and** suggest what caused this change.

_____

_____

_____

**(2)**

(b) Titan is the largest moon of the planet Saturn.
Titan has an atmosphere that contains mainly nitrogen.
Methane is the other main gas.

| **Main gases in Titan's atmosphere** | **Percentage (%)** | **Boiling point in °C** |
|---|---|---|
| Nitrogen | 95 | −196 |
| Methane | 5 | −164 |
| Average surface temperature −178°C | | |

When it rains on Titan, it rains methane!

Use the information above and your knowledge and understanding to explain why.

_____

_____

_____

_____

**(2)**

(c) Ultraviolet radiation from the Sun produces simple alkenes, such as ethene ($C_2H_4$) and propene ($C_3H_6$) from methane in Titan's atmosphere.

State the general formula for alkenes.

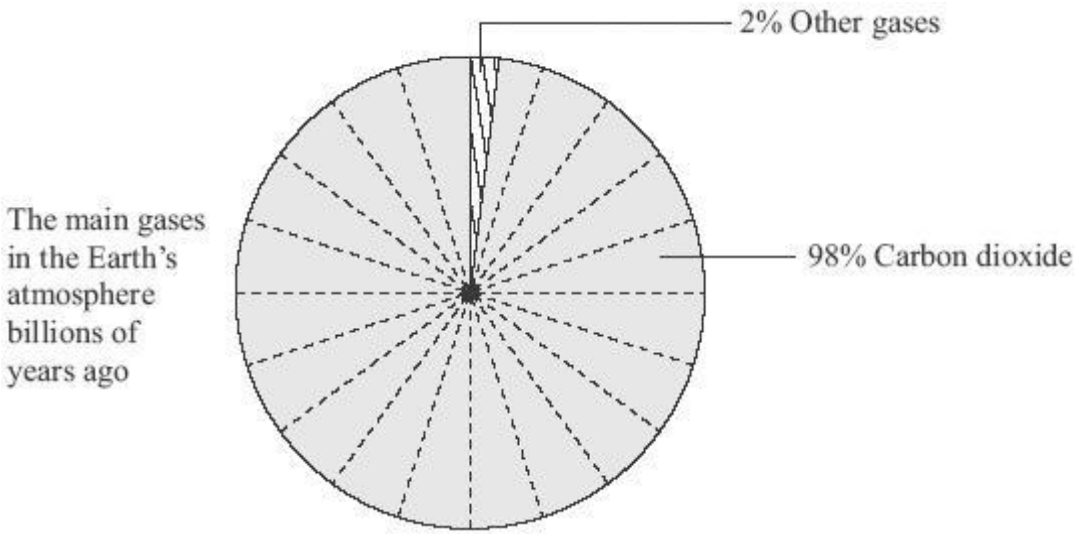
_____

**(1)**

**(Total 5 marks)**

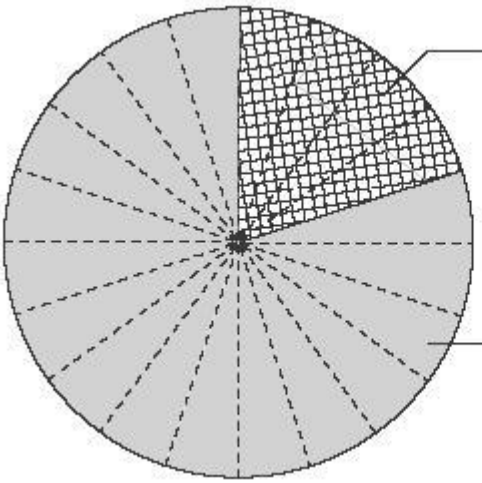
## Q5.

Life on Earth would not exist without the atmosphere. Billions of years ago the composition of the Earth's atmosphere was very different from the composition today.




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

The main gases in the Earth's atmosphere today



.....% .....

.....% .....

**(2)**

(b) There is evidence that the composition of the Earth's atmosphere is still changing. One possible reason is that many power stations generate electricity by burning fossil fuels such as coal, oil or natural gas. Sulfur dioxide, $SO_2$, is produced when coal burns in air.

(i) What environmental problem does sulfur dioxide cause?

_____

_____

**(1)**

(ii) How could this environmental problem be reduced in coal-fired power stations?

_____

_____

**(1)**

(iii) Gas-fired power stations burn methane, $CH_4$, in air.

Complete the word equation for this reaction.

methane + _____ → carbon dioxide + _____

**(2)**

(c) Excess carbon dioxide should be prevented from entering the atmosphere.

Explain why.

_____

_____

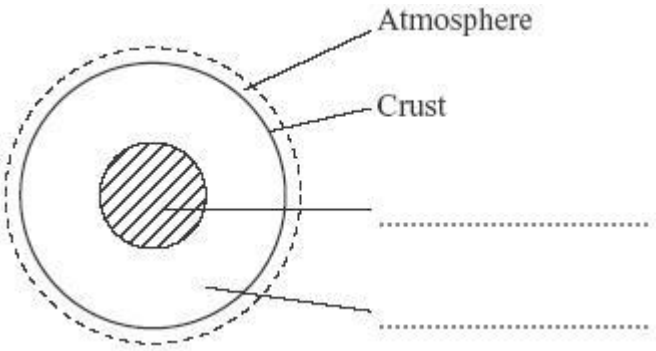
_____

_____

**(2)**

**Q6.** The Earth is shaped like a ball and is surrounded by an atmosphere.

(a) The diagram shows the layered structure of the Earth.



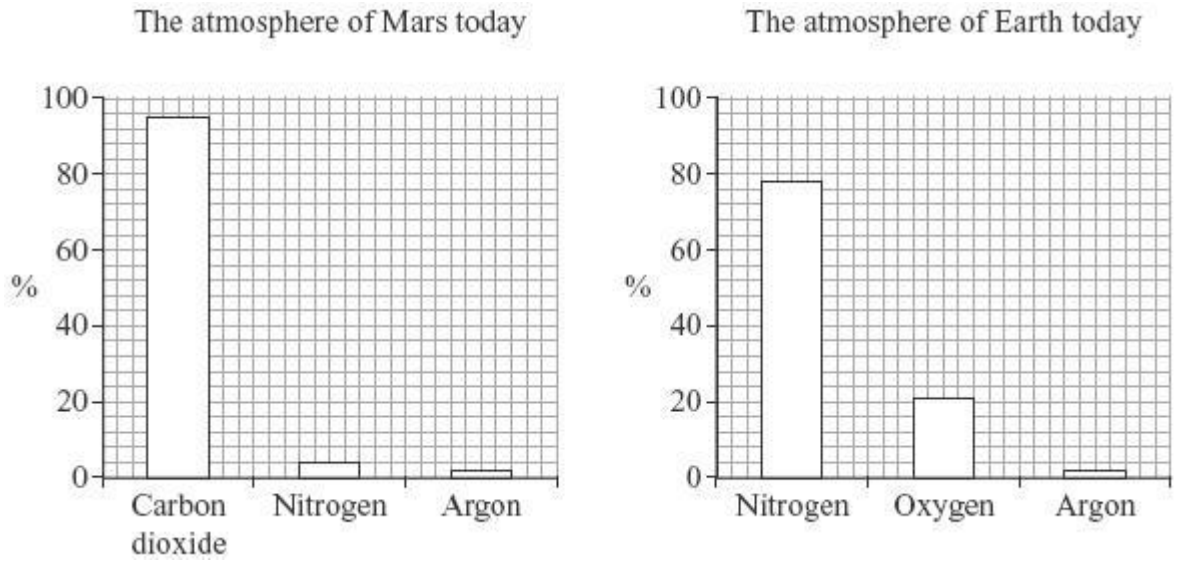

Choose words from the box to complete the labels on the diagram.

| core | mantle | plate |
|---|---|---|

**(2)**

(b) Some theories suggest that the Earth's early atmosphere was like the atmosphere of Mars today.

The bar charts show the three most common gases in each atmosphere today.




(i) Use the bar charts to complete the sentence by writing in the correct gases.

In the atmosphere of Mars today there is mainly _____

and no _____ .

**(2)**

(ii) Use the bar charts to complete the sentence by writing in the correct number.

These theories suggest that there was about _____ % nitrogen in the Earth's early atmosphere.

**(1)**

(iii) The atmosphere of the Earth today has much more nitrogen than in the early atmosphere. Denitrifying bacteria released most of this nitrogen into the atmosphere.

There are other differences between the Earth's early atmosphere and the atmosphere of the Earth today.

Use the bar charts to describe and explain **two** of these other differences.

_____

_____

_____

_____

_____

_____

**(3)**

**(Total 8 marks)**

**Q7.** Greenhouse gases affect the temperature of the Earth.

(a) Which gas is a greenhouse gas?

Tick **one** box.

Argon ☐

Methane ☐

Nitrogen ☐

Oxygen ☐

**(1)**

(b) An increase in global temperature will cause climate change.

What is **one** possible effect of climate change?

Tick **one** box.

Deforestation ☐

Global dimming ☐

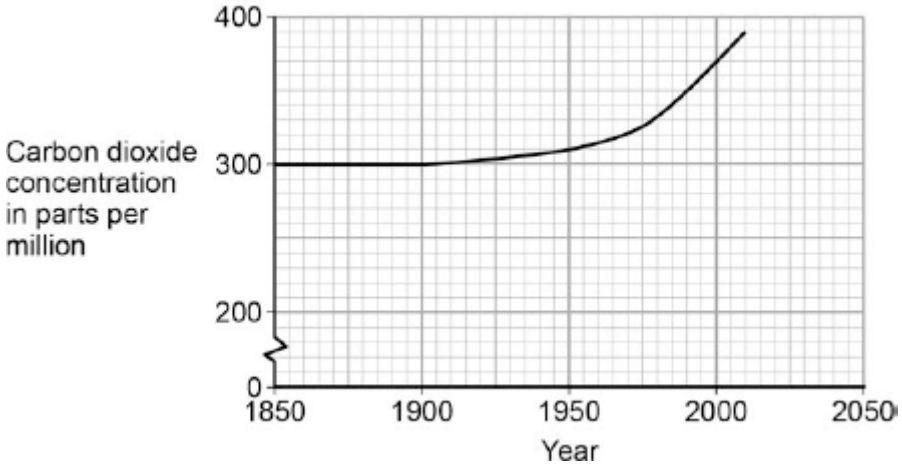
Sea levels rising ☐

Volcanic activity ☐

**(1)**

(c) Carbon dioxide is also a greenhouse gas.

The figure below shows how the concentration of carbon dioxide in the atmosphere has changed since 1850.




Which process is the reason for the change in carbon dioxide concentration shown on the figure above?

Tick **one** box.

Burning of fossil fuels ☐

Carbon capture ☐

Formation of sedimentary rocks ☐

Photosynthesis ☐

**(1)**

(d) Give **three** conclusions that can be made from the figure above.

1. _____

2. _____

3. _____

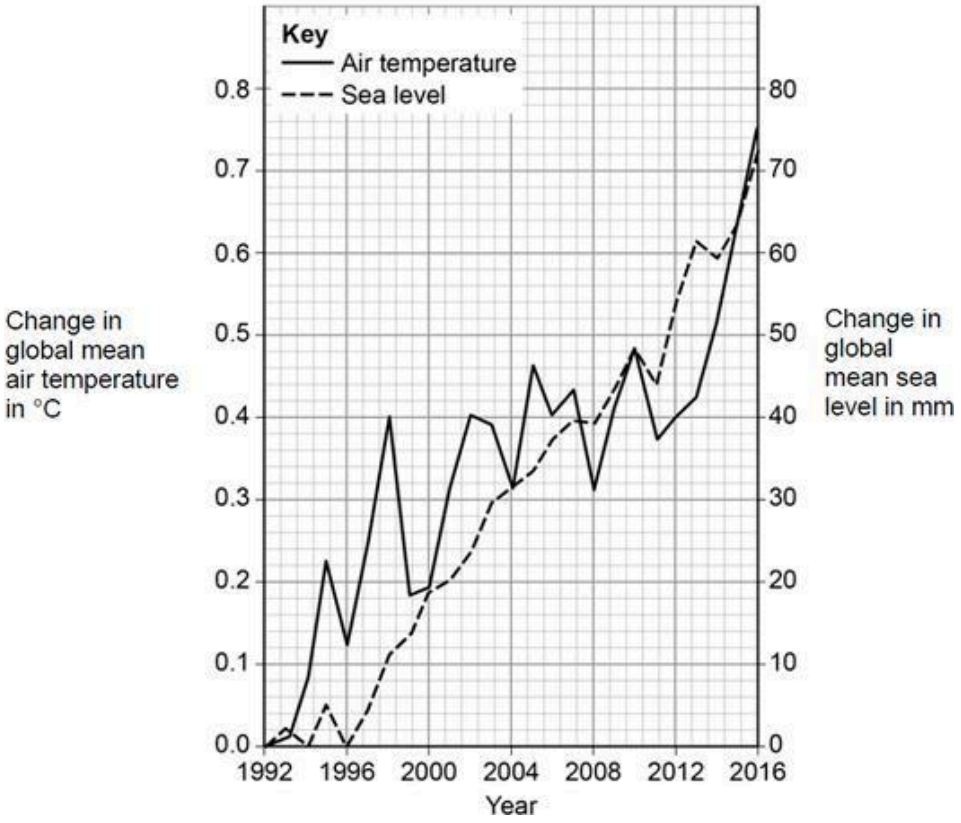
**(3)**

**(Total 6 marks)**

**Q8.** This question is about climate change.

**Figure 1** shows the changes in the global mean air temperature and global mean sea level from 1992 to 2016.

**Figure 1**




(a) Calculate the mean yearly increase in sea level between 1992 and 2016.

Use **Figure 1**.

_____

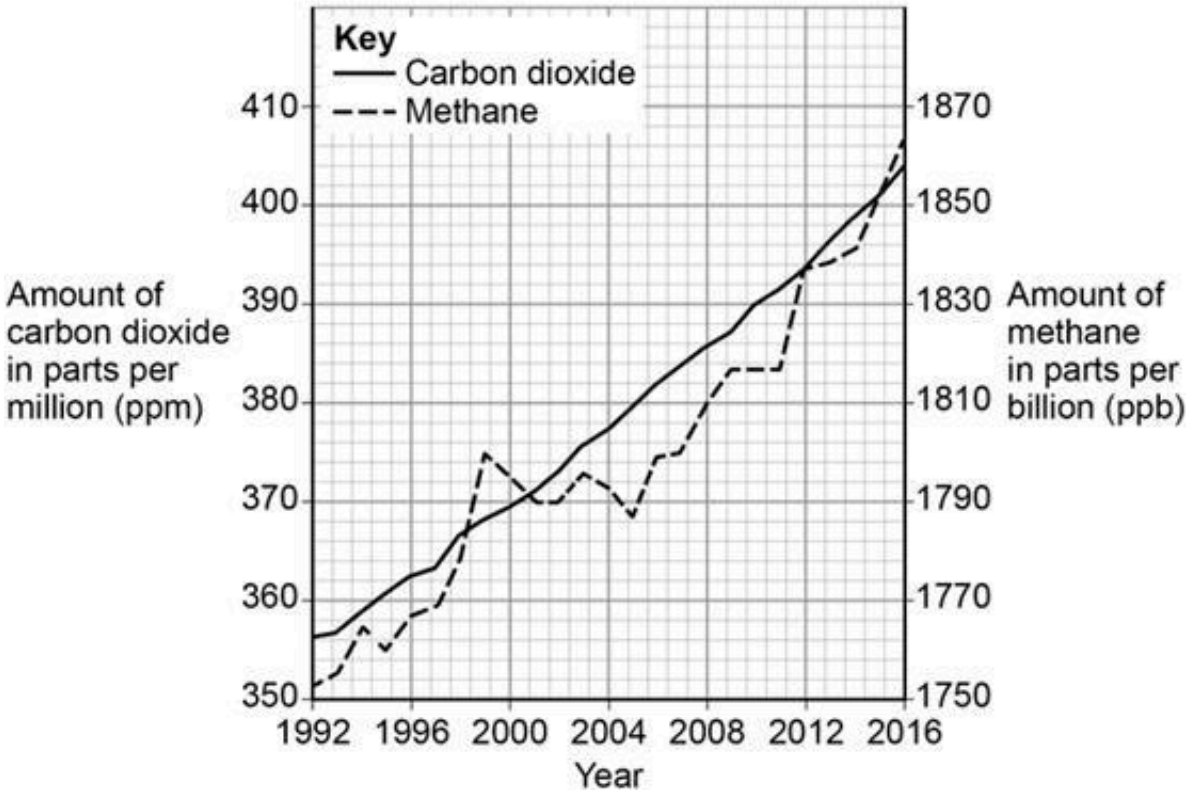
Mean yearly increase in sea level = _____ mm / year

**(2)**

Most scientists think carbon dioxide and methane are a cause of global climate change.

**Figure 2** shows the amounts of these gases in the atmosphere from 1992 to 2016.

Figure 2




(b) Describe the changes in **Figure 1** and in **Figure 2**.

Explain how these changes have taken place.

**(6)**

(c) The data was collected by a single scientific group.

Give **two** reasons why more evidence is needed to support any conclusions made by this scientific group.

1. _____

2. _____

**(2)**

**(Total 10 marks)**

## Q9.

This question is about copper.

(a) Copper can be extracted by smelting copper-rich ores in a furnace.

The equation for one of the reactions in the smelting process is:

$$Cu_2S(s) + O_2(g) \longrightarrow 2\,Cu(s) + SO_2(g)$$

Explain why there would be an environmental problem if sulfur dioxide gas escaped into the atmosphere.

_____

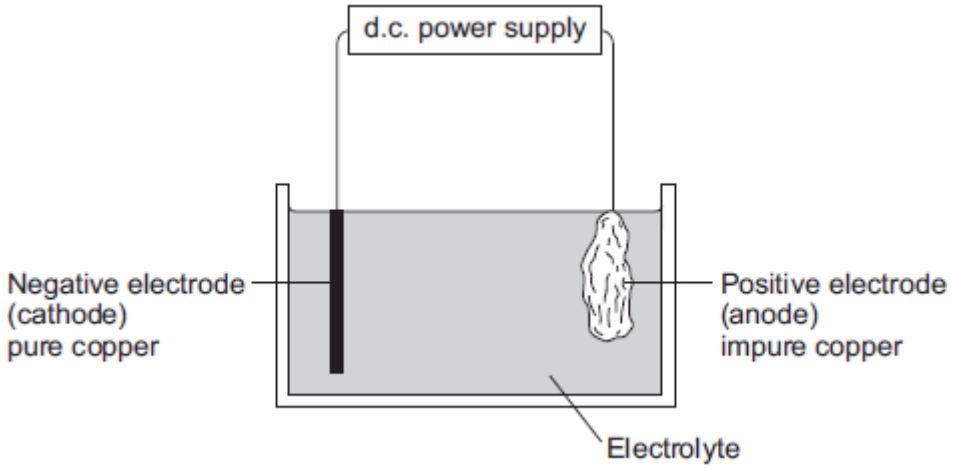
_____

_____

_____

**(2)**

(b) The impure copper produced by smelting is purified by electrolysis, as shown below.




Copper atoms are oxidised at the positive electrode to $Cu^{2+}$ ions, as shown in the half equation.

$$Cu(s) \longrightarrow Cu^{2+}(aq) + 2e^{-}$$

(i) How does the half equation show that copper atoms are oxidised?

_____

_____

**(1)**

(ii) The $Cu^{2+}$ ions are attracted to the negative electrode, where they are reduced to produce copper atoms.

Write a balanced half equation for the reaction at the negative electrode.

_____

**(1)**

(iii) Suggest a suitable electrolyte for the electrolysis.

_____

**(1)**

(c) Copper metal is used in electrical appliances.

Describe the bonding in a metal, and explain why metals conduct electricity.

_____

_____

_____

_____

_____

_____

_____

**(4)**

(d) Soil near copper mines is often contaminated with low percentages of copper compounds.

Phytomining is a new way to extract copper compounds from soil.

Describe how copper compounds are extracted by phytomining.

_____

_____

_____

_____

**(3)**

**(Total 16 marks)**

**Q10.** Sulfur is a non-metal.

Sulfur burns in the air to produce sulfur dioxide, $SO_2$

(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.

_____

_____

_____

_____

_____

_____

**(3)**

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

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**.

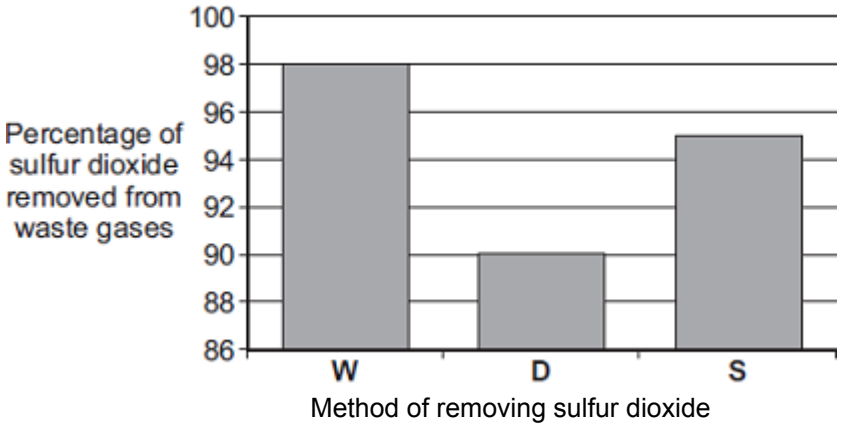



**Table 1**

| Method | Material used | How material is obtained |
|---|---|---|
| **W** | Calcium carbonate, $CaCO_3$ | Quarrying |
| **D** | Calcium oxide, CaO | Thermal decomposition of calcium carbonate: $CaCO_3 \longrightarrow CaO + CO_2$ |
| **S** | Seawater | From the sea |

**Table 2**

| Method | What is done with waste material |
|---|---|
| **W** | Solid waste is sold for use in buildings.<br>Carbon dioxide is released into the atmosphere. |
| **D** | Solid waste is sent to landfill. |
| **S** | Liquid waste is returned to the sea. |

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

Compare the three methods and give a justified conclusion.

_____

_____

_____

_____

_____

_____

_____

_____

_____

**(6)**

**(Total 12 marks)**

## Q1.

(a) crust

*ignore Earth's*

**1**

core

*ignore inner and/or outer*

**1**

(b) bar chart

**1**

all heights are correct

*accept correctly plotted points*

**1**

all labels are correct for nitrogen, oxygen and other / argon

**1**

(c) (i) decomposed

**1**

(ii) global warming

**1**

**[7]**

## Q2.

(a) sulfur dioxide

**1**

(b) any **one** from:

- kills aquatic animals / plants
- damages limestone buildings / statues
- damage to forests

**1**

(c) (sample) **C**

**1**

contains most sulfur
**or**
produces most sulfur dioxide

**1**

(d) $1 \times \frac{66.3}{22.1}$

**1**

= 3 (kg)

**1**

*an answer of 3 (kg) scores **2** marks*

(e) any **two** from:

- not easily detected

- colourless

  *allow cannot see it*

- odourless

  *allow cannot smell it*

**2**

**[8]**

## Q3.

(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]**

## Q4.

(a) any **two** from:

*asks for cause therefore no marks for just describing the change*
*must link reason to a correct change in a gas*

**carbon dioxide has decreased due to:**

*accept idea of 'used' to indicate a decrease*

- plants / microorganisms / bacteria / vegetation / trees
- photosynthesis
  *ignore respiration*
- 'locked up' in (sedimentary) rocks / carbonates / fossil fuels
- dissolved in oceans
  *ignore volcanoes*

**oxygen has increased due to:**

*accept idea of 'given out / produced'*

- plants / bacteria / microorganisms / vegetation / trees
- photosynthesis
  *ignore respiration*

**nitrogen increased due to:**

*accept idea of 'given out / produced'*

- ammonia reacted with oxygen
- bacteria / micro organisms
  *ignore (increase in) use of fossil fuels / deforestation*

**2**

(b) (because methane's) boiling point is greater than the average / surface temperature **or** Titan's (average / surface) temperature is below methane's boiling point

*ignore references to nitrogen **or** water*

**1**

any methane that evaporates will condense

*accept boils for evaporates*
*accept cooling and produce rain for condensing*

**1**

(c) $C_nH_{2n}$

**1**

**[5]**

## Q5.

(a) oxygen **and** nitrogen

**1**

20 – 21 % and 78 – 80 %

*accept any two correct responses in the correct space for **one** mark*

**1**

(b) (i) acid rain

*accept toxic gas or consequence of acid rain*

**1**

(ii) idea of the removal or use of sulfur dioxide gas (from the waste gases)

*do **not** accept remove sulfur from coal*

**1**

(iii) oxygen

*accept $O_2$*

**1**

water

*accept $H_2O$*
*accept hydrogen oxide / steam*

**1**

(c) any **two** from:

- it's a 'greenhouse gas' or increase greenhouse effect
  *accept action of a 'greenhouse gas'*
- causes global warming or increase in the Earth's temperature
- sea-levels rise or flooding
- climate change
- (polar) ice-caps melt
- extension of deserts

*mention of ozone / acid rain / global dimming = max **1** mark*

**2**

(d) idea trap / store / lock the carbon dioxide

**1**

in the oil reservoir or under the sea bed

*do **not** accept 'into the oil' / 'under the sea'*

**1**

**[10]**

## Q6.

(a) core

*ignore outer or inner*

**1**

mantle

**1**

(b) (i) carbon dioxide

*accept formula $CO_2$*

**1**

oxygen

*accept formulae $O_2$ / $O$*

**1**

(ii) 4%

**1**

(iii) carbon dioxide has decreased / from 95% to 0%

**1**

oxygen has increased / from 0% to 21%

**1**

any **one** from:

(carbon dioxide decrease)

- carbon dioxide used during photosynthesis / by plants
- carbon dioxide dissolves in oceans
- carbon dioxide is locked up in rocks / carbonates / fossil fuels

(oxygen increase)

- oxygen released during photosynthesis / by plants

**1**

## Q7.

(a) Methane

**1**

(b) Sea levels rising

**1**

(c) Burning of fossil fuels

**1**

(d) carbon dioxide concentration stayed constant from 1850 to 1900

**1**

carbon dioxide concentration slowly increased from 1900

**1**

carbon dioxide concentration increased more rapidly from 1965

*allow values from 1965 − 1975*

**1**

**[6]**

## Q8.

(a) 72/24

*an answer of 3 (mm / year) scores **2** marks*

**1**

= 3 (mm / year)

*an answer of 3.125 (mm / year) scores **1** mark*

**1**

(b) **Level 3 (5-6 marks):**
Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.

**Level 2 (3-4 marks):**
Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.

**Level 1 (1-2 marks):**
Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

**Level 0**
No relevant content

**Indicative content**

**description**
- global air temperature has risen overall / erratically
- mean sea level has risen (steadily)
- carbon dioxide has risen steadily
- methane has risen overall / erratically

**explanations**
- (carbon dioxide increase because) increase in fossil fuel combustion
  **or**
- (carbon dioxide increase because) increase in deforestation
- methane from cattle / landfill / rice plantations
- carbon dioxide and / or methane trap heat
  **or**
- carbon dioxide and / or methane are greenhouse gases
- polar ice caps melt
  **or**
- seawater expands

**linked explanation**
- greenhouse gases linked to temperature rise
- temperature rise linked to seawater level

**6**

(c) any **two** from:

- bias
- simplified models
- lack of peer review

*ignore reproducible*

**2**

**[10]**

## Q9.

(a) because sulfur dioxide causes <u>acid rain</u>

**1**

which kills fish / aquatic life **or** dissolves / damages statues / stonework **or** kills / stunts growth of trees

*if no other mark awarded then award 1 mark for sulfur dioxide is toxic or causes breathing difficulties.*

**1**

(b) (i) <u>electrons</u> are lost

**1**

(ii) $Cu^{2+} + 2e^- \rightarrow Cu$

*allow* $Cu^{2+} \rightarrow Cu - 2e^-$

*ignore state symbols*

**1**

(iii) copper sulfate

*allow any ionic copper compound*

**1**

(c) (lattice of) positive ions

**1**

delocalised electrons

*accept sea of electrons*

**1**

(electrostatic) attraction between the positive ions and the electrons

**1**

electrons can move through the metal / structure **or** can flow

*allow electrons can carry charge through the metal / structure*

*if wrong bonding named or described or attraction between oppositely charged ions then do not award M1 or M3 − MAX 2*

**1**

(d) (copper compounds are absorbed / taken up by) plants

*allow crops*

**1**

which are burned

**1**

the ash contains the copper compounds

*do not award M3 if the ash contains copper (metal)*

**1**

(e)

| / $A_r$ | 55.6 / 63.5 | 16.4 / 56 | 28.0 / 32 |
|---|---|---|---|
| moles | 0.876 | 0.293 | 0.875 |
| ratio | 3 | 1 | 3 |
| formula | $Cu_3FeS_3$ | | |

*award **4** marks for $Cu_3FeS_3$ with some correct working*

*award **3** marks for $Cu_3FeS_3$ with **no** working*

*if the answer is not $Cu_3FeS_3$ award up to **3** marks for correct steps from the table apply ecf*

*if the student has inverted the fractions award **3** marks for an answer of $CuFe_3S$*

**4**

**[16]**

## Q10.

(a) Sulfur dioxide causes acid rain.

**1**

(b) red / orange / yellow

*do **not** accept any other colours*

**1**

because sulfur dioxide (when in solution) is an acid

**1**

(c) (there are) weak forces (of attraction)

*do **not** accept any reference to covalent bonds breaking*

**1**

between the molecules

*do **not** accept any other particles*

**1**

(these) take little energy to overcome

*award third mark only if first mark given*

**1**

(d) Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5 and apply a 'best-fit' approach to the marking.

**0 marks**
No relevant content

**Level 1 (1 – 2 marks)**
A relevant comment is made about the data.

**Level 2 (3 – 4 marks)**
Relevant comparisons have been made, and an attempt made at a conclusion.

**Level 3 (5 – 6 marks)**
Relevant, detailed comparisons made and a justified conclusion given.

**examples of the points made in the response**

**effectiveness**

- W removes the most sulfur dioxide
- D removes the least sulfur dioxide

**material used**

- Both W and D use calcium carbonate
- Calcium carbonate is obtained by quarrying which will create scars on landscape / destroy habitats
- D requires thermal decomposition, this requires energy
- D produces carbon dioxide which may cause global warming / climate change
- S uses sea water, this is readily available / cheap

**waste materials**

- W product can be sold / is useful
- W makes carbon dioxide which may cause global warming / climate change
- D waste fill landfill sites
- S returned to sea / may pollute sea / easy to dispose of

**6**

**[12]**