

Nutrient Cycles and Decomposition

Mark Scheme



www.scienceexamssorted.co.uk

1. All living organisms require essential materials from their environment to survive and grow this question explores how these materials are continuously recycled within ecosystems through processes like the carbon and water cycles, driven by the vital role of decomposers.

- a. The figure below shows a simplified image of the water cycle.
Which label represents **transpiration**?

C – is the only correct answer.	1 mark
	Total: 1 mark

- b. Which statement best describes the role of decomposers in an ecosystem?

C – is the only correct answer.	1 mark
	Total: 1 mark

- c. A student sets up an investigation into the rate of decay. For decay to happen quickly, the decomposers need the right conditions to respire and grow.

Which combination of conditions would lead to the fastest rate of decay?

C – is the only correct answer.	1 mark
	Total: 1 mark

- d. The figure below shows an image of the carbon cycle.
Identify the process labelled X in the figure.

C – is the only correct answer.	1 mark
	Total: 1 mark

- e. Water is continuously cycled between the land, the atmosphere and living organisms.

Which process describes water vapour turning back into liquid water droplets?

A – is the only correct answer.	1 mark
	Total: 1 mark

- f. A scientist investigated how temperature affects the rate of decay. They placed identical samples of dead leaves into two composters, J and K. Both composters started with 4000 g of dead leaves.

Calculate the mean rate of decay in composter J.

B – is the only correct answer.	1 mark
	Total: 1 mark

(Total for Question 1 is 6 marks)

2. The figure below shows the carbon cycle.

a. Identify the processes taking place at the labelled points in the figure above.

Any four from:		
1: Photosynthesis		1 mark
2: Respiration	Accept aerobic respiration.	1 mark
3: Combustion	Accept burning	1 mark
4: Feeding / consumption	Accept eating	1 mark
		Total: 4 mark

b. Green plants are important in the carbon cycle.

Describe **two** processes by which green plants affect the concentration of carbon dioxide in the atmosphere.

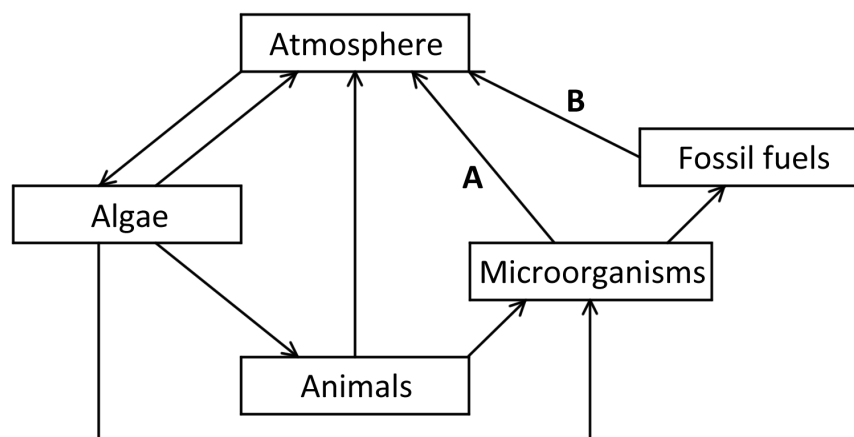
An answer that makes reference to the following points:		
(By) photosynthesis, (they) take in / use / remove carbon dioxide.		1 mark
(By) respiration, (they) release / produce carbon dioxide.		1 mark
		Total: 2 marks

c. Give **one** biological process that could cause the lower concentration of carbon dioxide in the summer.

Photosynthesis.	1 mark
Accept an answer that refers to an increased rate of photosynthesis.	
	Total: 1 mark

(Total for Question 2 is 7 marks)

3. The figure below shows a small part of a carbon cycle in a marine habitat.



a. Identify the processes shown by arrows **A** and **B**.

A = Respiration.	1 mark
B = Combustion.	1 mark
	Total: 2 marks

- b. Describe how the activities of algae can both decrease and increase the concentration of dissolved carbon dioxide in the water.

An answer that makes reference to the following points:	
Algae decrease carbon dioxide concentration through photosynthesis. Accept 'take in' / 'use' carbon dioxide.	1 mark
(because) photosynthesis uses carbon dioxide (from the water).	1 mark
Algae increase carbon dioxide concentration through respiration. Accept 'give out' / 'produce' / 'release' carbon dioxide.	1 mark
	Total: 3 marks

- c. Decomposition of dead organic matter happens much faster in tropical rainforests than in colder habitats. Explain two reasons why.

Any two from:	
Reason: Tropical rainforests are warmer / have a higher temperature. Allow: hotter. Explanation: which is closer to the optimum temperature for decomposers / enzymes OR increases rate of decay / enzyme activity.	1 mark
Reason: Tropical rainforests are moister / have more water (available). Explanation: water is needed for decomposition / by microorganisms.	1 mark
	Total: 2 marks

(Total for Question 3 is 7 marks)

4. The figure below shows the water cycle.

- a. Identify the processes **A**, **B**, **C** and **D**.

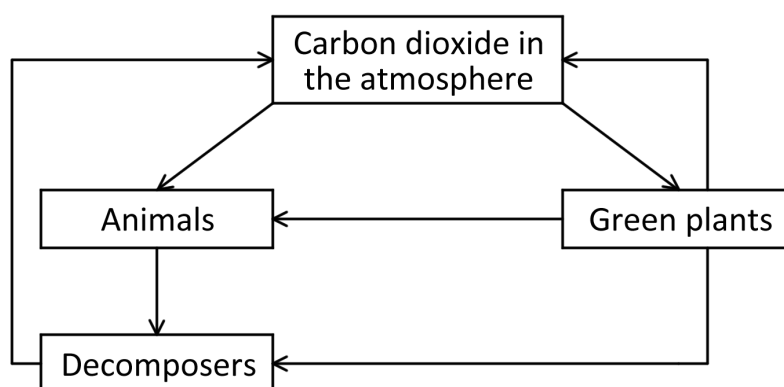
A = Transpiration.	1 mark
B = Evaporation	1 mark
C = Precipitation	1 mark
D = Respiration.	1 mark
	Total: 4 marks

- b. Explain how surface run-off from a field fertilised by farmers can lead to an increase in the population of fish in a lake.

An answer that makes reference to the following points in a logical order:	
Fertilisers / minerals / nitrates run-off into the lake. Accept named minerals e.g. phosphates.	1 mark
Causing an increase in the growth of algae / aquatic plants. Accept algal bloom.	1 mark
This provides more food for the fish / organisms that fish eat, so the fish population increases.	1 mark
	Total: 3 marks

(Total for Question 4 is 7 marks)

5. The figure below shows part of the carbon cycle in a grassland habitat.



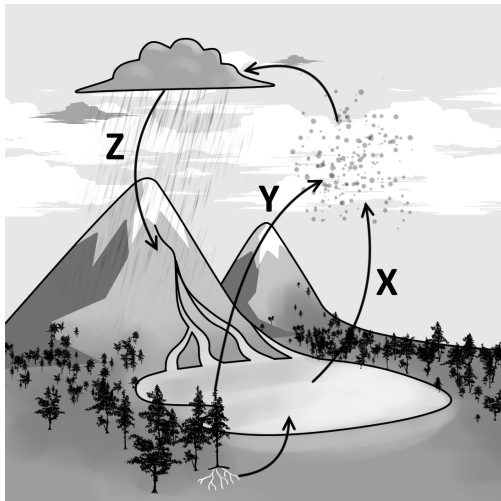
Describe how living things are involved in the constant cycling of carbon.

Marking guidance		
Level	Marks	Descriptor
Level 1	1 - 2	A simple, limited description that identifies at least one relevant biological process (e.g. photosynthesis or respiration). The answer consists of isolated statements with few or no links made.
Level 2	3 - 4	A good description of several processes in the carbon cycle, with some logical links made between organisms. The answer may lack detail or coherence in places.
Level 3	5 - 6	A detailed and coherent description that correctly links the roles of plants, animals and decomposers in the carbon cycle. The answer logically sequences the key processes of photosynthesis, respiration, feeding and decomposition, using appropriate scientific terminology.

Indicative content:	
Photosynthesis: - Green plants take in / remove carbon dioxide from the atmosphere. - Carbon is used to make carbohydrates / glucose / organic molecules / biomass. Feeding: - Carbon is transferred to animals when they eat plants. Respiration: (Green) plants respire, releasing carbon dioxide. - Animals respire, releasing carbon dioxide. - Decomposers / microorganisms respire, releasing carbon dioxide. Decomposition: - When plants and animals die, they are broken down / decayed by decomposers / microorganisms (e.g. bacteria and fungi). - Carbon from the dead organic matter is returned to the atmosphere (as carbon dioxide via respiration).	
	Total: 6 marks

(Total for Question 5 is 6 marks)

6. Water is cycled through ecosystems. The figure below shows a water cycle.



- a. Identify the processes **X**, **Y** and **Z**.

X = Evaporation.	1 mark
Y = Precipitation.	1 mark
Z = Condensation.	1 mark
	Total: 3 marks

- b. Describe the role of water in **two** named life processes that occur in plants.

Any two from the following, with one mark for the named process and its role:	
(In) photosynthesis as a reactant / to make glucose.	1 mark
(In) transport (in xylem) to carry dissolved mineral ions.	1 mark
To maintain turgor / provide support.	1 mark
	Total: 2 marks

- c. Burning fossil fuels releases gases like sulphur dioxide.

Explain how this type of air pollution can negatively affect organisms when it interacts with the water cycle.

An answer that makes reference to the following points:	
Sulphur dioxide dissolves in water / rain.	1 mark
To form acid rain (which damages plants / kills aquatic organisms).	1 mark
Accept a valid named consequence of acid rain for the second mark.	
	Total: 2 marks

- d. Use the information in the figure above to calculate the percentage efficiency of energy transfer for the oak tree. Give your answer to **two** significant figures.

Efficiency = $(48\,000 \div 2\,000\,000) \times 100$	1 mark
2.4 (%)	1 mark
	Total: 2 marks

- e. The total energy taken in by the caterpillar is 4500 kJ/m²/year.
The caterpillar uses 600 kJ/m²/year of this energy for growth.

Calculate the percentage of the energy taken in by the caterpillar that is **not** used for growth.
Give your answer to **three** significant figures.

Energy not used for growth = 4500 – 600 = 3900	1 mark
Percentage = (3900 ÷ 4500) × 100 = 86.7 (%)	1 mark
	Total: 2 marks

- f. The efficiency of energy conversion for the caterpillar is 8.9%.
The efficiency for the oak tree is significantly lower.

Calculate how many times more efficient the caterpillar is at converting its energy input into growth compared to the oak tree. Use your answer from part (d).

8.9 ÷ 2.4	1 mark
3.7	1 mark
Accept an answer in the range 3.7 to 3.71.	
	Total: 2 marks

- g. A large proportion of the energy taken in by the caterpillar is not converted to biomass.

Explain **two** ways this energy is lost. The figure above shows two of these losses.

Any two from:	
Respiration (to release energy for life processes).	1 mark
Accept energy lost as heat / for movement.	
(In) faeces / egestion (because not all material is digested).	1 mark
Do not accept excretion / waste alone.	
	Total: 2 marks

- h. The diagram shows that 35 000 kJ/m²/year of energy is transferred to decomposers when parts of the oak tree, such as leaves, die.

Describe the role of decomposers in the carbon cycle.

An answer that makes reference to the following points:	
Decomposers / microorganisms break down dead organic matter / waste products.	1 mark
They respire.	1 mark
This releases carbon dioxide back into the atmosphere.	1 mark
	Total: 3 marks

(Total for Question 6 is 18 marks)