

Transfers of energy and matter: practice questions

8 questions • 28 marks • mark scheme at the back

For IB Diploma Biology, Standard Level and Higher Level (first assessment 2025). **HL only** is additional higher level content, for HL students only.

Name

Total / 28

1 PAPER 1A STYLE [1 mark]

What is the source of energy that iron-oxidising bacteria use to fix carbon dioxide?

- A. ☐ Light absorbed by chlorophyll
- B. ☐ Oxidation of iron(II) ions to iron(III) ions
- C. ☐ Reduction of iron(III) ions to iron(II) ions
- D. ☐ Carbon compounds absorbed from dead organic matter

2 PAPER 1A STYLE [1 mark]

Which statement describes a closed system?

- A. ☐ Energy and matter can both enter and exit
- B. ☐ Matter can enter and exit but energy cannot
- C. ☐ Energy can enter and exit but matter cannot
- D. ☐ Neither energy nor matter can enter or exit

3 PAPER 1A STYLE [1 mark]

Which statement about production in an ecosystem is correct?

- A. ☐ Secondary production is usually greater than primary production
- B. ☐ Primary production is measured in kJ per individual
- C. ☐ Secondary production is lower than primary production because carbon compounds are lost as CO₂ and water in respiration
- D. ☐ Primary production is the total biomass of the producers at one moment

The table shows sample data for the energy flowing through each trophic level of a food chain in a grassland. (a) Calculate the percentage of energy transferred from producers to primary consumers. [1] (b) Calculate the percentage transferred from secondary to tertiary consumers. [1] (c) Explain two reasons why less than 100% of the energy is transferred between trophic levels. [2] (d) Using the data, suggest why this food chain has no quaternary consumer. [2]

Energy flow through a grassland food chain / $\text{kJ m}^{-2} \text{ yr}^{-1}$	
Trophic level	Energy / $\text{kJ m}^{-2} \text{ yr}^{-1}$
Producers	24 000
Primary consumers	2 160
Secondary consumers	194
Tertiary consumers	15

Answer =

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5 PAPER 1B STYLE

[5 marks]

The table shows illustrative monthly mean CO₂ concentrations at Mauna Loa in two consecutive years, following the pattern of the Keeling Curve. (a) Calculate the difference between the May and September concentrations in Year 1. [1] (b) Explain why CO₂ concentration falls between May and September. [2] (c) Calculate the rate of increase in mean CO₂ concentration between the January values, giving units. [1] (d) State the main cause of the long-term increase. [1]

Illustrative monthly mean CO ₂ concentration / ppm			
Year	January	May	September
Year 1	416.5	420.0	413.5
Year 2	419.0	422.5	416.0

Answer =

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6 PAPER 2A STYLE

[4 marks]

Distinguish between the ways in which autotrophs and heterotrophs obtain the carbon compounds they require, and state one process they have in common.

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7 PAPER 2B STYLE

[7 marks]

Explain how carbon is recycled in ecosystems, and how ecosystems and human activity can change the amount of carbon dioxide in the atmosphere.

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8 PAPER 2A STYLE

[3 marks]

Explain why chemical elements can be recycled in ecosystems but energy cannot.

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Mark scheme

One mark for each point unless a maximum is given. Words in brackets are not needed for the mark.

1. [1]

B B [1]. Oxidation reactions release energy; these bacteria are chemoautotrophs.

2. [1]

C C [1]. A describes an open system such as a natural ecosystem.

3. [1]

C C [1]. B: units are $\text{g m}^{-2} \text{yr}^{-1}$; D describes biomass, not production (a rate).

4. [6]

- (a) $2\,160 \div 24\,000 \times 100 = 9.0\%$ [1]
- (b) $15 \div 194 \times 100 = 7.7\%$ [1] accept 7.73%
- (c) energy converted to heat in cell respiration (lost to environment) [1]
- (c) not all of the organisms / parts eaten (e.g. roots, bones) [1]
- (c) not all food digested/absorbed; lost in faeces [1]
- (d) only $15 \text{ kJ m}^{-2} \text{yr}^{-1}$ reaches tertiary consumers / about 8% of that would pass on, about $1 \text{ kJ m}^{-2} \text{yr}^{-1}$ [1]
- (d) too little energy to sustain a population of a further trophic level [1]
- max 6

5. [5]

- (a) $420.0 - 413.5 = 6.5 \text{ ppm}$ [1]
- (b) northern hemisphere spring/summer: photosynthesis exceeds respiration [1]
- (b) net uptake of CO_2 by (the large area of) land plants in the northern hemisphere [1]
- (c) $419.0 - 416.5 = 2.5 \text{ ppm yr}^{-1}$ / ppm per year [1] units required
- (d) combustion of fossil fuels (coal, oil, natural gas) / accept deforestation by burning [1]

6. [4]

- autotrophs synthesise carbon compounds from simple inorganic substances / CO_2 [1]
- autotrophs use an external energy source (light or oxidation reactions) [1]
- heterotrophs obtain carbon compounds from other organisms [1]
- heterotrophs digest complex compounds (internally or externally) and assimilate the products to build their own compounds [1]
- both release energy by (oxidising carbon compounds in) cell respiration [1]
- max 4

7. [7]

- autotrophs/producers fix CO_2 by photosynthesis into carbon compounds [1]
- carbon compounds pass to consumers by feeding [1]
- dead organisms / faeces / dead parts are broken down by decomposers [1]
- producers, consumers and decomposers release CO_2 by (cell) respiration [1]
- if photosynthesis exceeds respiration, there is net uptake / ecosystem is a carbon sink [1]
- if respiration exceeds photosynthesis, there is net release / ecosystem is a carbon source [1]
- named sink/source, e.g. growing forest / peat bog as sink; drained peatland as source [1]
- combustion of biomass / peat / coal / oil / natural gas releases CO_2 [1]
- fossil fuels / peat are carbon stores formed over long periods (thousands to millions of years) [1]
- natural combustion after lightning strikes occurs, but human activity has greatly increased combustion rates [1]
- decomposers also recycle other elements, not just carbon [1]
- max 7

8. [3]

- elements/atoms are not destroyed / the supply of each element is finite [1]
- decomposers break down dead organic matter, releasing elements in inorganic forms that producers can reuse [1]
- energy is converted to heat in cell respiration / when ATP is made and used [1]
- heat is lost to the environment and cannot be converted back to chemical energy by organisms [1]
- so energy must be continually supplied by sunlight [1]
- max 3