Name: _____

Class: _____

Date: _____

Chemical Analysis part 5 AQA Triple Chemistry

Time: **79 minutes**

Marks: **76 marks**

Comments:

1. Older cars are tested each year to measure the amount of pollutants contained in exhaust fumes.

The table below shows the maximum allowed percentages of exhaust pollutants for petrol cars.

Age of car in years	Maximum allowed percentage (%) of exhaust pollutant	
	Carbon monoxide	Unburned hydrocarbons
16−24	0.30	0.02
3−16	0.20	0.02

(a) Explain how carbon monoxide is produced when petrol is burned in car engines.

_____

_____

_____

_____

(2)

(b) Suggest **two** reasons why the maximum allowed percentage of carbon monoxide has been decreased for newer cars.

1. _____

_____

2. _____

_____

(2)

(c) Give **one** reason for having a maximum allowed percentage of unburned hydrocarbons in exhaust fumes.

_____

_____

(1)

Oxides of nitrogen are also pollutants contained in exhaust fumes.

(d) Describe how oxides of nitrogen are produced when petrol is burned in car engines.

_____

_____

_____

_____

(2)

Catalytic converters are fitted to car exhausts to reduce the amount of pollutants released into the atmosphere.

(e) Nitrogen dioxide is an oxide of nitrogen.

Nitrogen dioxide reacts to produce nitrogen and oxygen in catalytic converters.

Complete the equation for this reaction.

The equation should be balanced.

$$\_\_\_\ NO_2\,(g) \longrightarrow \_\_\_\_\_ + \_\_\_\ O_2\,(g)$$

(2)

(f) Give **two** effects of atmospheric pollution which are reduced by using catalytic converters.

1. _____

_____

2. _____

_____

(2)

(g) The catalyst in catalytic converters is a mixture of three elements.

Where in the periodic table are these elements most likely to be found?

Tick **one** box.

Alkali metals ☐

Halogens ☐

Noble gases ☐

Transition metals ☐

(1)

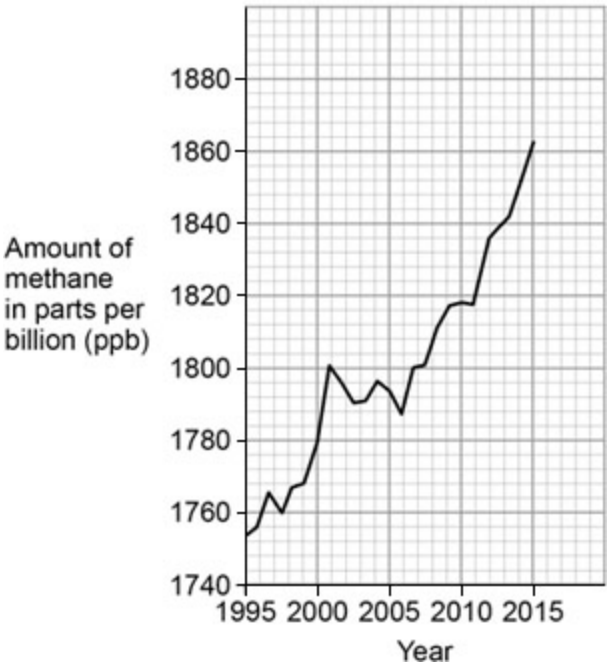
(Total 12 marks)

2. Methane gas is present in the atmosphere.

Most scientists think methane is a cause of global climate change.

Figure 1 shows the changes in the amount of methane in the atmosphere from 1995 to 2015.

Figure 1



(a) Calculate the increase in the amount of methane between 1999 and 2012.

Amount in 1999 _____ ppb

Amount in 2012 _____ ppb

Increase in amount of methane = _____ ppb

(2)

(b) How did the amount of methane in the atmosphere change between 2003 and 2005?

Tick (✓) **one** box.

Methane levels fell. ☐

Methane levels rose. ☐

Methane levels rose and fell. ☐

Methane levels stayed the same. ☐

(1)

(c) Name **two** activities that increase the amount of methane in the atmosphere.

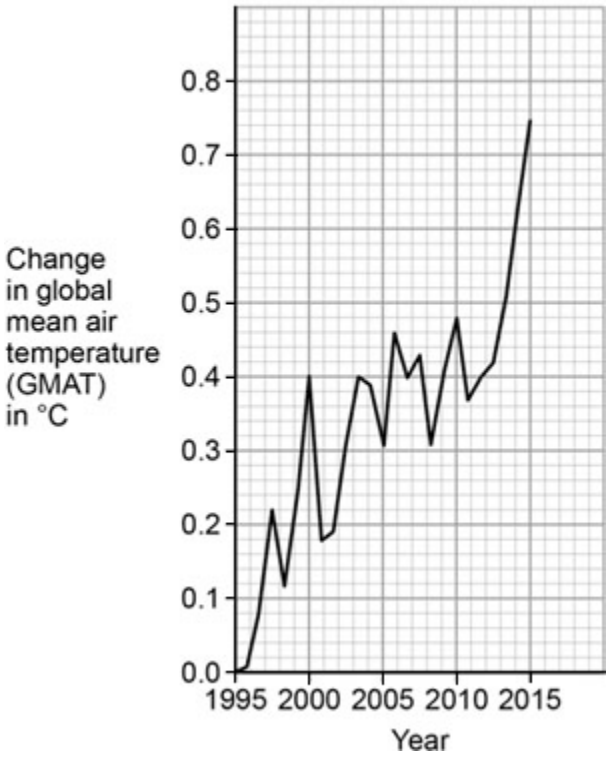
1. _____

2. _____

(2)

Figure 2 shows the changes in global mean air temperature (GMAT) from 1995 to 2015.

Figure 2



(d) What patterns in global mean air temperature (GMAT) between 1995 and 2015 are shown in **Figure 2**?

Tick (✓) **two** boxes.

The largest increase in GMAT was between 1995 and 1996. ☐

There was a continuous increase in GMAT. ☐

There was a fall in GMAT in some years. ☐

There was an overall decrease in GMAT. ☐

There was an overall increase in GMAT. ☐

(2)

(e) Increasing air temperatures can result in rising sea levels.

Give **one** reason why.

_____

(1)

(f) What could be an effect of rising sea levels on coastal areas?

Tick (✓) **one** box.

Reduced rainfall ☐

Flooding of low lying areas ☐

Global dimming ☐

More land for houses ☐

(1)

(g) Between 2004 and 2010:

- the global mean air temperature (GMAT) increased by 0.09 °C
- global mean sea level (GMSL) increased by 9 mm.

Estimate the increase in GMSL produced by a 1 °C increase in GMAT.

Tick (✓) **one** box.

0.1 mm ☐

1 mm ☐

10 mm ☐

100 mm ☐

(1)

(Total 10 marks)

3. 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. _____

_____

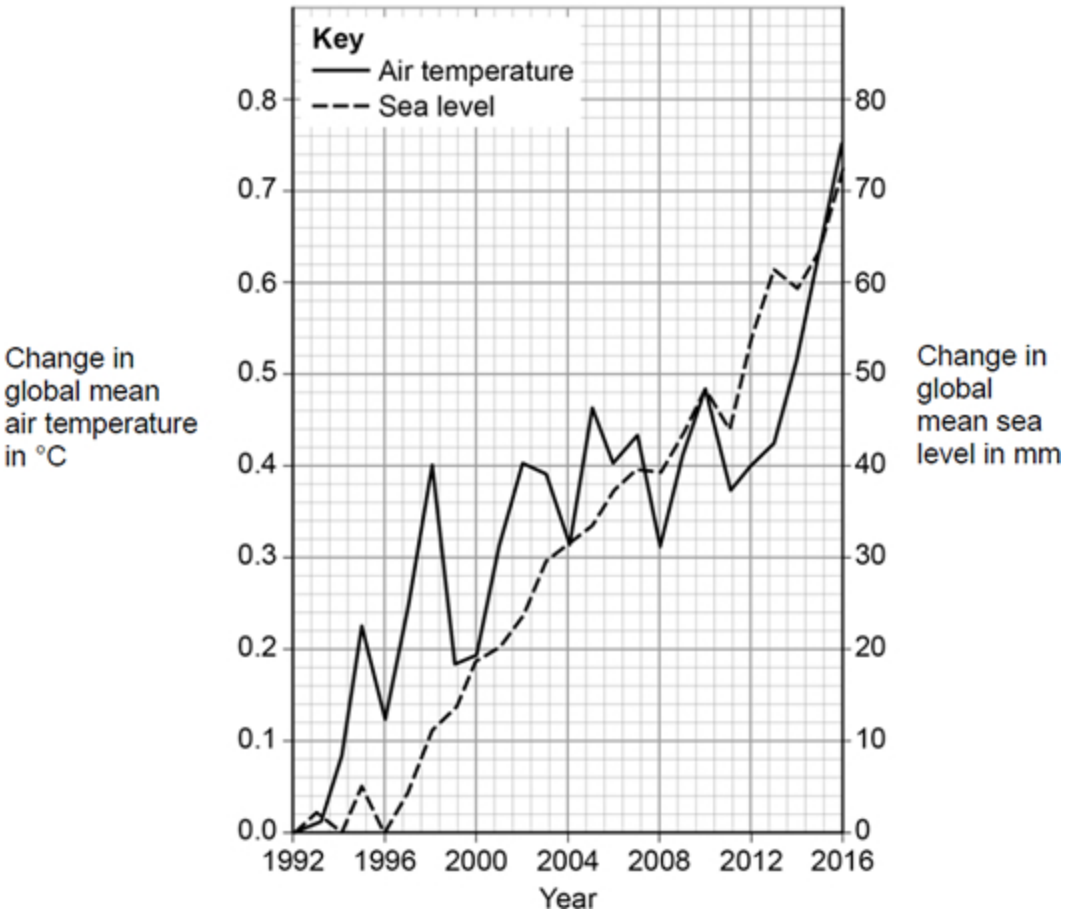
(2)

(Total 8 marks)

4. 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**.

_____

_____

_____

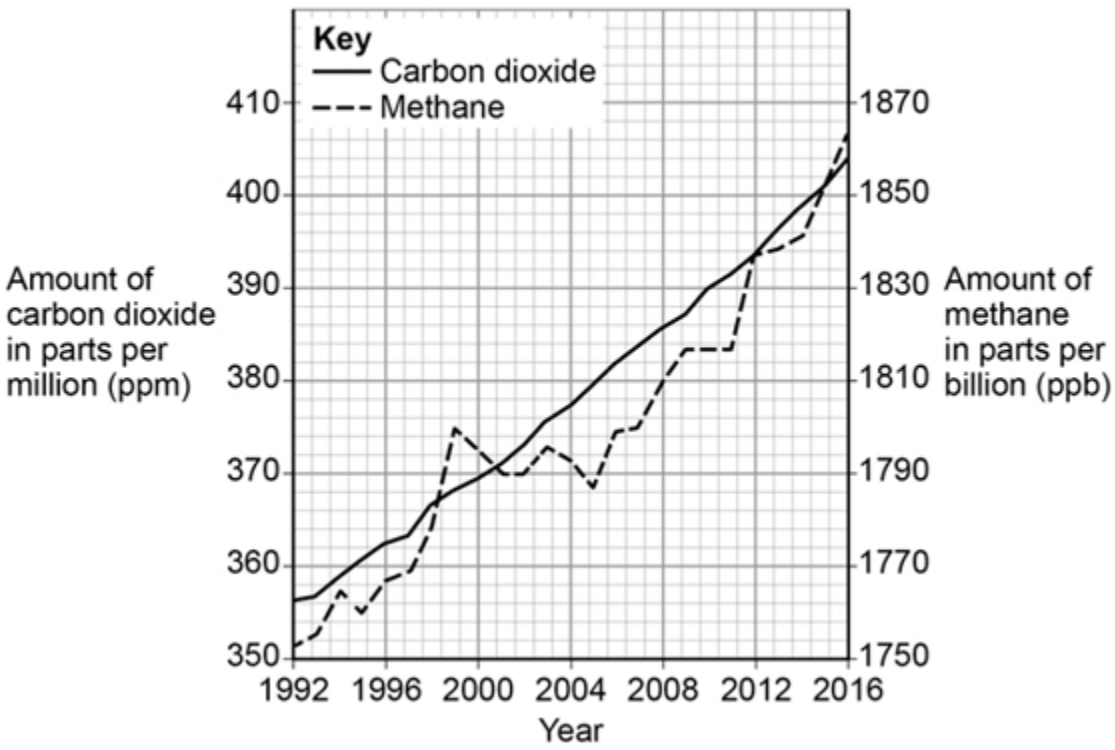
Mean yearly increase in sea level = _____ mm / year

(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)

5. 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?

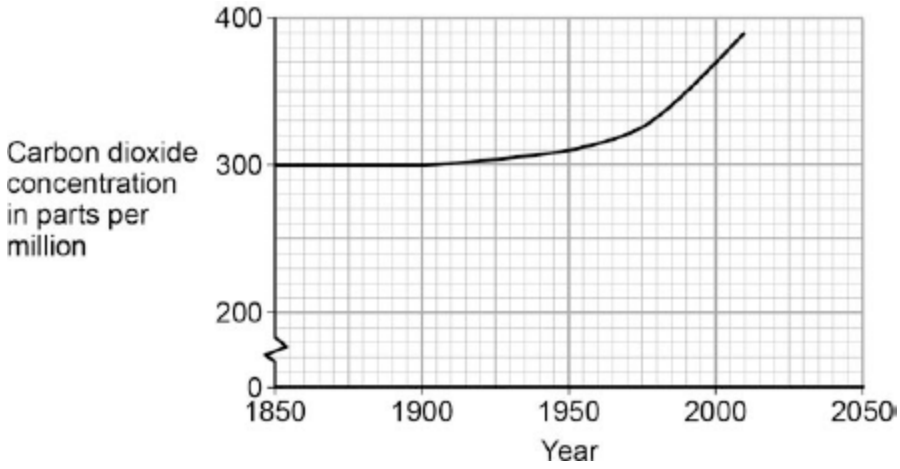
Tick **one** box.

- 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)

6. This question is about the temperature of the Earth's atmosphere.

(a) Give **one** reason why it is difficult to produce models for future climate change.

_____

_____

(1)

(b) Describe how carbon dioxide helps to maintain temperatures on Earth.

_____

_____

_____

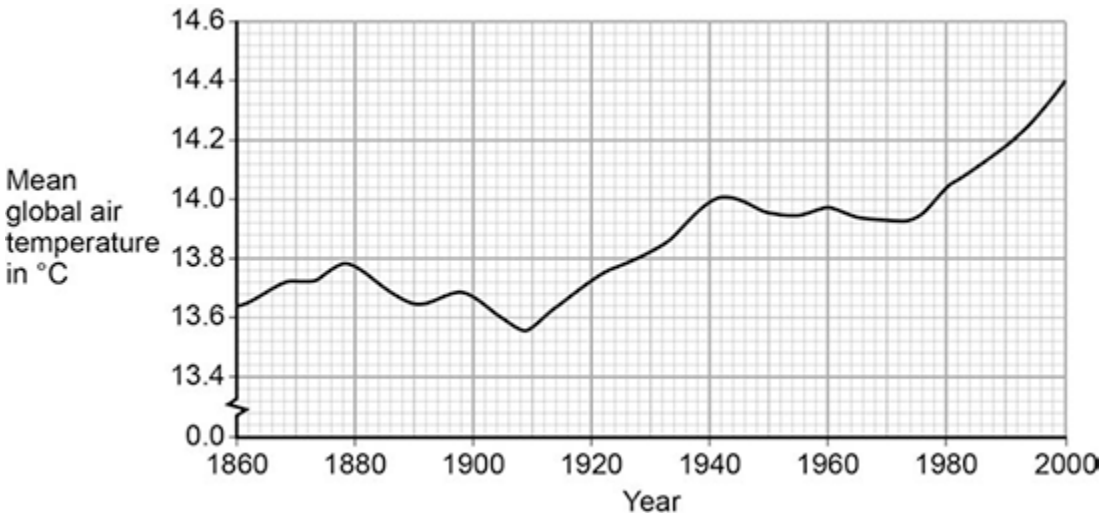
_____

_____

_____

(3)

(c) The figure below shows the change in mean global air temperature from 1860 to 2000.



Explain how human activities have contributed to the main trend shown from 1910 in the figure above.

_____

_____

_____

_____

_____

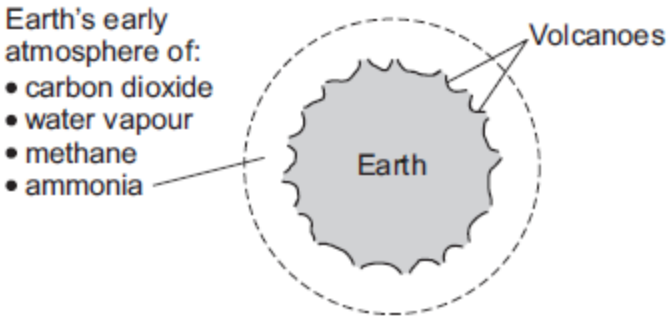
(3)

(Total 7 marks)

7. This question is about the Earth and its atmosphere.

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

Figure 1



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.

Substance	Description of the substance
air	compound
carbon dioxide	element
argon	hydrocarbon
	metal
	mixture

(3)

(ii) Which gas in the Earth's atmosphere is used when hydrocarbons burn?

Tick (✓) **one** box.

carbon dioxide ☐

nitrogen ☐

oxygen ☐

(1)

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

Tick (✓) **one** box.

about 40% ☐

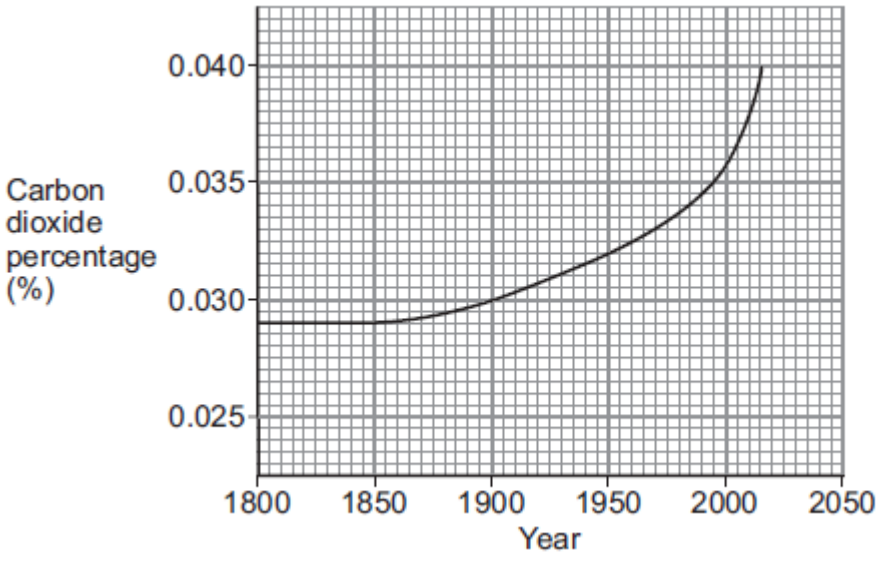
about 60% ☐

about 80% ☐

(1)

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

Figure 2



(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)

8. 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.*

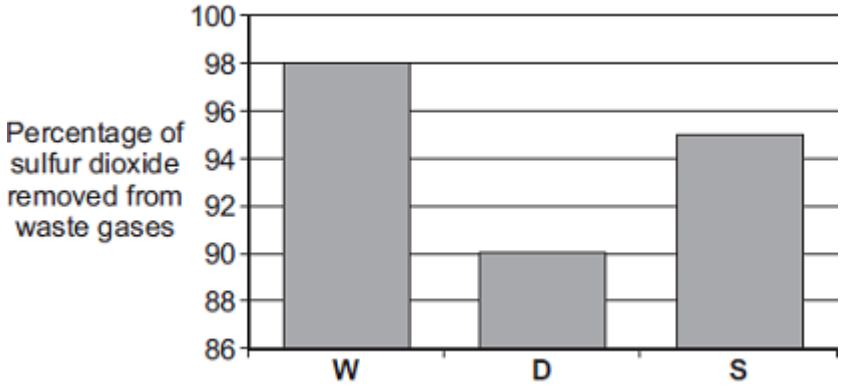
Sulfur dioxide is produced when fossil fuels are burned.

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**.



Method of removing sulfur dioxide

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. 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)

1. (a) incomplete combustion

1

(because) insufficient / limited oxygen supply

1

(b) any **two** from:

- carbon monoxide toxic / poisonous

  allow description of how carbon monoxide is toxic / poisonous
  ignore carbon monoxide is harmful / dangerous / deadly

- greater public concern / awareness about pollution

  ignore comments about the effects of other pollutants

  ignore unspecified comments about carbon monoxide pollution

- more cars so otherwise there would be more carbon monoxide entering atmosphere

- improved engine technology

- catalytic converters have been introduced

2

(c) any **one** from:

- (to reduce) health problems

  allow (to reduce) specified health problems e.g. breathing difficulties, asthma, lung cancer

- (to reduce) global dimming

  allow (to reduce) the effects of global dimming e.g. reduced light levels

  allow (to reduce) smog
  allow (to reduce) the formation of particulates

  ignore global warming

  *do **not** accept to reduce soot*

1

(d) nitrogen (from atmosphere) reacts with oxygen (from atmosphere)

1

at high temperature (in engine)

ignore heat / hot

or
with a spark (from spark plug)

1

(e) **2** $NO_2 \longrightarrow N_2 + \mathbf{2}\ O_2$

allow multiples

*if incorrect, allow N_2 for **1** mark*

2

(f) any **one** from:

- acid rain

  allow specific effects of acid rain

- respiratory problems

  allow specific respiratory problems e.g. breathing difficulties, asthma

- carbon monoxide

- global dimming **or** smog

2

***max 1** mark if global warming mentioned*

(g) transition metals

1

[12]

2. (a) 1836 – 1768

both required

1

= 68 (ppb)

allow ecf from graph values

1

(b) methane levels rose and fell

1

(c) any **two** from:

- rice growing
- farm animals
- landfill

  allow other valid activities

2

(d) there was a fall in GMAT in some years

1

there was an overall increase in GMAT

1

(e) any **one** from:

- melting polar ice caps
- water expansion

1

(f) flooding of low lying areas

1

(g) 100 mm

1

[10]

3. (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]

4.

(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]

5. (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]

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

- complex systems
- many different variables
- many alternative theories

1

(b) carbon dioxide allows short wavelength radiation to pass through

allow greenhouse gas(es) for carbon dioxide

1

the atmosphere to the Earth's surface

1

carbon dioxide absorbs outgoing long wavelength radiation

1

(c) general increase in temperature caused by increase in greenhouse gases

1

any **two** human activities correctly linked to a named greenhouse gas

eg

increased burning of fossil fuels causes more carbon dioxide

2

deforestation causes more carbon dioxide

more cattle production causes more methane

use of landfill causes more methane

[7]

7. (a) the Earth's (surface) temperature was high **or** at/above 100 °C

allow the Earth's (surface) temperature was too / very hot ***or*** *water evaporated / boiled* ***or*** *turned to steam / gas*

allow because of heat from volcanoes

ignore the Earth's (surface) was covered by volcanoes

ignore water turned to water vapour

1

(b) (i) air ——————— mixture

1

carbon dioxide ——— compound

1

argon ——————— element

1

allow only one line from each substance

(ii) oxygen

1

(iii) about 80 %

1

(c) (i) 0.03(0) (%)

1

(ii) increased

1

slowly then rapidly

1

allow figures from graph to indicate increase

(iii) any **two** from:

- use of fossil fuels
- deforestation

allow less trees / plants

- cars/transport
- industry/factories

ignore more people

2

[11]

8. (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) <u>weak</u> 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]