

Structured Questions: Paper 2

4.2 Carbon Cycling & Climate Change

4.2.1 Carbon Cycle: Carbon Dioxide / 4.2.2 Carbon Cycle: Carbon Dioxide in the Atmosphere / 4.2.3 Carbon Cycle: Methane / 4.2.4 Carbon Cycle: Organic Matter / 4.2.5 Climate Change: Greenhouse Effect / 4.2.6 Climate Change: Impact / 4.2.7 Climate Change: Causes / 4.2.8 Skills: Carbon Cycling & Climate Change

Easy (5 questions)	/39
Medium (5 questions)	/45
Hard (5 questions)	/42
Total Marks	/126

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Easy Questions

- 1 (a) Methane (CH₄) is a simple hydrocarbon gas present in the atmosphere or underground as part of natural gas fossil fuel. A group of single-celled organisms, called archaeans, can produce methane by means of different mechanisms.

State the name of the process by which methane is produced.

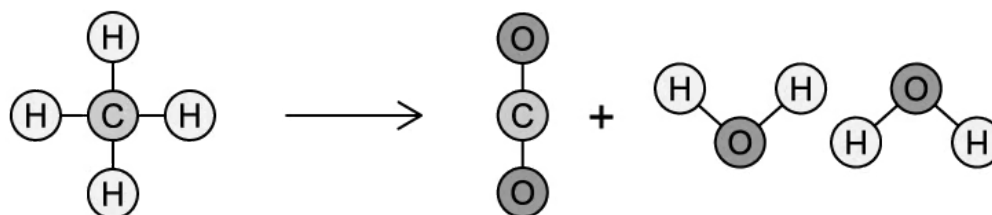
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(1 mark)

- (b) Archaeans can produce methane in a range of different environments.

List **two** of these environments where methane can be produced.

.....
(2 marks)

- (c) When methane is released into the atmosphere, it is involved in the following reaction:



Identify the type of reaction that is illustrated above.

.....
(1 mark)

- (d) Carbon compounds, such as methane, can become trapped in peat which can be burned as fuel.

Briefly describe how peat is formed.

(2 marks)

- 2 (a)** Many marine animals, such as mussels and corals, extract carbon from their surroundings to produce hard body parts such as shells.

State the chemical substance that these hard body parts consist of.

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(1 mark)

- (b)** Describe the process by which the hard body parts of marine organisms, such as molluscs and corals, can become a carbon store.

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(2 marks)

- (c)** The following table shows the atmospheric carbon dioxide levels over time.

Year	Carbon dioxide concentration / ppm
1960	316
1970	325
1980	338
1990	354
2000	369
2010	387

Calculate the percentage increase in carbon dioxide concentration between 1960 and 2010. Record your answer to one decimal place.

.....
(2 marks)

- (d)** Atmospheric carbon dioxide levels have shown a dramatic increase since the industrial revolution.

State the main reason for this increase.

(1 mark)

3 (a) Carbon dioxide is an example of a greenhouse gas.

Define the term 'greenhouse gas'.

(2 marks)

(b) List **two** other examples of greenhouse gases, other than carbon dioxide.

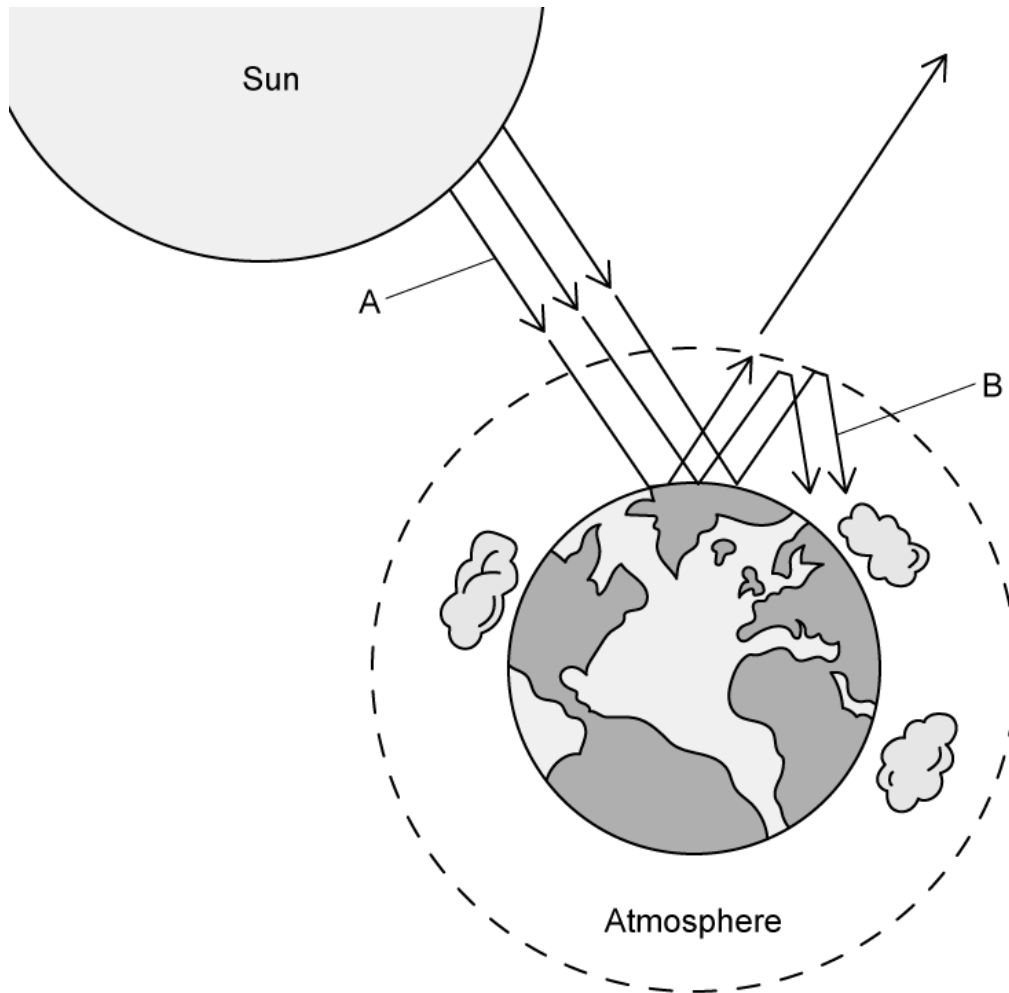
(2 marks)

(c) The impact of greenhouse gas in the atmosphere can vary considerably.

State **two** factors that determine the significance of the impact that a greenhouse gas can have.

(2 marks)

4 (a) Study the diagram below.



- (i) State the name of the process illustrated by the diagram. [1]
- (ii) Label the type of radiation represented by A and B in the diagram. [2]

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(3 marks)

(b) Greenhouse gases, especially carbon dioxide, have increased in the atmosphere over the past few decades.

State the effect this increase in greenhouse gases will have on global average temperatures.

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(1 mark)

(c) List **two** possible impacts on climate patterns caused by the change in global temperatures described in part (b).

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(2 marks)

5 (a) One mark is available for clarity of communication throughout this question.

Describe the role of autotrophs within the carbon cycle.

(4 marks)

(b) There are several processes in the carbon cycle that increase the levels of carbon dioxide in the atmosphere.

List **two** of these processes and state how they increase carbon dioxide levels in the atmosphere.

(4 marks)

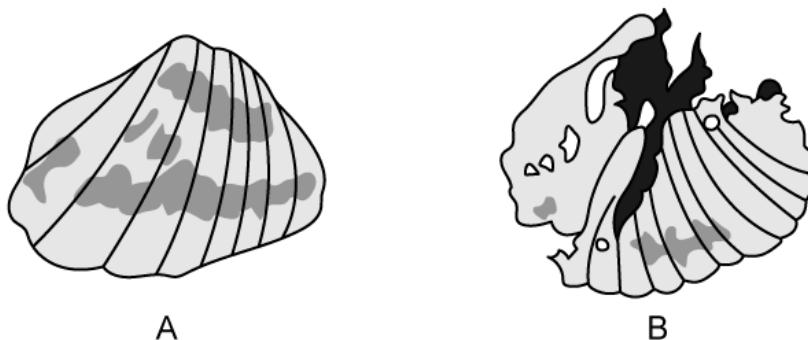
(c) Increased carbon dioxide levels in the atmosphere are having an effect on ocean chemistry.

Outline the way in which atmospheric carbon dioxide affects the pH of oceans and how this change may impact marine organisms.

(7 marks)

Medium Questions

1 (a) The image below shows two shells from marine organisms. Both shells were placed in a saltwater solution for 45 days; shell A at pH 8.5 and shell B at a pH of 7.



Explain the results shown in the image.

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(2 marks)

(b) Outline the relevance of increasing atmospheric carbon dioxide levels to the results shown in part (a).

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(3 marks)

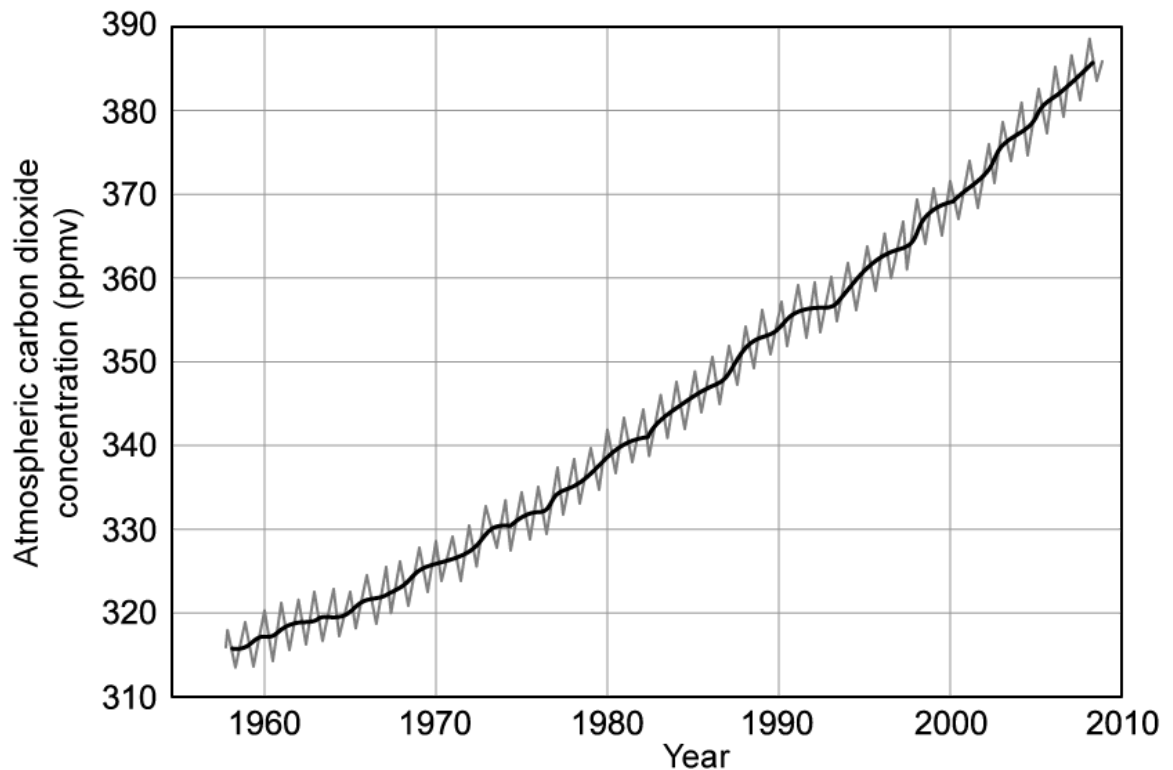
(c) Describe a process that removes carbon dioxide from the atmosphere **other** than that referred to in part (b).

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(2 marks)

2 (a) The graph below shows changes in atmospheric carbon dioxide levels between 1960-2010, recorded at Mauna Loa observatory, Hawaii.



Key: — = Average carbon dioxide concentration per year
— = Actual carbon dioxide concentration

Estimate the increase in average atmospheric carbon dioxide concentration between 1960 and 2000.

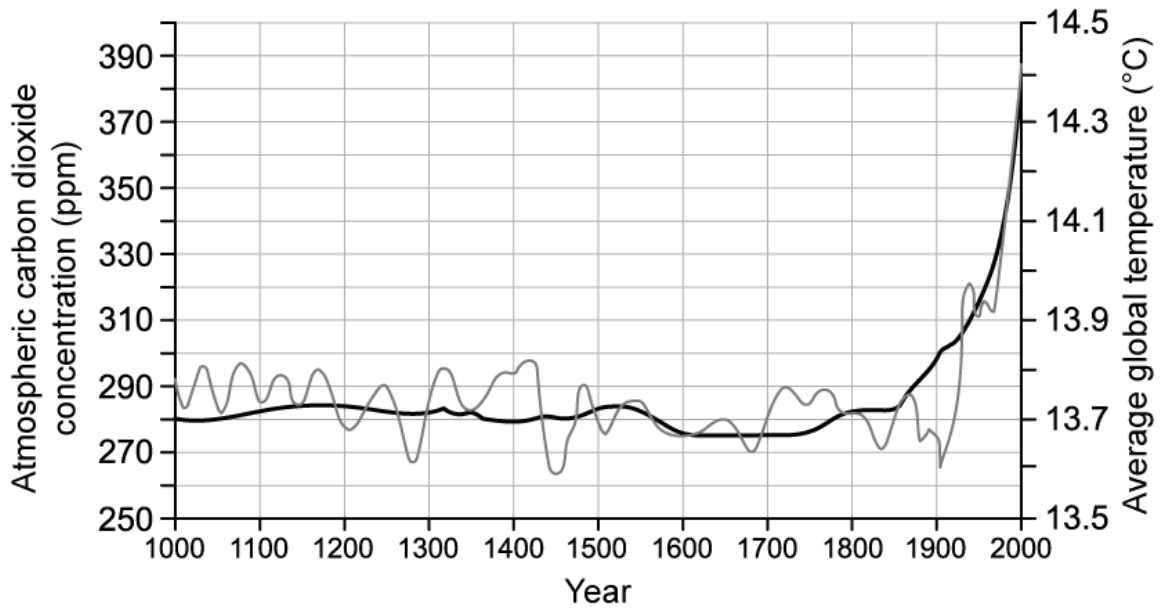
(1 mark)

(b) Suggest why yearly fluctuations occur in actual atmospheric carbon dioxide concentration, as seen in the graph in part (a) above.

(2 marks)

(c) In addition to collecting data on atmospheric carbon dioxide levels, scientists also collect data on average global temperatures. Both sets of data between the years 1000 and

2000 are shown together in the graph below.



Key: — = Carbon dioxide — = Temperature

Evaluate the claim that rising global temperatures are caused by rising atmospheric carbon dioxide levels.

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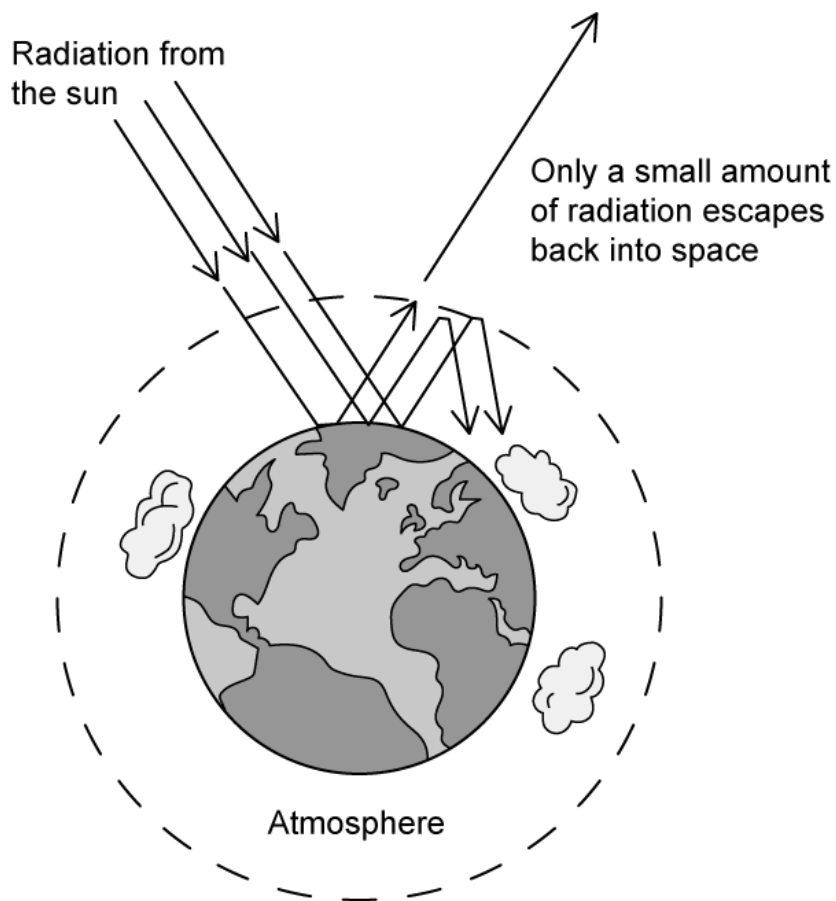
(3 marks)

(d) State what the graph shows about the impact of human activities on atmospheric carbon dioxide levels **and** average global temperatures. Note that the industrial revolution began in the mid 1700s.

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(1 mark)

3 (a) The diagram below illustrates the greenhouse effect.



Explain why a higher proportion of the sun's radiation reaches the earth's surface than escapes back into space.

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(3 marks)

(b) The table below shows the global warming potential (GWP) of some other greenhouse gases in relation to carbon dioxide.

Gas	GWP over 100 years
Carbon dioxide	1
Methane	21
Water vapour	<0.0005

Methane has more than 80 times the radiation absorbing ability of carbon dioxide. Given that this is the case, explain the GWP value for methane shown in the table above.

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(2 marks)

(c) Despite the GWP of water vapour shown in the table in part **(a)** it has a very powerful short-term warming effect.

Suggest why water vapour has such a strong short-term warming effect.

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(1 mark)

(d) **Other** than the burning of fossil fuels, state **three** sources of atmospheric greenhouse gases.

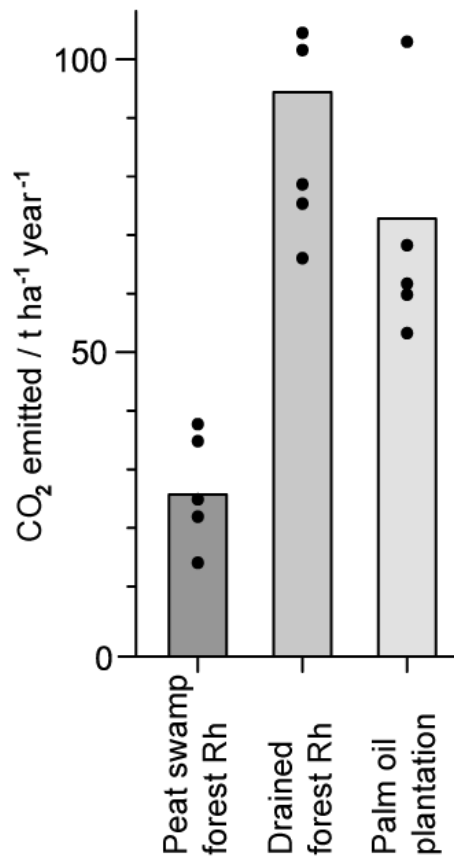
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(3 marks)

4 (a) A study was carried out on the impact of peat swamp forest drainage for the purpose of planting palm oil plantations on greenhouse gas emissions. Some of the results are shown below. Note that Rh denotes heterotrophic respiration.



Explain the difference in carbon dioxide emissions between peat swamp forest Rh and drained forest Rh.

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(3 marks)

(b) A local councillor suggested that the data shows that planting oil palms would go some way to reducing the climate damage caused by draining the peat swamp.

Evaluate this suggestion.

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(2 marks)

- (c)** The study described in part (a) was carried out by analysing the processes taking place in 25 m by 25 m quadrats.

Outline how the researchers could have ensured that their results from quadrat sampling were valid.

(2 marks)

5 (a) *One mark is available for clarity of communication throughout this question.*

Draw a labelled diagram of the carbon cycle.

(5 marks)

(b) Outline the impacts of increasing average global temperatures.

(4 marks)

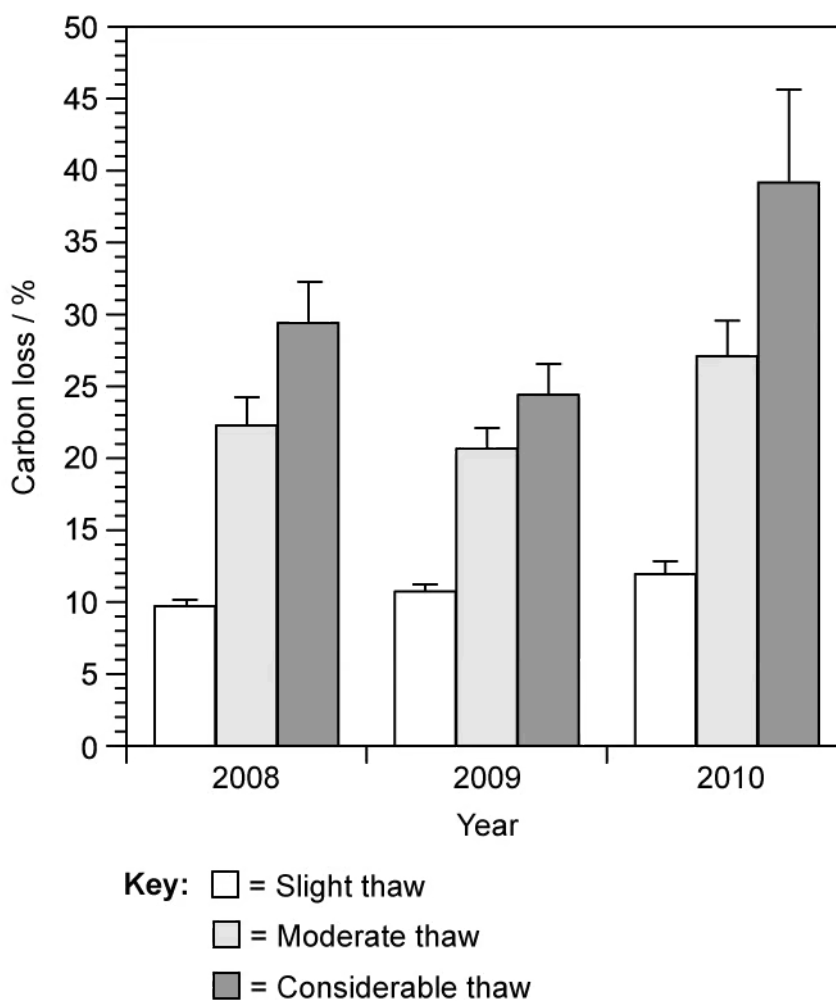
(c) A common claim among people who are skeptical of climate science is that because rates of warming have not been consistent, global warming has in fact slowed down or stopped.

Discuss the factors that should be considered when deciding whether or not a claim such as this is valid.

(6 marks)

Hard Questions

1 (a) Tundra soils are mainly composed of peat that forms in the extreme cold conditions found within this ecosystem. Peat contains large amounts of carbon which is released when the tundra soils thaw during warmer seasons. Scientists investigated the amount of carbon released from tundra soils at one location, that were thawed to different extents over the course of three years. The results from this investigation can be seen in the graph below.



Explain why tundra soils act as a carbon store.

(2 marks)

(b) Calculate the difference in the mean carbon loss that occurred in tundra soils that were thawed considerably and those that were thawed slightly. Show your working.

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(2 marks)

(c) Compare the rate of carbon release in moderately thawed soils with those in soils that were considerably thawed.

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(2 marks)

(d) Scientists concluded that the carbon released from the considerable thawing of tundra soils will lead to a further increase in global temperatures.

Evaluate this statement based on the investigation that was done.

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(2 marks)

2 (a) The following data show fluxes in carbon between different storage reserves in an ecosystem, measured in gigatonnes per year (GT yr⁻¹). A gigatonne equals 1 billion tonnes.

Process of carbon transfer	Flux / GT yr ⁻¹
Release from the oceans	101
Ocean dissolving	104
Release from soil	62
Incomplete decomposition	52
Respiration of terrestrial organisms	53
Photosynthesis	117
Deforestation	2.0
Combustion of fossil fuels	4.9

(i) Calculate the net flux of carbon. Show your working.

[2]

(ii) State the direction of this movement with regards to the atmosphere.

[1]

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(3 marks)

(b) Explain how the combustion of fossil fuels can affect the carbon balance in the atmosphere.

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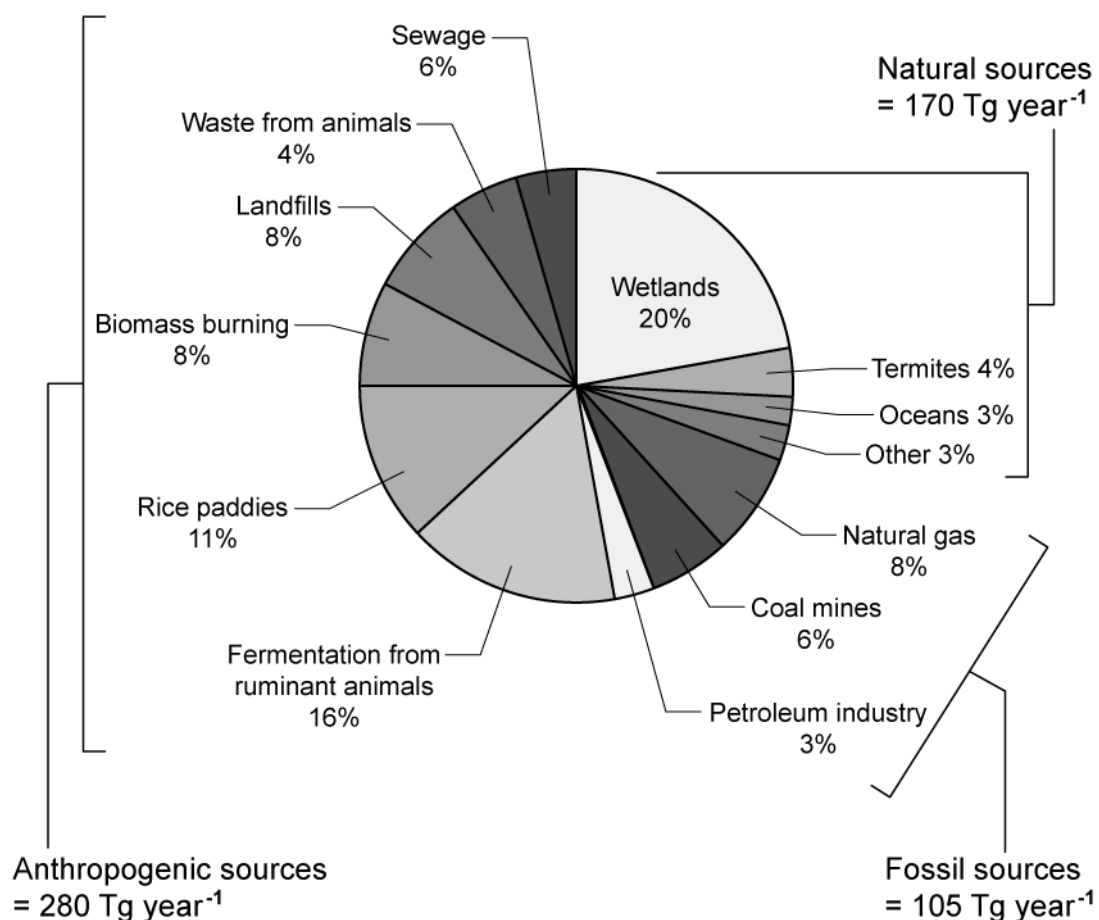
(2 marks)

- (c) Estimating global carbon fluxes are of great interest to scientists, even though it may be challenging to make accurate measurements.

Discuss the scientific importance of estimating carbon fluxes.

(2 marks)

- 3 (a)** Methane is an example of a greenhouse gas that commonly occurs in the atmosphere. The graph below shows the main sources of methane as well as the percentage contribution of the different components of each source. A teragram (Tg) equals 10^{12} grams and is equivalent to one megatonne (1 million tonnes).



Calculate the amount of methane, in Tg year⁻¹, that is released from wetlands. Show your working.

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(2 marks)

- (b)** Suggest a reason why wetlands would be the largest contributor of atmospheric methane, as shown in the graph above.

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(2 marks)

(c) Recent studies predict a decrease in levels of hydroxyl radicals in the atmosphere of between 10% and 16%. Hydroxyl radicals are often called the 'detergent of the atmosphere' and plays an important part in regulating atmospheric levels of gases such as methane.

(i) Predict the possible long-term effect these decreased levels of hydroxyl radicals could have on atmospheric concentrations of methane.

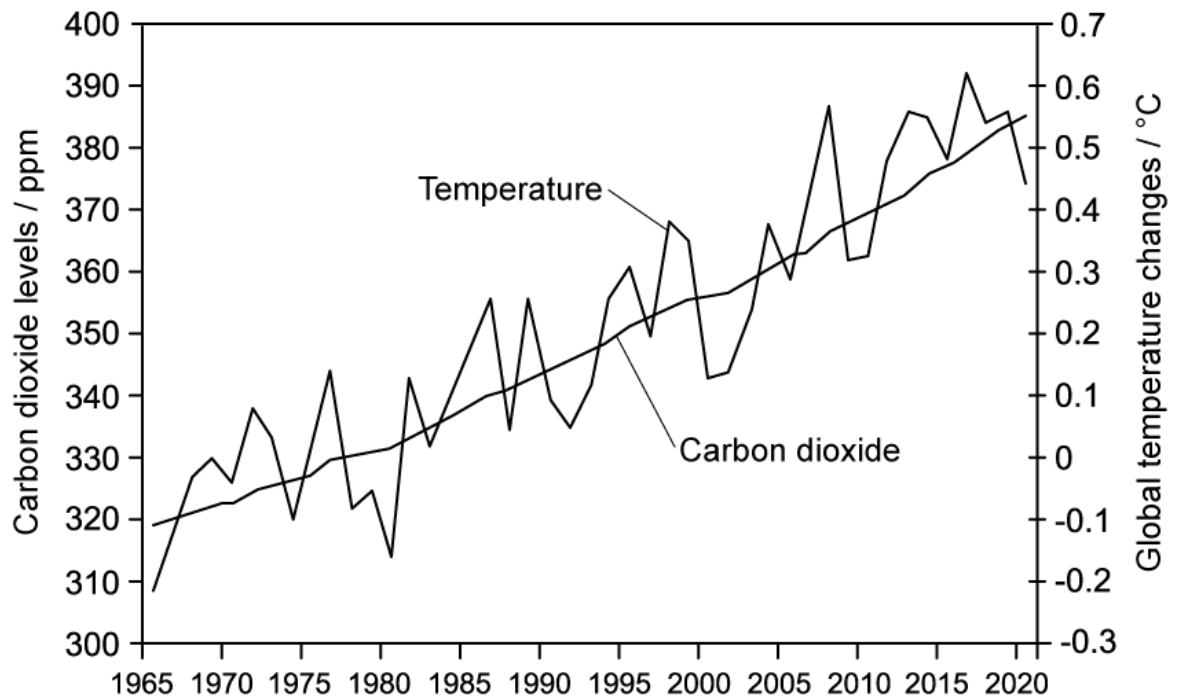
[1]

(ii) Explain your answer to part c) i).

[1]

(2 marks)

- 4 (a) Carbon dioxide is one of the main greenhouse gases in the atmosphere. The graph below shows the changes of carbon dioxide levels in the atmosphere, as well as the change in global temperatures over a period of time.



Describe the general trends in the data.

(3 marks)

- (b) Suggest possible causes of the trends in the data presented in part (a).

(2 marks)

- (c) Discuss the importance of greenhouse gases, such as carbon dioxide, in the atmosphere.

(2 marks)

5 (a) *One mark is available for clarity of communication throughout this question.*

Coal, oil and natural gas are all examples of fossil fuels that can be utilised as an energy source.

Compare and contrast the formation of coal with that of oil and natural gas.

(5 marks)

(b) The amount of carbon in the atmosphere is constantly changing over time. Carbon dioxide and methane gases contribute to carbon levels in the atmosphere and have important impacts on the planet.

Discuss the importance of obtaining reliable data on the atmospheric concentration of these gases over time.

(6 marks)

(c) Suggest the possible impact that an increase in global temperatures would have on the polar regions, as well as the global consequences of this impact.

(3 marks)