6.2 Climate change: causes and impacts

Name: _____ Class: _____ Date: _____ **Total: 19 marks**

KEY WORDS enhanced greenhouse effect • permafrost • feedback loop • tipping point • sea-level rise • ocean acidification

Objective

Build the skills to answer exam questions on **climate change** : the enhanced greenhouse effect, evidence, **feedback loops** , tipping points, and impacts on people and ecosystems.

You must be able to:

- distinguish between the natural and the enhanced greenhouse effect
- describe and analyse evidence for climate change, such as the Keeling curve
- explain positive and negative feedbacks and tipping points
- explain why the impacts of climate change differ between places and people

1 Key knowledge and worked examples

Climate change

Enhanced greenhouse effect: human activity adds greenhouse gases, so more long-wave radiation is trapped and the mean temperature rises.

gas	main human sources
CO_2	burning fossil fuels, cement, deforestation
CH_4 (methane)	cattle, rice paddies, landfill, gas leaks
N_2O	nitrogen fertilizer

Evidence: CO_2 at Mauna Loa (the **Keeling curve**) rose from about 317 ppm in 1960 to over 420 ppm today; ice cores show it stayed between about 180 and 300 ppm for 800 000 years. Global mean temperature is about 1.1–1.2 °C above 1850–1900; 2024 was the first calendar year above 1.5 °C.

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feedback	example
positive (makes change bigger)	ice melts → lower albedo → more warming; permafrost thaws → CH_4 and CO_2 released; warmer ocean holds less CO_2
negative (makes change smaller)	more CO_2 → faster plant growth → more CO_2 taken up

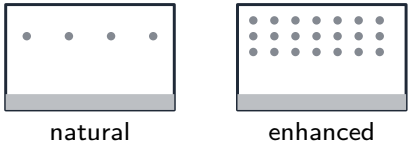
A **tipping point** is a threshold beyond which a system changes to a new state and does not easily return, e.g. ice-sheet loss, Amazon dieback, coral reef collapse.

Impacts: sea-level rise (warm water expands, land ice melts); more heatwaves, droughts and heavy rain; coral bleaching; species move towards the poles or uphill; crop yields change; ocean acidification. Poorer and low-lying places suffer most, though they emitted least.

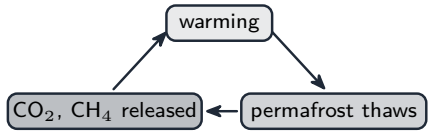
Answer shapes: for a feedback, write the loop as a chain of three links that ends back at the start.

2 Practice

2.1 Distinguish between the natural greenhouse effect and the enhanced greenhouse effect. [2]

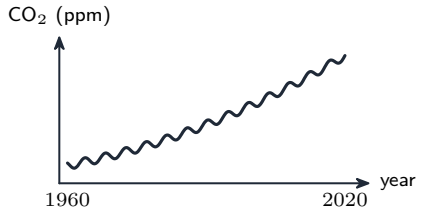


2.2 Explain how thawing permafrost is a positive feedback. [3]



3 Exam-style questions

3.1 The graph shows the CO_2 concentration at Mauna Loa, Hawaii.



(a) The annual mean was 317 ppm in 1960 and 414 ppm in 2020. Calculate the mean rate of increase per year. [2]

(b) Explain the small rise and fall within each year. [2]

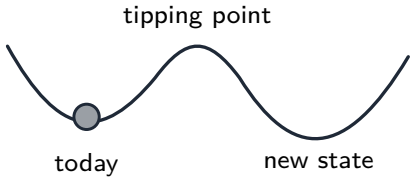
3.2 Low-lying island nations such as Tuvalu are among the most at risk.



(a) Outline **two** impacts of climate change on low-lying islands. [2]

(b) Explain why the impacts of climate change are unequal between countries. [3]

3.3 Scientists describe some parts of the climate system as having **tipping points**.



Discuss whether tipping points mean that cutting emissions is now urgent. [5]

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Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

natural: greenhouse gases that occur naturally keep Earth about 33 °C warmer than it would be, making life possible; enhanced: extra greenhouse gases from human activity trap more heat and raise the mean temperature further

2.2

warming thaws frozen soil (permafrost) in the Arctic; dead organic matter in it decomposes and releases CO_2 and methane; these greenhouse gases cause more warming, so more permafrost thaws, and the change grows

3.1

(a) $414 - 317 = 97$ ppm over 60 years; $97 \div 60 \approx \mathbf{1.6}$ ppm per year

(b) the Northern Hemisphere has most of the land and plants; in its summer photosynthesis takes in CO_2, so it falls; in winter respiration and decay continue but photosynthesis slows, so it rises

3.2

(a) any two: flooding and loss of land from sea-level rise; salt water entering wells and farmland; stronger storms; coral reef damage that harms fishing and coastal protection

(b) physical exposure differs, e.g. low coasts, dry regions and the Arctic change most; poorer countries have less money and technology to adapt, such as sea walls or irrigation; many depend more on farming and fishing, which are sensitive to climate

3.3

award up to [5]: a tipping point is a threshold after which a system shifts to a new state that is hard to reverse; examples: Greenland ice sheet, Amazon dieback, permafrost; positive feedbacks could push warming beyond human control; but the exact thresholds are uncertain, and some may be centuries away; conclusion: uncertainty and high risk support urgent action (precautionary principle)

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