HELICATE · A-LEVEL BIOLOGY · TOPIC BANK

3.7.4 Populations in ecosystems

Mark scheme

Version 2 · 17 October 2026

TOTAL MARKS	QUESTIONS
64	9

How to use this mark scheme

;	Separates marking points. Each semicolon marks the end of one creditable point, and each point is worth one mark.
;;	Two marks for this answer (used for calculations).
/	Alternative words or phrases that are credited for the same point.
OR	An alternative answer for the same mark.
( )	Words in brackets are not needed to gain the mark.
max	More marking points are listed than marks available. Award up to the number of marks shown.
Accept	An alternative answer that gains credit.
Reject	A wrong answer. It does not gain credit and cancels a correct point it contradicts.
Ignore	Neither credited nor penalised. Mark the rest of the answer.
ECF	Error carried forward: credit correct working that uses an earlier wrong answer.
AO	Assessment objective: AO1 knowledge and understanding; AO2 applying knowledge; AO3 analysing, interpreting and evaluating.

Where an answer is correct but not listed, credit it if it is biologically accurate and answers the question at the depth the marks require. Right + wrong = wrong: a contradiction cancels a correct point.

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Communities, niches and carrying capacity 3.7.4

Question	Marking guidance	Mark	Comments
01.1	It is made up of the community and the non-living components of its environment;	**1** (1 × AO1)	An ecosystem is a community together with the non-living (abiotic) components of its environment; ecosystems range from very small to very large.

Question	Marking guidance	Mark	Comments
01.2	1. (They) occupy different niches OR feed in different places/at different heights OR feed on different (sizes of) prey; 2. So there is little/no interspecific competition (for food/prey);	**2** (2 × AO2)	1. **Accept** 'different niches' alone, or one difference in feeding place or prey 1. **Reject** 'live in different habitats' 2. **Accept** 'they do not compete for the same food' 2. **Reject** intraspecific competition **Ignore** references to feeding at different times

Question	Marking guidance	Mark	Comments
02.1	Carrying capacity;	**1** (1 × AO1)	**Reject** 'maximum population', 'climax' or 'population size' alone

Question	Marking guidance	Mark	Comments
02.2	1. Intraspecific competition; 2. For food/algae (because the supply of algae is limited/the same each day) OR for oxygen/space; 3. Fewer water fleas reproduce/fewer offspring are produced OR more water fleas die (of starvation); 4. Birth rate equals death rate OR births are balanced by deaths;	**3 max** (2 × AO1) (1 × AO2)	1. **Accept** 'competition between water fleas' or 'competition within the species' 1. **Reject** interspecific competition 2. **Ignore** 'resources' unqualified 3 and 4. **Ignore** immigration and emigration (closed tank)

Question	Marking guidance	Mark	Comments
02.3	Correct answer for 2 marks: 37.5 (%);; Accept for 1 mark: (240 − 150) ÷ 240 (× 100) **OR** correct readings of 240 **and** 150	**2** (2 × AO2)	**Accept** 38 (%) for 2 marks 60 (dividing by the tank B value) = 1 mark Day 40 values lie on gridlines at 240 (tank A) and 150 (tank B); readings must be exact for 2 marks 1 mark for a correct method using misread values from Figure 1

Question	Marking guidance	Mark	Comments
02.4	1. Tank B: interspecific competition (with the second species); 2. For the algae/food, so less food for each water flea, so fewer offspring/more deaths OR so the carrying capacity is lower; 3. Tank C: predation (by the larvae) kills water fleas OR increases the death rate (of water fleas); 4. Predation reduced the number more than competition did (tank C about 90, tank B about 150, tank A about 240);	**3 max** (2 × AO2) (1 × AO3)	**Max 2** if no reference to the data 1. **Reject** intraspecific competition 1. **Accept** 'competition between species' 3. **Accept** 'larvae eat water fleas' only if linked to fewer water fleas/more deaths 4. **Accept** any correct comparison of the three tanks after day 20

Question	Marking guidance	Mark	Comments
03.1	The number of cells ranges over (two) orders of magnitude/from 10^6 to 10^8, so on a linear scale the early/small values would be too close to zero to read OR exponential growth gives a straight line on a log scale (so the growth rate/doubling time can be found);	**1** (1 × AO2)	**Accept** 'the numbers are very large and very different' **Ignore** 'to make the graph easier to read' unqualified **Ignore** 'to show exponential growth' unless linked to a straight line

Question	Marking guidance	Mark	Comments
03.2	Correct answer for 2 marks: 2.0 (hours);; Accept for 1 mark: 3 doublings OR (7.2 − 6.3) ÷ 0.30 **OR** a correct method using misread values from Figure 2	**2** (2 × AO2)	Plotted values lie on gridlines: 6.3 at 4 hours and 7.2 at 10 hours. Accept readings of 6.25–6.35 and 7.15–7.25 for the 1-mark method **Accept** 2 (hours) for 2 marks 6.7 (time ÷ change in $\log_{10}$) = 0 marks

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Question	Marking guidance	Mark	Comments
03.3	1. To prevent contamination by other microorganisms (eg bacteria/fungi from the air or equipment); 2. Other microorganisms would also make the broth cloudy/turbid, so the number of yeast cells would be overestimated; 3. Other microorganisms would compete with the yeast (for glucose/nutrients), so would change the growth of the yeast population;	**2 max** (1 × AO2) (1 × AO3)	1. **Accept** 'aseptic technique' only if linked to keeping out other microorganisms 1. **Ignore** 'to keep it sterile' or 'to keep it clean' unqualified **Ignore** references to safety

Estimating population size: quadrats and transects 3.7.4

Question	Marking guidance	Mark	Comments
04.1	1. Divide the field into a grid OR lay two tape measures (at right angles) along two sides (of the field) as axes; 2. Use random numbers (from a table/generator/calculator/computer) to give coordinates (for each quadrat);	**2** (2 × AO1)	1. **Accept** 'use a map divided into squares' 2. 'Random numbers' must be linked to coordinates/positions for the mark **Reject** throwing the quadrat (over the shoulder) **Ignore** belt transects

Question	Marking guidance	Mark	Comments
04.2	Correct answer for 3 marks: 43 200;;; Accept for 2 marks: 12 (daisy plants) per m^2 OR 3 × 14 400 (mean × number of quadrats that fit in the field) Accept for 1 mark: mean of 3 (daisy plants) per quadrat OR field area of 3 600 m^2 OR 14 400 quadrats fit in the field	**3** (3 × AO2)	**Accept** 4.32×10^4 for 3 marks 21 600 (using 0.5 m^2 as the quadrat area) = 1 mark 'Scale up' without a correct method gains no marks beyond the mean

Question	Marking guidance	Mark	Comments
04.3	1. Numbers vary widely between quadrats (from 0 to 7) OR daisies are unevenly distributed/clumped (shown by the range of counts) OR only 15 quadrats/3.75 m^2 of the 3 600 m^2 field were sampled, so the sample may not be representative; 2. Use more quadrats (so the mean is more representative) OR keep adding quadrats until the running mean stays the same;	**2** (2 × AO3)	1. Must refer to the data in Table 1, eg the range of counts or the number of quadrats used; 'clumped' alone is not enough 2. **Accept** a stated number greater than 15 2. **Ignore** 'repeat the investigation' unqualified **Ignore** 'use smaller quadrats'

Question	Marking guidance	Mark	Comments
04.4	80%;	**1** (1 × AO2)	Daisy plants were present in 12 of 15 quadrats; 12 ÷ 15 × 100 = 80%

Question	Marking guidance	Mark	Comments
05.1	1. Lay a tape measure/line from the grassland into the woodland (at right angles to the woodland edge); 2. Place quadrats at regular intervals along the line (eg every 2 m) OR place quadrats next to each other along the line (belt transect); 3. Estimate the percentage cover of red fescue in each quadrat OR count the number of red fescue plants/shoots in each quadrat; 4. Measure light intensity at each quadrat with a light meter/light sensor; 5. Measure light intensity at the same height (eg ground level) **and** at the same time/in the same weather conditions; 6. Repeat with more transects (at random positions along the woodland edge) **and** calculate a mean for each distance; 7. Plot (mean) percentage cover against light intensity OR use a statistical test for correlation/a correlation coefficient; 8. Also measure other abiotic factors that may vary along the transect, eg soil water content/soil pH (to see whether they also change);	**6 max** (5 × AO1) (1 × AO2)	1 and 2. **Accept** 'belt transect' for point 1 and 'quadrats along the belt transect' for point 2 1 and 2. Randomly placed quadrats alone do not gain points 1 or 2 3. **Accept** frequency (the percentage of squares within the quadrat containing red fescue) 3. **Ignore** 'abundance' or 'amount' unqualified 3. **Reject** counting the number of species 4. **Accept** lux meter or data logger with a light sensor 6. **Accept** a stated number of transects of 3 or more

Question	Marking guidance	Mark	Comments
05.2	1. (Supports) percentage cover falls as light intensity falls OR there is a positive correlation between light intensity and cover (eg 62% at 100% sunlight, 0% at 12% sunlight); 2. (Against) soil water content also changes/increases (from 18% to 37%), so this could cause the change in cover; 3. A correlation does not show that light causes the change OR other (unmeasured) factors may differ, eg competition from woodland plants/soil pH/leaf litter; 4. Only one transect OR no repeats OR no statistical test of the correlation (so it may be due to chance);	**3 max** (3 × AO3)	**Max 2** if no data from Table 2 are used 3. **Ignore** 'other factors' without an example unless linked to correlation not showing cause **Ignore** sample size unqualified

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Mark-release-recapture 3.7.4

Question	Marking guidance	Mark	Comments
06.1	Correct answer for 2 marks: 525;; Accept for 1 mark: 84 × 75 ÷ 12	**2** (2 × AO2)	**Reject** methods that add the first and second samples, or that use the number of unmarked voles in the second sample **Ignore** 'voles' or units given

Question	Marking guidance	Mark	Comments
06.2	1. The mark is not visible to predators/owls/kestrels (hunting from above), so marked voles are no more likely to be eaten/their survival is not affected (compared with unmarked voles); 2. To allow the marked voles to mix/distribute (randomly) through the population;	**2** (1 × AO1) (1 × AO2)	1. **Ignore** 'does not harm the vole' unless linked to survival/predation 1. **Ignore** 'so the mark is not lost' 2. **Ignore** births, deaths, immigration and emigration 2. **Accept** 'to spread out' for distribute

Question	Marking guidance	Mark	Comments
06.3	1. No births, deaths, immigration or emigration between the two samples; 2. Marked voles mix/distribute randomly with the unmarked voles; 3. Marks are not lost OR the clipped fur does not grow back between samples; 4. Marking does not affect survival OR marked and unmarked voles are equally likely to be caught;	**2 max** (2 × AO1)	1. **Accept** 'the population size does not change between samples' OR 'closed population' 2. Must refer to mixing/distribution, not to the chance of capture 4. **Accept** 'every vole has an equal chance of being caught' **Ignore** 'the sample is large'

Question	Marking guidance	Mark	Comments
06.4	1. Fewer marked voles would be caught in the second sample (than if they behaved normally); 2. So the estimate would be too high/an overestimate (because the number marked in the second sample is the divisor);	**2** (2 × AO3)	2. **Accept** 'population size would be overestimated' 2. No mark for 'overestimate' unless linked to fewer marked voles recaptured **Reject** 'fewer voles caught' unqualified for point 1

Question	Marking guidance	Mark	Comments
06.5	3;	**1** (1 × AO2)	Number marked in second sample = 60 × 45 ÷ 900 = 3

Succession 3.7.4

Question	Marking guidance	Mark	Comments
07.1	They are pioneer species, which can survive in the hostile conditions of bare rock;	**1** (1 × AO1)	

Question	Marking guidance	Mark	Comments
07.2	1. Pioneer species (lichens and mosses) colonise the bare rock/gravel; 2. (Pioneer) species change the abiotic environment: (when they die and decompose) they form soil/humus/organic matter (soil depth rises from 0 to 95 mm); 3. Nitrogen-fixing shrubs increase the nitrogen/nitrates in the soil/ground (from 1.5 to 41 g m^{-2}); 4. The environment becomes less hostile/more suitable for other species (with different adaptations), eg (larger) shrubs and trees; 5. New species out-compete earlier species OR change the environment so it is less suitable for earlier species (eg by shading); 6. Number of species/biodiversity increases (from 4 to 33);	**5 max** (4 × AO1) (1 × AO2)	**Max 4** if no data from Table 3 are used 1. **Reject** 'pioneers' or 'colonisers' without 'species' 2. The change must be caused by the organisms 4. **Accept** 'favourable' or 'less harsh' 4. **Ignore** 'more hospitable' or 'more habitable' 6. **Accept** species richness 6. **Ignore** genetic diversity **Reject** natural selection, evolution or speciation as the explanation of the changes

Question	Marking guidance	Mark	Comments
07.3	Correct answer for 2 marks: 1.0 (mm per year);; Accept for 1 mark: (95 − 8) ÷ (110 − 25) OR 87 ÷ 85 OR 1.02 (not to two significant figures)	**2** (2 × AO2)	0.86 (site 4 only) = 0 marks

Question	Marking guidance	Mark	Comments
07.4	1. Site 5 is (close to) the climax community OR site 5 is dominated by one species/spruce; 2. (Tall) spruce trees shade the ground, so less light (for photosynthesis) for smaller plants/other species; 3. Spruce out-compete other species (so light-demanding species/willow die out) OR interspecific competition (for light/water/nutrients);	**2 max** (2 × AO3)	**Max 1** if neither point 2 nor point 3 is given (a reason is needed for 2 marks) 3. 'Other species die out' alone is not enough; it must be linked to competition 1. **Reject** 'climax' alone 2. **Ignore** 'no light' **Reject** references to speciation, mutation or natural selection

Conservation and managing succession 3.7.4

Question	Marking guidance	Mark	Comments
08.1	1. Without management, succession continues (towards a climax community/woodland) OR birch trees shade out/out-compete the heather; 2. So heathland species (eg sand lizards) lose their habitat/niche; 3. Management (eg removing birch/grazing) stops succession at the heathland stage OR prevents the climax community from forming;	**2 max** (1 × AO1) (1 × AO2)	1. **Ignore** 'trees take over' unqualified 2. **Accept** 'biodiversity of heathland species falls' **Reject** references to evolution or natural selection

Question	Marking guidance	Mark	Comments
08.2	1. Grazing gave the lowest mean number of birch saplings (9 per 100 m^2); 2. But the standard deviations for grazing and cutting overlap, so there is no significant difference between them/the difference is probably due to chance; 3. Both grazing and cutting have far fewer saplings than no management, and the standard deviations do not overlap, so this difference is significant/probably not due to chance; 4. Only birch saplings were measured, not the effect on heather or on rare species (eg sand lizards) OR ponies might eat/trample heather or other heathland species; 5. Only 6 plots for each method OR only 5 years OR only one heathland; 6. Other factors, eg cost or practicality, are not known;	**4 max** (4 × AO3)	**Max 3** if no reference to standard deviation/error bars 2. **Accept** 'error bars overlap' 3. Must refer to the standard deviations/error bars not overlapping **Accept** SD for standard deviation **Ignore** 'no statistical test' unqualified

Question	Marking guidance	Mark	Comments
09.1	1. Cut (the reed bed) in rotation OR cut a different part each winter so each part is cut only once every 4 years; 2. This gives the most bittern nests (3.1 per 10 hectares) because tall/dense/older reed is always left for nesting; 3. Local people can still harvest some reed (260 bundles per hectare per year) OR provides an income/a sustainable supply of reed; 4. Cutting prevents succession OR stops willow colonising (2% compared with 35% willow when never cut), so the reed bed habitat is kept;	**3 max** (2 × AO2) (1 × AO3)	**Max 2** if no data from Table 4 are used **Accept** other suitable plans, eg cutting some areas every winter and others in rotation, if justified using the data 4. **Accept** 'stops the reed bed becoming woodland'

Question	Marking guidance	Mark	Comments
09.2	1. The never-cut plots in the second reed bed may not yet have dried out/been colonised by willow OR may have been left uncut for less time; 2. Differences in abiotic conditions, eg water depth/soil, between the reed beds; 3. Differences in food (eg fish/frogs) for bitterns between the reed beds; 4. Different length of rotation/cutting method in the second study; 5. Small numbers of nests/plots, so the difference could be due to chance;	**2 max** (2 × AO3)	**Ignore** 'different location' unqualified **Ignore** 'human error'

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