Oxford Revise | AQA A Level Geography | Answers

Chapter 1

Exemplar answers have been written by the author of the revision guide and are not created or approved by AQA. They do not necessarily represent the only possible solution or way to answer the question. All exemplar answers are likely to be in the top mark band.

Questions 1–6 are point-marked. Allow 1 mark per valid point with extra marks for development.

1 AO1 = 4

- Dynamic equilibrium involves a balance between carbon sources and carbon sinks (1).
- The concept involves the flow of carbon molecules between different stores, such as atmosphere, biosphere, and hydrosphere (1).
- Negative feedback mechanisms are key to dynamic equilibrium (1). As atmospheric CO2 increases, carbon uptake by plants increases, lowering atmospheric CO2 (1).
- Global warming as example of human activities interrupting dynamic equilibrium (1).

Example answer: *Dynamic equilibrium involves a balance between carbon sources and carbon sinks. It involves the flow of carbon molecules between different stores, such as atmosphere, biosphere, and hydrosphere, so that the amount of carbon entering and leaving these stores is balanced. Negative feedback mechanisms are key to dynamic equilibrium. As atmospheric CO2 increases, carbon uptake by plants increases, lowering atmospheric CO2. Human activities have interrupted dynamic equilibrium resulting in global warming.*

2 AO1 = 4

- Evaporation is conversion of liquid water into water vapour involving heat from the Sun (1)
- Transportation of water vapour by air currents (1).
- Transpiration by plants with water vapour leaving stomata, released into air (1).
- Condensation and return of water vapour to the biosphere/soils for uptake by plants (1).
- Evapotranspiration is influenced by, for example, density of vegetation, type of leaf cover (large surface area), soil moisture (1).

3 AO1 = 4

- Natural variations such as wildfires and volcanic eruptions, releasing large amounts of carbon into the atmosphere from the biosphere (1).
- Changes in vegetation cover, such as desertification or deforestation, reducing sequestration of carbon from the atmosphere store into plants and soils (1).
- Combustion of fossil fuels for energy production and transportation, from lithosphere to atmosphere (1).
- Changes in land use, such as farming practices, urbanisation, e.g. increasing decomposition of organic material in soils, releasing carbon into the atmosphere (1).
- Climate change, e.g. rising temperatures causing thawing of permafrost, releasing carbon from soil store into the atmosphere (1).
- Changes in the rates of photosynthesis, respiration, decomposition, and weathering also affect magnitude (1).

4 AO1 = 4

- Role of the water cycle in supplying water used in photosynthesis (1), providing energy for secondary consumers and oxygen for living organisms as by-product (1).
- Role in replenishing stores of fresh water, on which terrestrial life on Earth depends (1).
- Regulating climate: evaporation absorbs heat energy, condensation releases heat energy (1), role this has in regulating temperature extremes (1).
- Water vapour as (most abundant) greenhouse gas, helping to sustain life through warmer global temperatures (1).
- Water cycle's role in providing range of habitats, e.g. ponds, lakes, swamps (1).

5 AO1 = 4

- Ability of carbon dioxide to dissolve in water to form carbonic acid (1).
- Uptake of carbon into the surface water of the oceans (1).
- Role of water cycle and carbon cycle in chemical weathering of rocks (1).
- In respiration: release of both CO2 and water vapour into the atmosphere (1).
- In photosynthesis: carbon from the air combines with water taken up by plants (1).
- Higher levels of atmospheric CO2 reduce the amount plant stomata need to open, reducing release of water vapour into the atmosphere through evapotranspiration (1).

6 AO1 = 4

- The water balance is the balance between inputs and outputs over a period of time (1); (P) = (O) + (E) +/− (S) (1).
- Concept of inputs explained: precipitation as primary input (1).
- Concept of outputs: total runoff explained, EVT (1).
- Concept of stores and role in water balance explained (1).
- Importance of water balance for drainage basin management (1).

Questions 7–20 are level-marked.

7 AO1 – Knowledge and understanding of the carbon cycle. Awareness of deforestation, its causes, and impacts.
AO2 – Application of knowledge to show how and why changes to forest cover impact on the carbon cycle.
AO1 = 2 AO2 = 4

Level	Marks	Description
2	4–6	• Thorough, detailed, organised, and relevant throughout with supporting evidence and examples. • Communicates detailed, clear knowledge and understanding. • Communicates using developed statements and ideas (e.g. uses connectives to fully explore ideas). • Good use of geographical terms and vocabulary.
1	1–3	• Sound throughout with some supporting evidence and examples. • Communicates some knowledge and understanding. • Communicates using linked statements and ideas (e.g. uses connectives, but needs further development). • Some use of geographical terms and vocabulary.

AO1

- Global distribution, and size of major stores of carbon – lithosphere, hydrosphere, cryosphere, biosphere, atmosphere.
- Factors driving change in the magnitude of these stores over time and space, including flows and transfers at plant, sere and continental scales. Photosynthesis, respiration, decomposition, combustion, carbon sequestration in oceans and sediments, weathering.
- Changes in the carbon cycle over time, to include natural variation (including wildfires, volcanic activity) and human impact (including hydrocarbon fuel extraction and burning, farming practices, deforestation, land use changes).

AO2

- The graphic shows a significant reduction in carbon sequestration post-disturbance (deforestation and land use change), suggesting that the impact of (tropical rainforest) deforestation on the carbon cycle is significant.
- Pre-disturbance, vegetation is shown taking up carbon dioxide (CO2) in both the upland and seasonally inundated rainforest. This occurs through photosynthesis: very high rates in tropical rainforest.
- Post-disturbance, a reduced uptake of carbon is shown due to deforestation and land use changes, clearing the rainforest trees and replacing them with crops that photosynthesis at a greatly reduced rate.
- Post-disturbance, the region has become a source of carbon due to forest fires (combustion of carbon stores) and increased release of methane (CH4) from livestock.
- Pre-disturbance, organisms (floating macrophytes) in rivers, streams and swamps (freshwater) absorbed CO2 from the atmosphere, while carbon was also stored in sediments. Post-disturbance (building of reservoirs and draining of seasonally inundated forest, this carbon store has become a carbon source due to the lack of vegetation in the reservoir.

Example answer: *The graphic shows a significant reduction in carbon sequestration post-disturbance, as a result of deforestation and subsequent land use change. This suggests that there is significant impact of rainforest deforestation on the carbon cycle. The pre-disturbance graphic shows that vegetation takes up carbon dioxide through photosynthesis in both the upland and seasonally inundated rainforest. Rates of photosynthesis are very high rates in tropical rainforest, so any reduction has significant effects. Post-disturbance, a reduced uptake of carbon is shown due to deforestation (and the methods used, such as burning) and land use changes. Rainforest trees are cleared and replaced with crops that photosynthesise at a greatly reduced rate. Post-disturbance, the region has become a carbon source, rather than a carbon sink, due to forest fires (combustion of carbon stores) and increased release of methane (CH4) from livestock.*

8 AO3 – Analysis of soil moisture data for the UK to identify patterns and anomalies in the data, using data manipulation to support response.
AO3 = 6

Level	Marks	Description
2	4–6	• Clear analysis of the quantitative evidence provided, which makes appropriate use of data in support. • Clear connection(s) between different aspects of the data and evidence.
1	1–3	• Basic analysis of the quantitative evidence provided, which makes limited use of data and evidence in support. • Basic connection(s) between different aspects of the data and evidence.

- The data shows general east–west division, with soil moisture at normal levels for May 2023 in the east, and soil moisture drier than normal in the west. This is useful as it suggests a pattern.
- Northern Ireland did not follow this pattern as its soil moisture levels were at normal levels.
- Having information on the soil wetness status was useful as it indicates how far from normal the status was. For example, some sites (e.g. Glensaugh in Scotland, Gisburn Forest, Cardington, and Tadham Moor in England) were wetter than normal.
- Soil moisture levels are likely to generally follow precipitation patterns, suggesting that, while precipitation in May was normal for the east of the UK and Northern Ireland, it was probably below average for the west of England and Wales. However, for the purposes of depicting the general pattern of soil moisture across the UK, a second figure showing precipitation patterns would have increased the usefulness.
- Other factors could be involved for the sites with wetter than normal soil moisture, e.g. localised heavy precipitation (thunderstorms), changes to drainage patterns or changes to land use. This makes Figure 2 less useful in depicting the pattern of soil moisture across the UK.
- One reason for increased soil moisture could be the removal of surface vegetation – vegetation draws up moisture from the soil and releases it into the atmosphere through EVT. Data on land use would therefore add to the usefulness of Figure 2 in explaining soil moisture patterns, though not in depicting them.

9 AO3 – Analysis of natural and human-induced changes in the carbon cycle to identify patterns and anomalies in the data, using data manipulation to support response.
AO3 = 6

Level	Marks	Description
2	4–6	• Clear analysis of the quantitative evidence provided, which makes appropriate use of evidence in support. • Clear connection(s) between different aspects of the evidence.
1	1–3	• Basic analysis of the quantitative evidence provided, which makes limited use of evidence in support. • Basic connection(s) between different aspects of the evidence.

- The natural carbon cycle (pre-industrial) shows a status of dynamic equilibrium, with flows between the atmosphere and hydrosphere broadly balanced (80 GtC of CO2 dissolving into the ocean and 78 GtC emitted from the ocean), also seen in flows between the atmosphere and biosphere (123 GtC sequestered by photosynthesis, 118 GtC emitted by respiration).
- The vast majority of carbon (100,000,000 GtC) is in the lithosphere. If all stores are added together (taking soil as 2400 GtC), then the lithosphere makes up 99.96 per cent of all carbon.
- The influence of human activities is most significant in the extraction of carbon from lithosphere fossil fuels (−365 GtC since 1750). This will have made the biggest contribution to the +240 GtC of carbon entering the atmosphere store.
- The importance of the oceans in reducing the impact of increased emissions from combusting fossil fuels is made clear by the +155 GtC entering the hydrosphere.
- The impact of deforestation and land use changes is probably seen in the −30 GtC reduction in the biosphere, with a reduction in sequestration by photosynthesis.

10 AO3 – Analysis of data of rates of water withdrawal in the carbon cycle to identify patterns and anomalies in the data, using data manipulation to support response.
AO3 = 6

Level	Marks	Description
2	4–6	• Clear analysis of the quantitative evidence provided, which makes appropriate use of evidence in support. • Clear connection(s) between different aspects of the evidence.
1	1–3	• Basic analysis of the quantitative evidence provided, which makes limited use of evidence in support. • Basic connection(s) between different aspects of the evidence.

- Groundwater withdrawal (abstraction) has increased at different rates, with two of the selected countries (Russia and France) showing declines in groundwater abstraction.
- India shows a very rapid increase in the rate of groundwater withdrawal, from approximately 10 km^3/year in 1950 to 260 km^3/year in 2020, a percentage increase of 2500 per cent, although the graphic shows signs of this rate levelling off.
- China showed a rapid increase between 1950 and 2000 (from approximately 10 km^3/year in 1950 to 105 km^3/year in 2000, a 950 per cent increase), but since then the rate has remained steady at around 105 km^3.
- The USA has seen a similar trend to China, although starting from a higher rate in 1950 and with a steadier increase to 1990, since when it has remained constant.
- Abstraction of groundwater is usually highest in regions where precipitation inputs are low and rates of evapotranspiration are high. Countries with relatively high inputs of precipitation will therefore see lower rates of withdrawal than arid and semi-arid countries.
- Abstraction rates in India are likely to have increased due to increased demand for fresh water. This could be related to several factors including population increase (more people needing water), economic development (higher demand for water in manufacturing and energy production (cooling)) and agricultural changes (increase in irrigated farmland, for example).

11 AO1 – Knowledge and understanding of the carbon cycle. Human interventions in the carbon cycle.
AO2 – Application of knowledge to show effectiveness of human interventions in the carbon cycle with the intention of mitigating climate change impacts.
AO1 = 2 AO2 = 4

Level	Marks	Description
2	4–6	• AO1 – Demonstrates clear knowledge and understanding of concepts, processes, interactions and change. • AO2 – Applies knowledge and understanding to the novel situation offering clear evaluation and analysis drawn appropriately from the context provided. Connections and relationships between different aspects of study are evident with clear relevance.
1	1–3	• AO1 – Demonstrates basic knowledge and understanding of concepts, processes, interactions, change. • AO2 – Applies limited knowledge and understanding to the novel situation offering only basic evaluation and analysis drawn from the context provided. Connections and relationships between different aspects of study are basic with limited relevance.

AO1

- Changes in the carbon cycle over time, to include natural variation (including wildfires, volcanic activity) and human impact (including hydrocarbon fuel extraction and burning, farming practices, deforestation, land use changes).
- Human interventions in the carbon cycle designed to influence carbon transfers and mitigate the impacts of climate change.

AO2

- The photo shows the Drax power station, which burns biomass to generate electricity, an example of BECCS. This is designed to mitigate the impacts of climate change by reducing greenhouse gases by combusting renewable resources (biomass from the biosphere) instead of fossil fuels (from the lithosphere).
- The photo shows that the process of generating energy in this way does still produce emissions. In this case, they are likely to be emissions of water vapour, since most electricity is generated in ways that require water for cooling or water in the form of steam to power turbines.
- Compared to other human interventions to mitigate climate change, BECCS may have strengths and weaknesses. A strength would be that growing biomass captures carbon dioxide from the air, and though burning it may then release carbon back into the atmosphere, inputs out of and back into the atmosphere are balanced, unlike with fossil fuels. If carbon capture and storage were also involved, then BECCS could start to reduce atmospheric carbon levels.
- A weakness of many human interventions to mitigate climate change is that the scale of the impact is very small compared with the excess carbon in the atmosphere and the rate at which greenhouse gas emissions need to be reduced to stop the impacts of climate change becoming severe.

12 AO3 – Analysis of data of CO_2 measurements in both the atmosphere and seawater to identify patterns and anomalies in the data, using data manipulation to support response.
AO3 = 6

Level	Marks	Description
2	4–6	• Clear analysis of the quantitative evidence provided, which makes appropriate use of evidence in support. • Clear connection(s) between different aspects of the evidence.
1	1–3	• Basic analysis of the quantitative evidence provided, which makes limited use of evidence in support. • Basic connection(s) between different aspects of the evidence.

- The graph shows an increasing/positive trend in recorded atmospheric CO_2 at Mauna Loa, with a similar upward/positive trend in the amount of CO_2 dissolved in seawater. The graph shows a downwards/negative trend in seawater pH.
- There is a positive correlation between atmospheric and seawater CO_2 and a negative correlation between seawater CO_2 and seawater pH.
- Atmospheric CO_2 is shown to have increased by approximately 85 ppm (parts per million) from approximately 320 ppm to approximately 405 ppm between 1958 and 2018. Climate science has proved that this increase is due to human activities, primarily the combustion of carbon, adding significantly to the atmosphere store.

- The increase in CO_2 shows more variation, but a line of best fit indicates an increase from approximately 320 ppm when records began in 1990 to approximately 375 ppm (55 ppm) in 2018. Over the same period, atmospheric CO_2 increased from 350 ppm to 405 ppm (55 ppm) – indicating a strong correlation.
- Atmospheric CO_2 dissolves into seawater, with higher concentrations of CO_2 in the atmosphere leading to more CO_2 being dissolved.
- Carbon dioxide reacts with water to form carbonic acid (H_2CO_3), and the graph indicates that as more CO_2 dissolves into the ocean from the atmosphere, the ocean's natural alkaline pH is becoming more acidic.

13 AO1 – Knowledge and understanding of the carbon cycle. Human interventions in the carbon cycle.
AO2 – Application of knowledge to show effectiveness of human interventions in the carbon cycle with the intention of mitigating climate change impacts.
AO1 = 2 AO2 = 4

Level	Marks	Description
2	4–6	• AO1 – Demonstrates clear knowledge and understanding of concepts, processes, interactions and change. • AO2 – Applies knowledge and understanding to the novel situation offering clear evaluation and analysis drawn appropriately from the context provided. Connections and relationships between different aspects of study are evident with clear relevance.
1	1–3	• AO1 – Demonstrates basic knowledge and understanding of concepts, processes, interactions, change. • AO2 – Applies limited knowledge and understanding to the novel situation offering only basic evaluation and analysis drawn from the context provided. Connections and relationships between different aspects of study are basic with limited relevance.

AO1

- Changes in the carbon cycle over time, to include natural variation (including wildfires, volcanic activity) and human impact (including hydrocarbon fuel extraction and burning, farming practices, deforestation, land use changes).
- The role of feedbacks within and between cycles and their link to climate change and implications for life on Earth.
- Human interventions in the carbon cycle designed to influence carbon transfers and mitigate the impacts of climate change.

AO2

- The graph compares per capita greenhouse gas (GHG) emissions on the *y*-axis with population in millions on the *x*-axis.
- The countries that produce the most GHG emissions per capita are not the countries with the largest populations – in fact, Southern Asia with 2 billion people has emissions of 3 tonnes of CO_2 per capita per year, while North America with around 200 million people has emissions of 24 tonnes of CO2 per capita per year.
- This is partly related to economic development: the countries with the highest GHG emissions include the highly industrialised economies of North America and Japan. Western Europe, although highly industrialised, is an anomaly here.

- Eastern Europe has relatively high emissions, perhaps due to historic dependence on heavy industry. Middle East has relatively high emissions, perhaps due to high dependence on energy for cooling and desalinisation.
- There is also a difference between regions where land use change makes a higher or equal contribution to GHG emissions than fossil fuel and industry emissions: Latin America and Caribbean and South-East Asia and Pacific in particular.
- This is likely to be related to deforestation of tropical rainforest, which reduces sequestration and increases emissions due to burning of forested land to clear it for agriculture.
- Challenges of reducing GHG emissions related to this include: highly industrialised countries having high emissions per capita because of, for example, air travel, individual car ownership, convenience-based consumer lifestyle. Reducing emissions involves significant lifestyle changes – likely to be unpopular. Developing economies have lower emissions per capita but may be on a development trajectory that will increase emissions per capita as, for example, car ownership and use increases. Large populations in these countries add to the challenge. Countries are also deforesting in order to industrialise, which is the route to economic development taken by the most industrialised countries. Reducing emissions relies on forests remaining a significant carbon sink, so this represents a major challenge for reducing GHG emissions.

14 AO1 – Knowledge and understanding of key themes of the carbon cycle in a tropical rainforest. Knowledge and understanding of impacts of increased carbon emissions. Knowledge and understanding of a tropical rainforest case study.
AO2 – Application of knowledge and understanding to assess the factors driving change in the magnitude of carbon stores over time in the case study region.
AO1 = 10 AO2 = 10

Level	Marks	Description
4	16–20	• AO2 – Detailed evaluative conclusion that is rational and firmly based on knowledge and understanding which is applied to the context of the question. Interpretations are comprehensive, sound and coherent. • AO2 – Detailed, coherent and relevant analysis and evaluation in the application of knowledge and understanding throughout. • AO2 – Full evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Detailed, highly relevant and appropriate knowledge and understanding of place(s) and environments used throughout. • AO1 – Full and accurate knowledge and understanding of key concepts, processes and interactions and change throughout. • AO1 – Detailed awareness of scale and temporal change which is well integrated where appropriate.
3	11–15	• AO2 – Clear evaluative conclusion that is based on knowledge and understanding which is applied to the context of the question. Interpretations are generally clear and support the response in most aspects. • AO2 – Generally clear, coherent and relevant analysis and evaluation in the application of knowledge and understanding. • AO2 – Generally clear evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Generally clear and relevant knowledge and understanding of place(s) and environments.

		• AO1 – Generally clear and accurate knowledge and understanding of key concepts, processes and interactions and change. • AO1 – Generally clear awareness of scale and temporal change which is integrated where appropriate.
2	6–10	• AO2 – Some sense of an evaluative conclusion partially based upon knowledge and understanding which is applied to the context of the question. • AO2 – Interpretations are partial but do support the response in places. Some partially relevant analysis and evaluation in the application of knowledge and understanding. • AO2 – Some evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Some relevant knowledge and understanding of place(s) and environments which is partially relevant. • AO1 – Some knowledge and understanding of key concepts, processes and interactions and change. There may be a few inaccuracies. • AO1 – Some awareness of scale and temporal change which is sometimes integrated where appropriate. There may be a few inaccuracies.
1	1–5	• AO2 – Very limited and/or unsupported evaluative conclusion that is loosely based upon knowledge and understanding which is applied to the context of the question. Interpretation is basic. • AO2 – Very limited analysis and evaluation in the application of knowledge and understanding. This lacks clarity and coherence. • AO2 – Very limited and rarely logical evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Very limited relevant knowledge and understanding of place(s) and environments. • AO1 – Isolated knowledge and understanding of key concepts, processes and interactions and change. There may be a number of inaccuracies. • AO1 – Very limited awareness of scale and temporal change which is rarely integrated where appropriate. There may be a number of inaccuracies.
0	0	• Nothing worthy of credit.

AO1

- Changes in the carbon cycle over time, to include natural variation (including wildfires, volcanic activity) and human impact (including hydrocarbon fuel extraction and burning, farming practices, deforestation, land use changes).
- The carbon budget and the impact of the carbon cycle upon land, ocean and atmosphere, including global climate.
- The key role of the carbon and water stores and cycles in supporting life on Earth with reference to climate. The relationship between the water cycle and carbon cycle in the atmosphere. The role of feedbacks within and between cycles and their link to climate change and implications for life on Earth.
- Case study of a tropical rainforest setting to illustrate and analyse key themes in water and carbon cycles and their relationship to environmental change and human activity.

AO2

- Answers are expected to apply knowledge and understanding of factors driving change in the magnitude of carbon stores to a chosen tropical rainforest case study over time.
- In terms of causes of changes to carbon stores, answers should refer to deforestation (reducing the role of tropical forests as a global carbon sink), burning of forest vegetation, use of deforested land for farming, which is a carbon source (especially livestock farming with the release of methane as a waste product of digestion).
- Answers should refer to specific case study detail, e.g. for causes: since 2000, Amazonia has lost 20.3 per cent of its original forest, 70 per cent of which has been to clear land for cattle ranching; for impacts: temperatures in Amazonia are predicted to rise by 3°C by 2050. There has been an increase in droughts in the Amazonia region – severe droughts occurred in 2005, 2010 and 2015–16; wildfires have become more common as Amazonia experiences droughts: it is estimated that forest fires now produce around 1.5 GtC per year.

Example answer: *Amazonia is an enormous carbon store – it is estimated that its trees and soil store 200 GtC, and absorb around 2.2 GtC per year, with photosynthesis rates being extremely high at the canopy, and much lower at the forest floor, due to the dense canopy blocking much of the sunlight. Natural carbon emissions are very large – an estimated 1 GtC from decomposition of dead trees and leaf litter.*

Deforestation is a major cause of changes to carbon stores in Amazonia, as it reduces the role of the tropical rainforest as a carbon sink. The burning of forests that takes place to clear land for farming releases carbon into the atmosphere.

Since 2000, Amazonia has lost 20.3 per cent of its original forest (832,000 km2), 70 per cent of which has been cleared for cattle ranching.

Severe droughts occurred in 2005, 2010 and 2015–16 and are more common now than in the past, which also increases the prevalence of wildfires. It is estimated that forest fires now produce around 1.5 GtC per year. Between 2010 and 2020, emissions have increased by 20 per cent, and it is now estimated that Amazonia emits more CO2 than it sequesters.

15 AO1 – Knowledge and understanding of changes in the carbon cycle over time. Knowledge and understanding of the role of feedback within and between cycles and their link to climate change. Knowledge and understanding of human interventions in the carbon cycle.
AO2 – Application of knowledge and understanding to assess the extent to which reducing carbon emissions is more important than adapting to the impacts of climate change.
AO1 = 10 AO2 = 10

Level	Marks	Description
4	16–20	• AO2 – Detailed evaluative conclusion that is rational and firmly based on knowledge and understanding which is applied to the context of the question. Interpretations are comprehensive, sound and coherent. • AO2 – Detailed, coherent and relevant analysis and evaluation in the application of knowledge and understanding throughout. • AO2 – Full evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts.

		• AO1 – Detailed, highly relevant and appropriate knowledge and understanding of place(s) and environments used throughout. • AO1 – Full and accurate knowledge and understanding of key concepts, processes and interactions and change throughout. • AO1 – Detailed awareness of scale and temporal change which is well integrated where appropriate.
3	11–15	• AO2 – Clear evaluative conclusion that is based on knowledge and understanding which is applied to the context of the question. Interpretations are generally clear and support the response in most aspects. • AO2 – Generally clear, coherent and relevant analysis and evaluation in the application of knowledge and understanding. • AO2 – Generally clear evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Generally clear and relevant knowledge and understanding of place(s) and environments. • AO1 – Generally clear and accurate knowledge and understanding of key concepts, processes and interactions and change. • AO1 – Generally clear awareness of scale and temporal change which is integrated where appropriate.
2	6–10	• AO2 – Some sense of an evaluative conclusion partially based upon knowledge and understanding which is applied to the context of the question. • AO2 – Interpretations are partial but do support the response in places. Some partially relevant analysis and evaluation in the application of knowledge and understanding. • AO2 – Some evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Some relevant knowledge and understanding of place(s) and environments which is partially relevant. • AO1 – Some knowledge and understanding of key concepts, processes and interactions and change. There may be a few inaccuracies. • AO1 – Some awareness of scale and temporal change which is sometimes integrated where appropriate. There may be a few inaccuracies.
1	1–5	• AO2 – Very limited and/or unsupported evaluative conclusion that is loosely based upon knowledge and understanding which is applied to the context of the question. Interpretation is basic. • AO2 – Very limited analysis and evaluation in the application of knowledge and understanding. This lacks clarity and coherence. • AO2 – Very limited and rarely logical evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Very limited relevant knowledge and understanding of place(s) and environments. • AO1 – Isolated knowledge and understanding of key concepts, processes and interactions and change. There may be a number of inaccuracies. • AO1 – Very limited awareness of scale and temporal change which is rarely integrated where appropriate. There may be a number of inaccuracies.
0	0	• Nothing worthy of credit.

ISBN 9781382052429

AO1

- Changes in the carbon cycle over time, to include natural variation (including wildfires, volcanic activity) and human impact (including hydrocarbon fuel extraction and burning, farming practices, deforestation, land use changes).
- The key role of the carbon and water stores and cycles in supporting life on Earth with particular reference to climate. The relationship between the water cycle and carbon cycle in the atmosphere.
- The role of feedbacks within and between cycles and their link to climate change and implications for life on Earth.
- Human interventions in the carbon cycle designed to influence carbon transfers and mitigate the impacts of climate change.

AO2

- Answers should discuss measures to reduce carbon emissions into the atmosphere against efforts to adapt to the impact of climate change.
- In terms of the reduction of carbon emissions, answers could refer to afforestation and reforestation, carbon capture and storage, direct air capture, enhanced rock weathering, carbon farming and other measures that aim at reducing the amount of carbon emitted from human activities that reaches the atmosphere.
- In evaluating reducing carbon emissions, answers could consider the scale of such reductions, the time required to make an impact, the cost and sustainability of such measures and their impact on factors such as, for example, food security.
- Adaptation measures may be drawn from other areas of study such as desertification, coastal sea level rise and coastal erosion management or management of cold environments.
- In evaluating adaptation, answers could refer to the feedback loops that may intensify the rate and impacts of climate change faster than adaptation measures can keep up with, with the implications of this for life on Earth.
- Answers can be argued either way, though the conclusions reached should be based upon preceding content.

16 AO1 –Knowledge and understanding of a chosen case study of a river catchment.
AO2 – Application of knowledge and understanding to assess impacts of precipitation on drainage basin stores and transfers and implications for sustainable water supply and/or flooding.
AO1 = 10 AO2 = 10

Level	Marks	Description
4	16–20	• AO2 – Detailed evaluative conclusion that is rational and firmly based on knowledge and understanding which is applied to the context of the question. Interpretations are comprehensive, sound and coherent. • AO2 – Detailed, coherent and relevant analysis and evaluation in the application of knowledge and understanding throughout. • AO2 – Full evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Detailed, highly relevant and appropriate knowledge and understanding of place(s) and environments used throughout. • AO1 – Full and accurate knowledge and understanding of key concepts, processes and interactions and change throughout.

		• AO1 – Detailed awareness of scale and temporal change which is well integrated where appropriate.
3	11–15	• AO2 – Clear evaluative conclusion that is based on knowledge and understanding which is applied to the context of the question. Interpretations are generally clear and support the response in most aspects. • AO2 – Generally clear, coherent and relevant analysis and evaluation in the application of knowledge and understanding. • AO2 – Generally clear evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Generally clear and relevant knowledge and understanding of place(s) and environments. • AO1 – Generally clear and accurate knowledge and understanding of key concepts, processes and interactions and change. • AO1 – Generally clear awareness of scale and temporal change which is integrated where appropriate.
2	6–10	• AO2 – Some sense of an evaluative conclusion partially based upon knowledge and understanding which is applied to the context of the question. • AO2 – Interpretations are partial but do support the response in places. Some partially relevant analysis and evaluation in the application of knowledge and understanding. • AO2 – Some evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Some relevant knowledge and understanding of place(s) and environments which is partially relevant. • AO1 – Some knowledge and understanding of key concepts, processes and interactions and change. There may be a few inaccuracies. • AO1 – Some awareness of scale and temporal change which is sometimes integrated where appropriate. There may be a few inaccuracies.
1	1–5	• AO2 – Very limited and/or unsupported evaluative conclusion that is loosely based upon knowledge and understanding which is applied to the context of the question. Interpretation is basic. • AO2 – Very limited analysis and evaluation in the application of knowledge and understanding. This lacks clarity and coherence. • AO2 – Very limited and rarely logical evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Very limited relevant knowledge and understanding of place(s) and environments. • AO1 – Isolated knowledge and understanding of key concepts, processes and interactions and change. There may be a number of inaccuracies. • AO1 – Very limited awareness of scale and temporal change which is rarely integrated where appropriate. There may be a number of inaccuracies.
0	0	• Nothing worthy of credit.

AO1

- Case study of a river catchment(s) at a local scale to illustrate and analyse the key themes above, engage with field data and consider the impact of precipitation upon drainage basin stores and transfers and implications for sustainable water supply and/or flooding.

- Drainage basins as open systems – inputs and outputs, to include precipitation, evapotranspiration, and runoff; stores and flows, to include interception, surface, soil water, groundwater and channel storage; stemflow, infiltration overland flow, and channel flow. Concept of water balance.
- Changes in the water cycle over time to include natural variation including storm events, seasonal changes and human impact including farming practices, land use change and water abstraction.

AO2

- Answers should apply knowledge of factors affecting water supply or flooding in a chosen case study of a river catchment and the impacts of human activities.
- Stores within the drainage basin include groundwater, soil moisture, vegetation (interception store), river and stream channels and surface storage (e.g. puddles, marshes, lakes).
- Factors affecting the impact of precipitation on stores and transfers include drainage basin size, drainage density, slope angle, rock type, antecedent conditions (e.g. soil saturation), extent and type of vegetation cover, intensity of rainfall.
- (if answering for flooding) Human activities can both increase flooding risks (e.g. by reducing stores, increasing flows) or reduce them.
- (If answering for sustainable water supply) Human activities can both reduce sustainable water supply (e.g. by increased abstraction, reduction in EVT through deforestation) and increase sustainability (e.g. by increasing store capacity).
- Interventions can include tree planting (to increase interception and infiltration and to reduce overland flow), changing farming techniques to increase infiltration into the groundwater store, building dams to reduce the ‘flashiness’ of drainage basin responses to storm events (overland flow), creation or extension of floodplains to reduce channel flow and increase infiltration.
- Assessment of the role of these inventions should be in the context of a chosen case study. For example, the Pickering ‘Slowing the flow’ project, with its aim to reduce the risk of flooding in Pickering from 25 per cent to 4 per cent, through creation of ‘leaky dams’ in channels and dams made of heather bales to smaller streams, blocking of moorland drains, 30 hectares of woodland being planted along the river, buffer zones on moorland, where burning of heather vegetation is banned. Success of the scheme in terms of a 20 per cent reduction in flood risk in Pickering.

17 AO1 – Knowledge and understanding of feedback systems in the carbon cycle over time. Knowledge and understanding of the implications of climate change for life on Earth.
AO2 – Application of knowledge and understanding to assess the relative importance of feedback systems compared to other causes of climate change.
AO1 = 10 AO2 = 10

Level	**Marks**	**Description**
4	16–20	• AO2 – Detailed evaluative conclusion that is rational and firmly based on knowledge and understanding which is applied to the context of the question. Interpretations are comprehensive, sound and coherent. • AO2 – Detailed, coherent and relevant analysis and evaluation in the application of knowledge and understanding throughout. • AO2 – Full evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Detailed, highly relevant and appropriate knowledge and understanding of place(s) and environments used throughout.

		• AO1 – Full and accurate knowledge and understanding of key concepts, processes and interactions and change throughout. • AO1 – Detailed awareness of scale and temporal change which is well integrated where appropriate.
3	11–15	• AO2 – Clear evaluative conclusion that is based on knowledge and understanding which is applied to the context of the question. Interpretations are generally clear and support the response in most aspects. • AO2 – Generally clear, coherent and relevant analysis and evaluation in the application of knowledge and understanding. • AO2 – Generally clear evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Generally clear and relevant knowledge and understanding of place(s) and environments. • AO1 – Generally clear and accurate knowledge and understanding of key concepts, processes and interactions and change. • AO1 – Generally clear awareness of scale and temporal change which is integrated where appropriate.
2	6–10	• AO2 – Some sense of an evaluative conclusion partially based upon knowledge and understanding which is applied to the context of the question. • AO2 – Interpretations are partial but do support the response in places. Some partially relevant analysis and evaluation in the application of knowledge and understanding. • AO2 – Some evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Some relevant knowledge and understanding of place(s) and environments which is partially relevant. • AO1 – Some knowledge and understanding of key concepts, processes and interactions and change. There may be a few inaccuracies. • AO1 – Some awareness of scale and temporal change which is sometimes integrated where appropriate. There may be a few inaccuracies.
1	1–5	• AO2 – Very limited and/or unsupported evaluative conclusion that is loosely based upon knowledge and understanding which is applied to the context of the question. Interpretation is basic. • AO2 – Very limited analysis and evaluation in the application of knowledge and understanding. This lacks clarity and coherence. • AO2 – Very limited and rarely logical evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Very limited relevant knowledge and understanding of place(s) and environments. • AO1 – Isolated knowledge and understanding of key concepts, processes and interactions and change. There may be a number of inaccuracies. • AO1 – Very limited awareness of scale and temporal change which is rarely integrated where appropriate. There may be a number of inaccuracies.
0	0	• Nothing worthy of credit.

AO1

- The key role of the carbon and water stores and cycles in supporting life on Earth with particular reference to climate. The relationship between the water cycle and carbon cycle in the atmosphere. The role of feedbacks within and between cycles and their link to climate change and implications for life on Earth.
- Changes in the carbon cycle over time, to include natural variation (including wildfires, volcanic activity) and human impact (including hydrocarbon fuel extraction and burning, farming practices, deforestation, land use changes).
- The carbon budget and the impact of the carbon cycle upon land, ocean, and atmosphere, including global climate.

AO2

- Explanation of feedback systems (loops) and their implications for driving change in carbon stores; differentiation between positive (amplifying a change) and negative feedback (counteracting or reducing a change).
- Example of a positive feedback loop: carbon in permafrost decomposes as it thaws and is released into the atmosphere as CO_2 and CH_4, increasing the enhanced greenhouse effect and the amount of permafrost melting, further depleting carbon stored in the soil and increasing the magnitude of carbon stores in the atmosphere.
- Example of a negative and then positive feedback loop: warmer oceans increase their ability to absorb CO_2 from the atmosphere – a negative feedback loop. However, more dissolved CO_2 increases seawater acidity, which can be harmful to corals and shellfish that build shells or skeletons from calcium carbonates, reducing their capacity to act as carbon sink, reducing the ocean's role in sequestering carbon (reducing the magnitude of this store) – a positive feedback loop.
- Example of a negative feedback loop: increased CO_2 levels stimulating plant growth, leading to greater carbon absorption through more photosynthesis, increasing the magnitude of the biomass store.

18 AO1 – Knowledge and understanding of systems in physical geography; knowledge and understanding of changes in the water cycle over time.
AO2 – Application of knowledge and understanding to assess the value of systems-based understanding compared to other forms of analysis.
AO1 = 10 AO2 = 10

Level	Marks	Description
4	16–20	• AO2 – Detailed evaluative conclusion that is rational and firmly based on knowledge and understanding which is applied to the context of the question. Interpretations are comprehensive, sound and coherent. • AO2 – Detailed, coherent and relevant analysis and evaluation in the application of knowledge and understanding throughout. • AO2 – Full evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Detailed, highly relevant and appropriate knowledge and understanding of place(s) and environments used throughout. • AO1 – Full and accurate knowledge and understanding of key concepts, processes and interactions and change throughout. • AO1 – Detailed awareness of scale and temporal change which is well integrated where appropriate.

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0	0	• Nothing worthy of credit.

AO1

- The water cycle and drainage basins as systems – inputs and outputs, to include precipitation, evapotranspiration, and runoff; stores and flows, to include interception, surface, soil water, groundwater, and channel storage; stemflow, infiltration overland flow, and channel flow. Concept of water balance.
- Runoff variation and the flood hydrograph.

- Changes in water cycle inputs over time to include natural variation including storm events, seasonal changes and human impact on inputs including farming practices, land use change and water abstraction.

AO2

- Explanation of the global water cycle as a closed system; explanation of drainage basin as an open system with inputs of precipitation, solar radiation and via infiltration and runoff.
- Factors which could contribute to changes in input: climate change.
- Stores within the drainage basin (groundwater, soil moisture, vegetation, river and stream channels and surface storage) and how they respond to changing inputs.
- Flows within the drainage basin system include stemflow, throughfall, overland flow, throughflow and groundwater flow, and how they respond to changing inputs.
- Value of systems approach in terms of insights it gives into how a drainage basin will respond to changing inputs, e.g. factors increasing flood risk within a catchment and ways in which those could be influenced, e.g. planting trees, expanding, or developing floodplains.
- Limitations of a purely systems-based response could be made in relation to other aspects of the course, e.g. in relation to hazard management, people's perception of risk, economic costs, and benefits of different approaches, etc.

19 AO1 – Knowledge and understanding of the concept of the water cycle; knowledge and understanding of ecosystem responses to changes in one or more of their components or environmental controls; knowledge and understanding of a case study of a specified region experiencing ecological change.
AO2 – Application of knowledge and understanding to assess the influence of different processes driving change in the water cycle within a tropical rainforest.
AO1 = 10 AO2 = 10

Level	Marks	Description
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AO1

- Changes in the water cycle over time to include natural variation including storm events, seasonal changes and human impact including farming practices, land use change and water abstraction.
- The key role of the carbon and water stores and cycles in supporting life on Earth with particular reference to climate. The relationship between the water cycle and carbon cycle in the atmosphere. The role of feedbacks within and between cycles and their link to climate change and implications for life on Earth.
- Factors influencing the changing of ecosystems, including climate change and human exploitation of the global environment.
- The key role of the carbon and water stores and cycles in supporting life on Earth with particular reference to climate. The relationship between the water cycle and carbon cycle in the atmosphere. The role of feedbacks within and between cycles and their link to climate change and implications for life on Earth.

AO2

- Discuss the water cycle and the different processes driving change in the water cycle (likely within a drainage basin context).
- Discuss long-term and short-term influences responsible for changes in tropical rainforest ecosystems, with reference to changes in the water cycle.
- Using case study details of land use changes, assess influence of different processes, likely comparing gradual nature of long-term influences compared to rapid nature of anthropogenic climate change.

20 AO1 – Knowledge and understanding of feedback systems in the carbon cycle over time. Knowledge and understanding of human interventions designed to mitigate the impacts of climate change.
AO2 – Application of knowledge and understanding to assess the relative importance of feedback systems compared to other factors in climate change in informing our interventions to mitigate the impacts of climate change.
AO1 = 10 AO2 = 10

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4	16–20	• AO2 – Detailed evaluative conclusion that is rational and firmly based on knowledge and understanding which is applied to the context of the question. Interpretations are comprehensive, sound and coherent. • AO2 – Detailed, coherent and relevant analysis and evaluation in the application of knowledge and understanding throughout. • AO2 – Full evidence of links between knowledge and understanding to the application of knowledge and understanding in different contexts. • AO1 – Detailed, highly relevant and appropriate knowledge and understanding of place(s) and environments used throughout. • AO1 – Full and accurate knowledge and understanding of key concepts, processes and interactions and change throughout. • AO1 – Detailed awareness of scale and temporal change which is well integrated where appropriate.
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0	0	• Nothing worthy of credit.

AO1

- Human interventions in the carbon cycle designed to influence carbon transfers and mitigate the impacts of climate change.
- The key role of the carbon and water stores and cycles in supporting life on Earth with particular reference to climate. The relationship between the water cycle and carbon cycle in the atmosphere. The role of feedbacks within and between cycles and their link to climate change and implications for life on Earth.
- Changes in the carbon cycle over time, to include natural variation (including wildfires, volcanic activity) and human impact (including hydrocarbon fuel extraction and burning, farming practices, deforestation, land use changes).

AO2

- Consider the link between positive feedback systems and the challenges of monitoring the rate of climate change. For example, fresh snow and ice reflect a lot of sunlight (a high albedo). The rise in global temperatures causes ice caps and glaciers to melt. Less ice cover means less sunlight is reflected, and more heat is absorbed by the oceans and land, increasing global temperatures, causing further ice melting. Without an understanding of this feedback loop, the prediction and monitoring of associated climate change impacts, such as sea level rise, would be inaccurate and would hamper attempts to mitigate their effects, such as shifting coastal populations.
- Feedback loops also help to influence where mitigation efforts should focus. For example, afforestation and reforestation are mitigation measures designed to increase the absorption of carbon dioxide by trees and shrubs. However, if positive feedback systems linked to past deforestation have already had the impact of a drier local climate and increased risk of drought, then reforestation or afforestation may have limited success.

- Some interventions in the carbon cycle, e.g., enhanced rock weathering in which high-silica rocks such as basalt are crushed and spread over land, would lock away CO_2 from the air into calcium carbonate, and move that through water infiltration into the soil store and groundwater. However, it is not known what the impact of such actions would be on the carbon cycle: would impacts on feedback systems have unintended consequences?
- A relevant example could be how warmer oceans increase their ability to absorb CO_2 from the atmosphere – a negative feedback loop – but then more dissolved CO_2 increases seawater acidity, which can be harmful to corals and shellfish that build shells or skeletons from calcium carbonates, reducing their capacity to act as carbon sinks, reducing the ocean's role in sequestering carbon – a positive feedback loop.
- Answers are likely to include that an understanding of feedback systems will be critical to informing our interventions in the carbon cycle to mitigate the impacts of climate change.