

Questions

Q1.

Grassland is an important habitat for grazing animals such as cattle.

Fields used for grazing cattle must have a high gross primary productivity.

State what is meant by the term gross primary productivity and include the units in which it is measured.

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(Total for question = 2 marks)

Q2.

Grassland is an important habitat for grazing animals such as cattle.

Cattle graze on the plants on grassland.

Describe what happens to the energy in the plants that are not eaten by cattle.

(2)

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(Total for question = 2 marks)

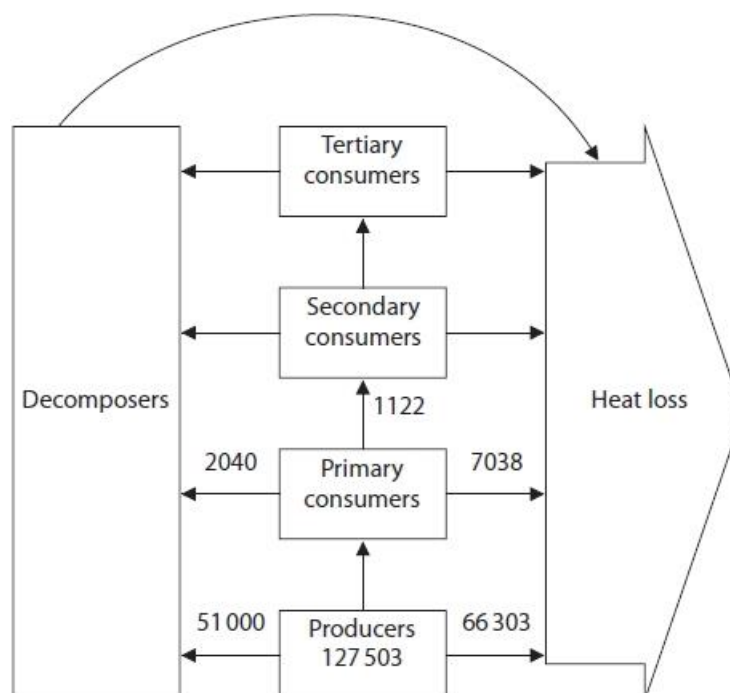
Q3.

The table shows information about one area of the North Atlantic Ocean.

Month	Mean hours of daylight / hr	Mean monthly temperature / °C	Net primary productivity (NPP) / g carbon m ⁻² day ⁻¹
January	9.0	2.8	-1.0
February	10.0	3.1	-1.2
March	11.0	6.7	-0.5
April	13.0	9.4	+3.0
May	14.0	15.5	+4.0
June	15.0	20.6	+8.0
July	14.0	23.9	+7.0
August	13.5	23.3	+7.0
September	12.0	21.1	+5.0
October	11.0	16.1	+4.0
November	10.0	11.1	+3.0
December	9.0	4.0	-1.2

The diagram shows some of the energy transfers through a food chain from this area.

The figures show the energy transfer in kJ m⁻² yr⁻¹.



(i) Calculate the percentage efficiency of energy transfer from the producers to the primary consumers.

(2)

Answer

(ii) Explain why the efficiency of energy transfer differs between different trophic levels.

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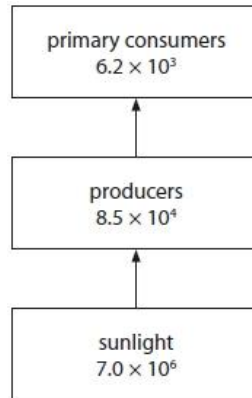
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(Total for question = 5 marks)

Q4.

The diagram shows the flow of energy in an ecosystem.

The numbers represent the energy in $\text{kJ m}^{-2} \text{yr}^{-1}$ in each category.



(i) Calculate the percentage efficiency of energy transfer from sunlight to the producers.

(2)

Answer %

(ii) Give one reason why the energy transfer from sunlight to the producers is less than 100% efficient.

(1)

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(iii) Explain the energy difference between the producers and the primary consumers.

(2)

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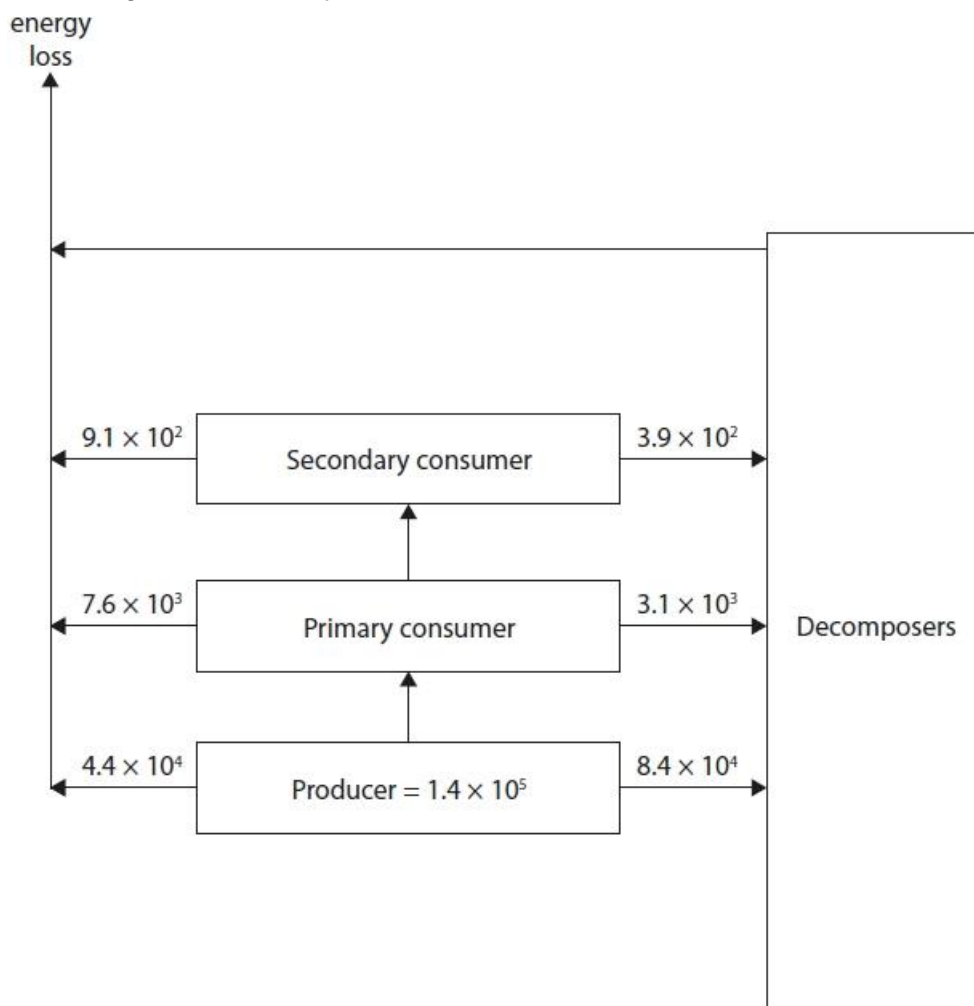
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(Total for question = 5 marks)

Q5.

(i) The diagram shows the transfer of energy through a grassland food chain.

All values are given in $\text{kJ m}^{-2} \text{yr}^{-1}$.

Calculate the percentage efficiency of the energy transfer from the producer to the primary consumer.

(2)

Answer

(ii) Explain the differences in the efficiency of energy transfer between the trophic levels in a food chain.

(3)

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(Total for question = 5 marks)

Q6.

Gilbert's potoroo is one of the most critically endangered species in the world.

Gilbert's potoroo was thought to be extinct until one was found in 1994.

It is thought that there are only 70 individuals.

The photograph shows a potoroo and its pouched baby feeding on berries.



The map shows the only part of Australia where Gilbert's potoroo is found.



The diet of Gilbert's potoroo is about 90% fungi.

Analysis has shown that the fungal spores are spread in the faeces of the potoroos.

These spores then germinate.

Explain the advantage to the ecosystem of fungal spores being spread by potoroos.

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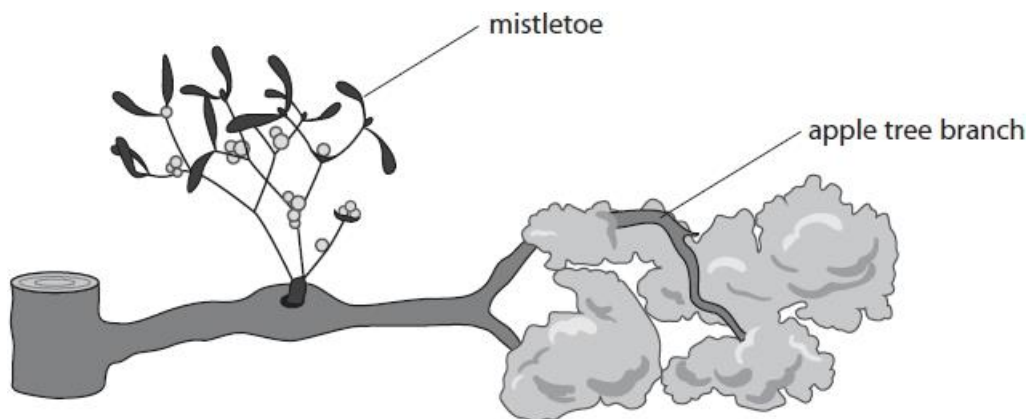
(Total for question = 2 marks)

Q7.

*Mistletoe is a plant that is a parasite on trees.

Mistletoe has green leaves. Mistletoe also has a modified root that grows into the xylem of a tree.

The diagram shows mistletoe growing on an apple tree branch.



The effect of mistletoe on the growth of apple trees was investigated.

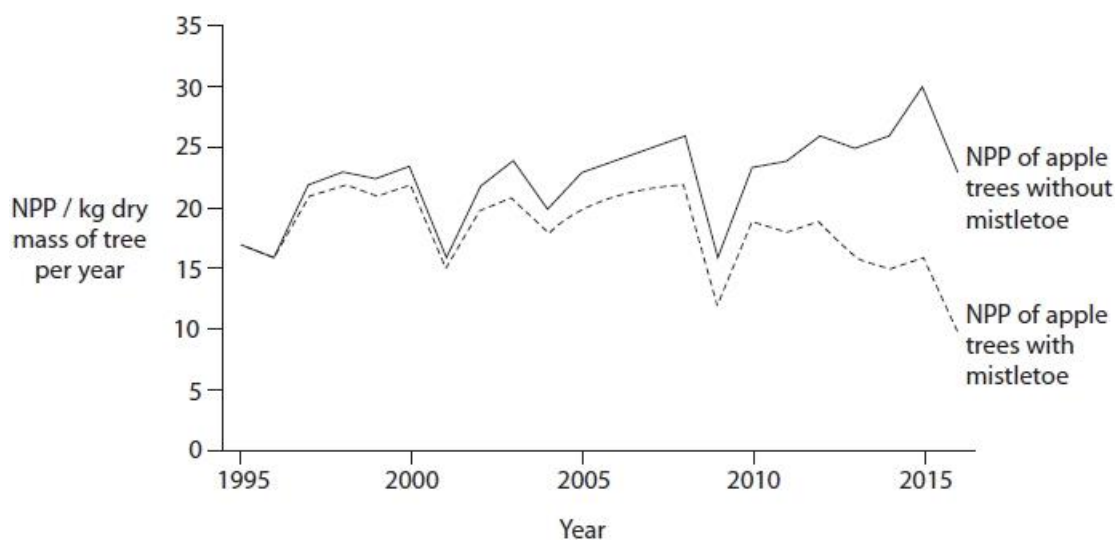
Every year for 20 years, scientists selected apple trees infected with mistletoe and measured the:

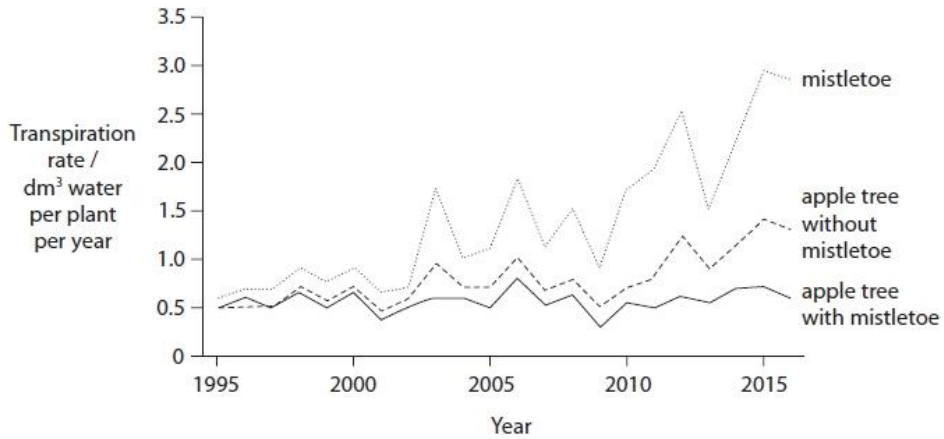
- mean net primary productivity (NPP) of the apple trees
- transpiration rate of the apple trees
- transpiration rate of the mistletoe branches on the apple trees

They also determined the mineral content of the apple tree leaves after 20 years.

A control group of apple trees not infected with mistletoe was included in this investigation.

The graphs and table show the results of the investigation.





Apple tree leaves from	Nitrogen content / mg per g of leaf	Calcium content / mg per g of leaf
trees infected with mistletoe	8.50	6.45
trees not infected with mistletoe	10.60	8.90

Analyse the data to explain the effect of mistletoe on the NPP of apple trees.

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(Total for question = 6 marks)

Q8.

The table shows information about one area of the North Atlantic Ocean.

Month	Mean hours of daylight / hr	Mean monthly temperature / °C	Net primary productivity (NPP) / g carbon m ⁻² day ⁻¹
January	9.0	2.8	-1.0
February	10.0	3.1	-1.2
March	11.0	6.7	-0.5
April	13.0	9.4	+3.0
May	14.0	15.5	+4.0
June	15.0	20.6	+8.0
July	14.0	23.9	+7.0
August	13.5	23.3	+7.0
September	12.0	21.1	+5.0
October	11.0	16.1	+4.0
November	10.0	11.1	+3.0
December	9.0	4.0	-1.2

(i) State what is meant by the term **net primary productivity** (NPP).

(1)

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(ii) Analyse the data to explain the effect of daylight and temperature on NPP.

(3)

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(Total for question = 4 marks)

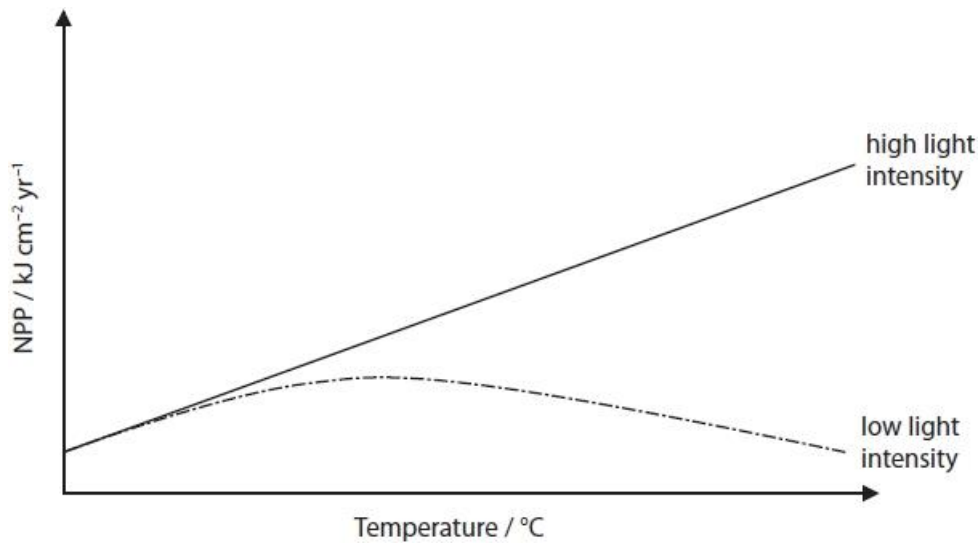
Q9.

The effects of light intensity and temperature on the net primary productivity (NPP) of young willow trees were investigated.

Young willow trees were grown in two greenhouses: one with high light intensity and one with low light intensity.

In each greenhouse, groups of these willow trees were kept at different temperatures for six months.

The results are shown in the graph.



(i) State what is meant by the term net primary productivity.

(1)

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(ii) Explain why temperature has different effects on NPP at these two light intensities.

(2)

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(Total for question = 3 marks)

Mark Scheme

Q1.

Question Number	Answer	Additional Guidance	Mark
	<p>An answer that includes the following</p> <ul style="list-style-type: none"> the rate at which producers make organic material (by photosynthesis) / <p>the rate at which light energy is incorporated into organic matter (by plants / producers) /</p> <p>rate at which carbon is fixed into organic matter (by photosynthesis) (1)</p> <ul style="list-style-type: none"> suitable units of biomass per area per time or energy per area per time (1) 	<p>Accept organic matter / carbon compounds/ biomass Accept plants / autotrophs</p> <p>Do not accept: energy produced Accept energy converted / turned into</p> <p>Accept eg $\text{g m}^{-2} \text{year}^{-1}$, $\text{kg m}^{-2} \text{year}^{-1}$, $\text{kJ m}^{-2} \text{year}^{-1}$ $\text{g (of carbon) m}^{-2} \text{year}^{-1}$ Accept cm^{-2} or min^{-1} as units Accept m^3</p>	Exp (2)

Q2.

Question Number	Answer	Additional Guidance	Mark
	<p>A description that includes two of the following:</p> <ul style="list-style-type: none"> (energy passes) to other animals (1) (energy remains) in plant biomass (1) (energy) released in respiration (in plants) (1) 	<p>Accept eaten by insects / rabbits etc</p> <p>Accept plants grow / energy stored in plants (remain in the field and) broken down by decomposers remains in humus in the soil</p> <p>Accept lost as heat from respiration used for active transport / other correct metabolic processes</p>	Exp (2)

Level	Marks	
0	0	No awardable content
1	1-3	<p>Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made.</p> <p>Vague statements related to consequences are made with limited linkage to a range of scientific ideas, processes, techniques and procedures.</p> <p>The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context</p>
2	4-6	<p>Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts.</p> <p>Consequences are discussed which are occasionally supported through linkage to a range of scientific ideas, processes, techniques and procedures.</p> <p>The discussion shows some linkages and lines of scientific reasoning with some structure.</p>
3	7-9	<p>Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts.</p> <p>Consequences are discussed which are supported throughout by sustained linkage to a range of scientific ideas, processes, techniques or procedures.</p> <p>The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.</p>

Q3.

Question Number	Answer	Additional Guidance	Mark
(i)	<p>An answer that makes reference to the following:</p> <ul style="list-style-type: none"> • add losses and subtract from 12 (1) • calculate percentage (1) 	<p>Correct answer gains full marks Correct answer: 8%</p> $127\,503 - 117\,303 = 10\,200$ $(10\,200 \div 127\,503) \times 100 = 8(\%)$ <p>If answer wrong award one mark for 10 200 or division by 127 503 x 100</p>	(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	<p>An explanation that makes reference three of the following:</p> <ul style="list-style-type: none"> • different {organisms / trophic levels} {use / lose} different proportions of energy (1) <p>and two from:</p> <ul style="list-style-type: none"> • because of respiration for {movement / maintaining body temperature} (1) • because of material that is not digested (1) • because some parts are not consumed (1) • because some is lost due to excretion (1) 	<p>ACCEPT different {organisms / trophic levels} {use / lose} energy in different ways</p> <p>ACCEPT heat loss</p> <p>ACCEPT material is lost as faeces</p> <p>ACCEPT shedding of skin</p>	(3)

Q4.

Question Number	Answer	Additional Guidance	Mark
(i)	<p>An explanation that makes reference to the following:</p> <p>divide energy in producers by energy in sunlight (1)</p> <p>multiply by 100 (1)</p>	<p>$85\,000 \div 7\,000\,000$</p> <p>$\times 100 = 1.21$</p> <p>Correct answer gains full marks, with no working shown.</p>	(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	<p>An answer that makes reference to one of the following:</p> <ul style="list-style-type: none"> light reflected (from leaf) (1) light misses {chloroplast / chlorophyll} (1) only certain wavelengths absorbed (1) 	<p>Accept transmitted / not absorbed by {chloroplast / chlorophyll}</p> <p>Accept limiting factors eg lack of CO₂, water etc may reduce rate</p>	(1)

Question Number	Answer	Additional Guidance	Mark
(iii)	<p>An explanation that makes reference to two of the following:</p> <ul style="list-style-type: none"> because some of the energy is lost through {respiration / heat / movement} (1) some of the producers not eaten (1) some of the producers not digested (1) 		(2)

Q5.

Question Number	Answer	Additional Guidance	Mark
(i)	<ul style="list-style-type: none"> correct calculation of energy in primary consumers(1) correct calculation of percentage efficiency of energy transfer (1) 	$1.2 \times 10^4 / 12000$ $(1200 / 14000) \times 100 = 8.6$ % Allow 8.57	2
(ii)	An explanation that makes reference to three from: <ul style="list-style-type: none"> (large amounts of) energy from producers is not transferred to primary consumers as producers have more {indigestible parts / inedible parts / parts not consumed}(1) animals / primary consumers / secondary consumers have higher respiration rates than producers (1) as more energy lost in {movement / heat loss} (1) animals / primary consumers / secondary consumers lose more energy as {urea / excretion}(compared with producers) (1) 	Allow more faeces released when consuming producers Allow different organisms have different amounts of indigestible /inedible parts Allow different organisms have different respiration rates Allow organisms have different levelof movement /heat loss	3

Q6.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to two of the following: <ul style="list-style-type: none"> fungi colonise new areas (1) fungi cause decomposition (1) so mineral ions are recycled within the ecosystem (1) 		(2)

Q7.

Question Number	Indicative content
*	<p>Answers will be credited according to candidate's deployment of knowledge and understanding of material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <ul style="list-style-type: none"> • mistletoe lowers the NPP of apple trees over time (D) • NPP of trees without mistletoe shows an upward trend over 20 years (D) • NPP of trees with mistletoe shows a downward trend over 20 years (D) • mistletoe decreases the transpiration rate of the trees (D) • mistletoe has a higher transpiration rate than the apple tree (D) • higher transpiration rate of mistletoe diverts transpiration stream to mistletoe rather than apple tree / mistletoe takes the water from apple tree (E) • so less minerals are given to the apple tree (E) • less water for photosynthesis (E) <ul style="list-style-type: none"> • nitrogen content of apple trees is lower (D) • less amino acid / protein synthesis occurs (E) • less enzyme production so less photosynthesis (E) • lowering NPP (due to less enzymes) (E) • less nucleic acid synthesis (E) • less chlorophyll synthesis (E) <ul style="list-style-type: none"> • calcium content of the apple trees is lower (D) • so there is less production of cell walls / calcium pectate (E) <p>Level 1: one or two D or E Level 2: three or four from both D and E Level 3: five or six from both D and E, must explain effect of either low nitrogen / calcium and have no major errors</p>

Level	Marks	
Level	Marks	
0	0	No awardable content
1	1-2	<p>An explanation may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just one piece of scientific information.</p> <p>The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.</p>
2	3-4	<p>An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information.</p> <p>The explanation shows some linkages and lines of scientific reasoning with some structure.</p>
3	5-6	<p>An explanation is made which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information.</p> <p>The explanation shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.</p>

Q8.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes reference to one of the following: gross primary productivity – respiration OR {energy / biomass} in producers which transfers to {next trophic level / primary consumers}	ACCEPT GPP – R	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to three of the following: <ul style="list-style-type: none"> NPP increases as daylight and temperature increase (1) because photosynthesis is greater than respiration (1) NPP falls if respiration rate rises more than photosynthesis rate / GPP (1) light is limiting factor (of photosynthesis) between {June and July / December and January} (1) 	ACCEPT converse ACCEPT NPP is negative if the rate of respiration exceeds GPP / NPP is negative when respiration is greater than photosynthesis ACCEPT other correct examples of where light is a limiting factor	(3)

Q9.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes reference to the following <ul style="list-style-type: none"> {gross primary productivity / total energy fixed by photosynthesis} minus energy released from {respiration / metabolism} 	Accept energy available to other organisms / next trophic level Accept $NPP = GPP - R$ / $GPP - R$	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	<p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none">• (at high light intensities) as temperature increases NPP increases because light is not limiting photosynthesis (1)• (at low light intensities) as temperature increases NPP decreases because respiration increases more than photosynthesis (1)	<p>Accept increasing temperature increases rate of photosynthesis more than respiration</p> <p>Accept photosynthesis rate {does not increase / is limited by light} but respiration rate does increase</p>	(2)