2.3 Biogeochemical cycles

Name: _____ Class: _____ Date: _____ **Total: 23 marks**

KEY WORDS carbon cycle • carbon sink • nitrogen fixation • nitrification • denitrification • ocean acidification

Objective

Build the skills to answer exam questions on **biogeochemical cycles** : the **carbon cycle** and the **nitrogen cycle** , their stores and flows, and how humans change them.

You must be able to:

- name the stores and flows of the carbon and nitrogen cycles
- explain sinks and sources, and how fossil fuels and deforestation change the carbon cycle
- explain nitrogen fixation, nitrification, denitrification and ammonification
- evaluate human impacts such as fertilizer use and ocean acidification

1 Key knowledge and worked examples

■ Carbon and nitrogen cycles

carbon store	carbon flow
atmosphere (CO_2, CH_4)	photosynthesis: atmosphere → biomass
biomass (plants, animals)	respiration: biomass → atmosphere
soil and dead matter	decomposition, feeding
oceans (dissolved CO_2, shells)	dissolving into and out of the ocean
fossil fuels, limestone	combustion; weathering

A **sink** stores more carbon than it releases (a growing forest, the ocean); a **source** releases more than it stores (burning fuels, cleared land). Burning fossil fuels moves carbon stored for millions of years into the atmosphere quickly; **deforestation** removes a sink and adds a source.

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Ocean acidification: CO_2 dissolves to form carbonic acid, lowering ocean pH. Shell-building animals (corals, molluscs) find it harder to build calcium carbonate shells.

nitrogen process	what happens	done by
nitrogen fixation	N_2 gas → ammonium (NH_4^+)	bacteria in soil and in legume root nodules; lightning; the Haber process
nitrification	ammonium → nitrite → **nitrate** (NO_3^-)	nitrifying bacteria (need oxygen)
assimilation	nitrate taken up to make proteins	plants
ammonification	proteins in dead matter and waste → ammonium	decomposers
denitrification	nitrate → N_2 gas	denitrifying bacteria, in waterlogged soil with little oxygen

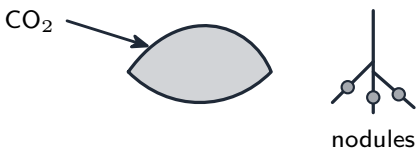
Fertilizers add nitrate and phosphate; runoff into water causes **eutrophication** (see 4.4).

Worked example. Fossil fuels add about 10 and land clearing about 1 GtC a year; the ocean and land sinks each take about 3: the atmosphere gains about $10+1-3-3 =$ **5** GtC a year.

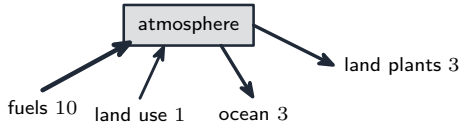
Answer shapes: name the store **and** the process; say which way carbon or nitrogen moves.

2 Practice

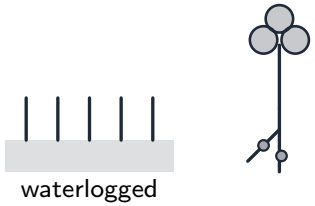
2.1 Name the process: (i) CO_2 is taken from the air into a leaf to make glucose; (ii) N_2 gas is changed to ammonium in root nodules. [2]



2.2 Each year, about 10 GtC of carbon is released by burning fossil fuels and 1 GtC by land clearing; the oceans absorb 3 GtC and land plants 3 GtC more than they release. (i) Calculate the yearly change in atmospheric carbon. (ii) Identify **one** sink and **one** source in the data. [3]



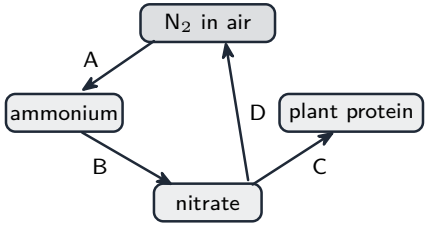
2.3 Explain why farmers on waterlogged soils lose nitrate faster, and why planting legumes such as beans or clover can reduce the need for fertilizer. [3]



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3 Exam-style questions

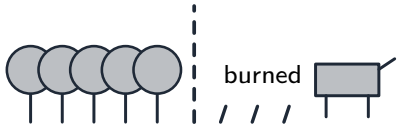
3.1 The diagram shows part of the nitrogen cycle.



(a) Name processes A and B. [2]

(b) Explain why ploughing that lets air into soil increases the nitrate in the soil. [2]

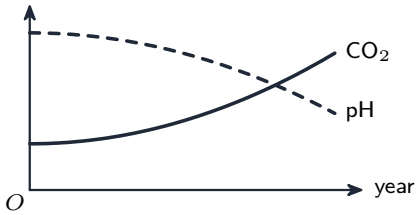
3.2 A large area of tropical rainforest is cleared and burned for cattle pasture.



(a) Explain **two** ways this changes the carbon cycle. [4]

(b) State **one** other effect of the clearing on a biogeochemical cycle. [1]

3.3 The ocean has absorbed about a quarter of the CO_2 released by human activity.



(a) Describe how the ocean takes in CO_2 and becomes more acidic. [2]

(b) Discuss the claim that the ocean "solves" the problem of carbon emissions. [4]

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