

PEARSON EDEXCEL A-LEVEL BIOLOGY B • 9B10

BIOLOGY



EXAM QUESTION PACK

TOPIC 10: ECOSYSTEMS

ENERGY TRANSFER THROUGH ECOSYSTEMS

SCORE

/66

PERCENTAGE

%

STEMUP

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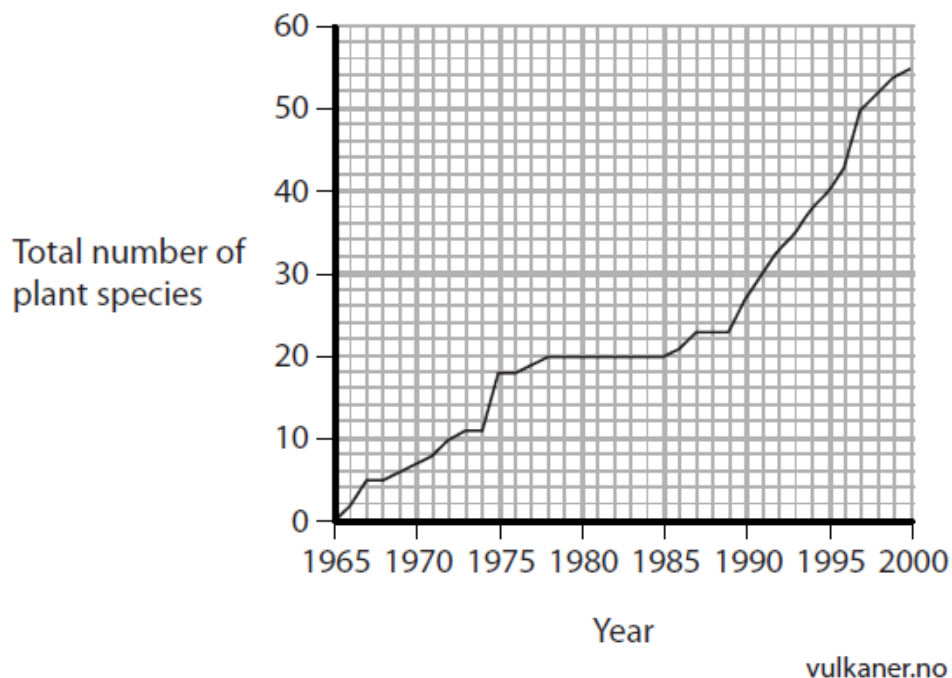
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Q1.

The scientists recorded the number of different plant species on the island each year from 1965 to 2000.

The number of new plant species present at each survey was recorded.

The graph shows the total number of plant species that have been found on the island.



A few groups of one species of seagull arrived on the island in 1974.

In 1985 a large group of a different species of seagull, the black-backed gull, arrived on the island.

Comment on the effects of these two species of seagull on the number of plant species.

(4)

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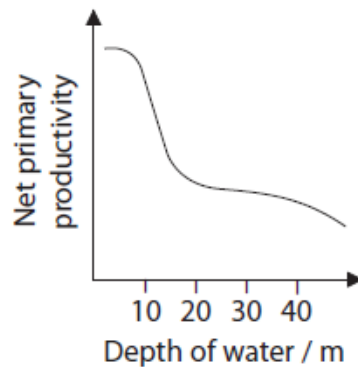
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Q2.

The graph below shows how the depth of water in a freshwater lake affects the net primary productivity (NPP).



Place a cross ☐ in the box next to the equation that describes the relationship between NPP, gross primary productivity (GPP) and respiration (R).

(1)

- ☐ **A** $GPP = R - NPP$
- ☐ **B** $NPP = GPP - R$
- ☐ **C** $NPP = GPP + R$
- ☐ **D** $R = GPP + NPP$

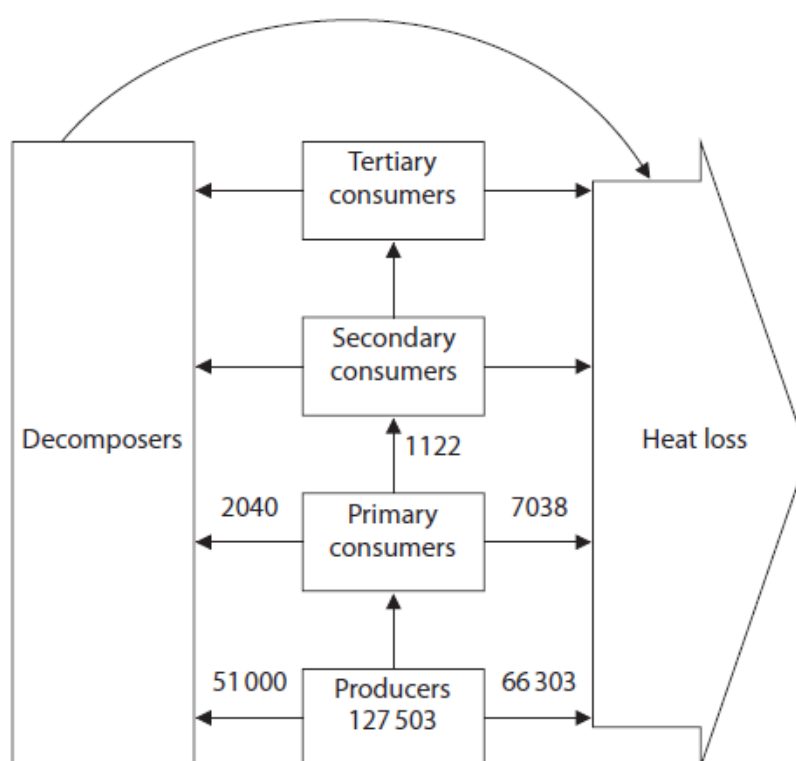
Q3.

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.

(3)

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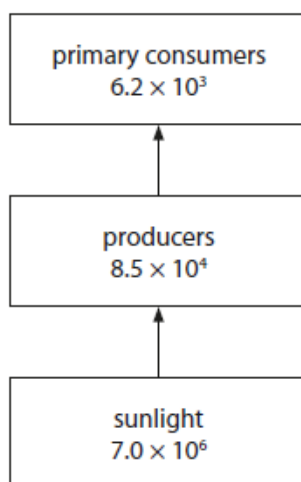
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(Total for question = 5 marks)

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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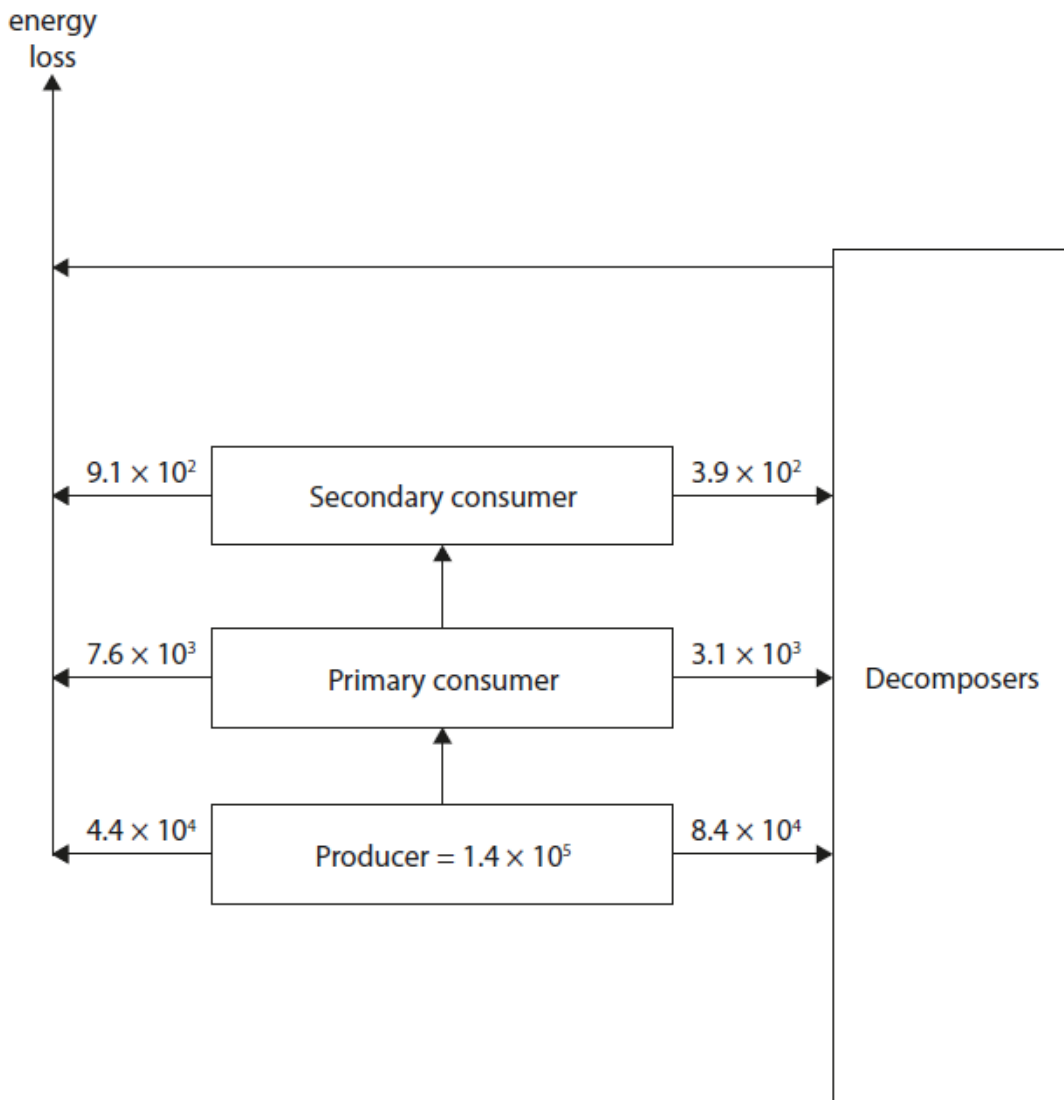
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(Total for question = 5 marks)

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.

(2)

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(Total for question = 2 marks)

Q7.

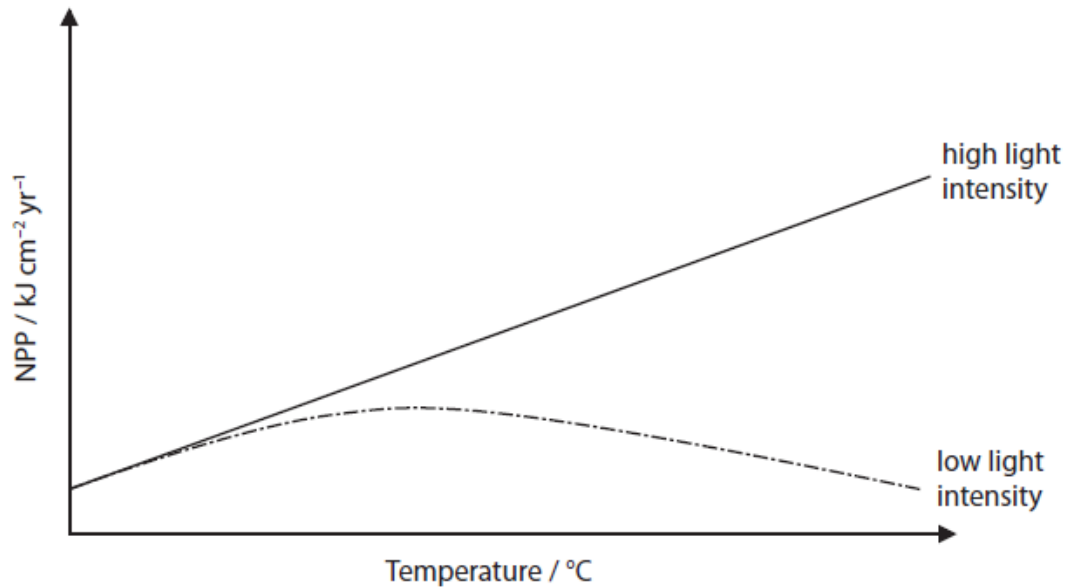
The effects of light intensity and temperature on the net primary productivity (NPP) of young willow trees were investigated.

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.



* In a further investigation, succession was monitored for fifty years in an abandoned field.

The field was originally used to grow crops.

After fifty years, large numbers of coniferous trees were growing in the field.

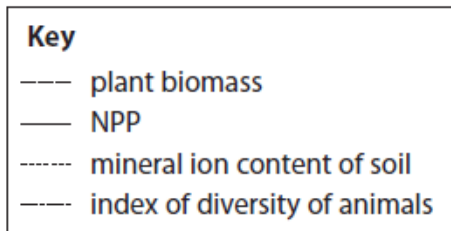
These coniferous trees do not shed many leaves.

When compared with younger trees, older coniferous trees have a much higher proportion of tree stem, branches and roots and a lower proportion of leaves.

The following factors were monitored:

- plant biomass
- NPP
- mineral ion content of soil
- index of diversity of animals

The line graphs show the trends that happened over fifty years for each of the factors.



(6)

[illegible]

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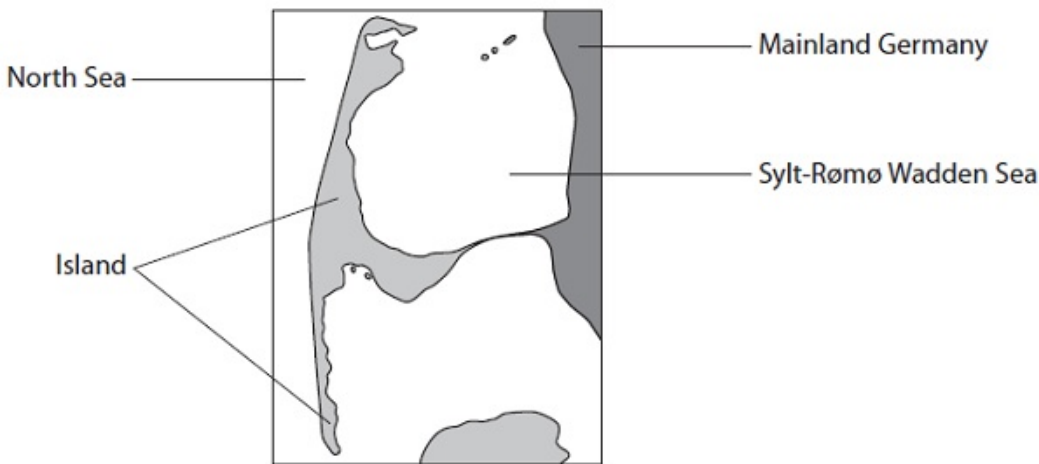
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(Total for question = 6 marks)

Q8. The Sylt-Rømø Wadden Sea, shown in the diagram below, has a high gross primary productivity (GPP) which is monitored constantly.

The Sylt-Rømø Wadden Sea is protected from the North Sea by an island.

There are no large rivers flowing into the Sylt-Rømø Wadden Sea.



(a) Explain the meaning of the term **gross primary productivity (GPP)**.

(2)

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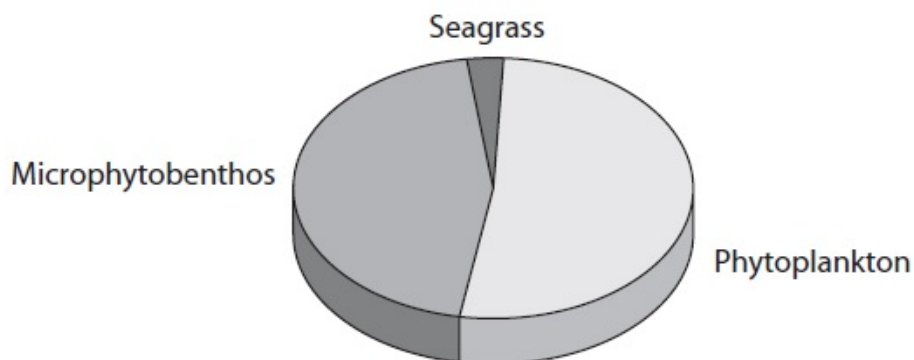
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(b) Seagrass, microphytobenthos and phytoplankton are the producers found in the Sylt-Rømø Wadden Sea.

The chart below shows the distribution of GPP between these producers.



(i) Using the chart, describe the distribution of GPP in this sea.

(2)

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(ii) The total GPP for this sea is $840 \times 10^6 \text{ kJ m}^{-2} \text{ y}^{-1}$.

Explain how GPP for the phytoplankton could be calculated.

(2)

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(iii) Suggest why GPP for this sea is very high.

(2)

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(c) Explain why net primary productivity (NPP) is lower than GPP.

(2)

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(Total for Question = 10 marks)

Q9.

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.

(2)

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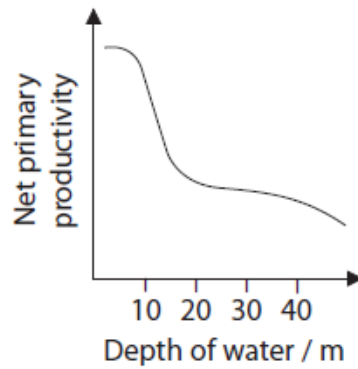
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(Total for question = 2 marks)

Q10.

The graph below shows how the depth of water in a freshwater lake affects the net primary productivity (NPP).



Place a cross ☒ in the box next to the units that should appear on the y-axis of this graph.

(1)

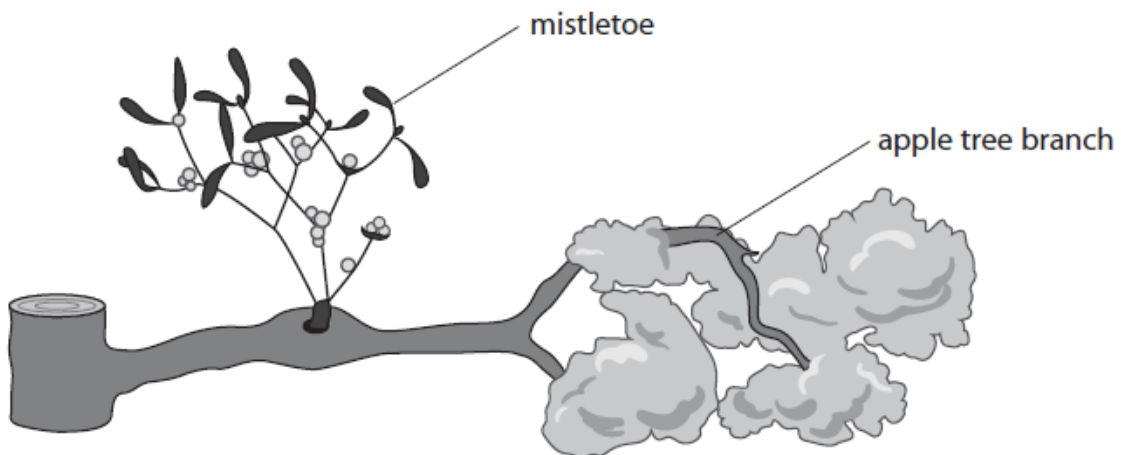
- ☐ **A** kg
- ☐ **B** kJ m^{-1}
- ☐ **C** $\text{kJ m}^{-2} \text{year}^{-1}$
- ☐ **D** $\text{kg m}^{-1} \text{year}^{-1}$

Q11.

*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

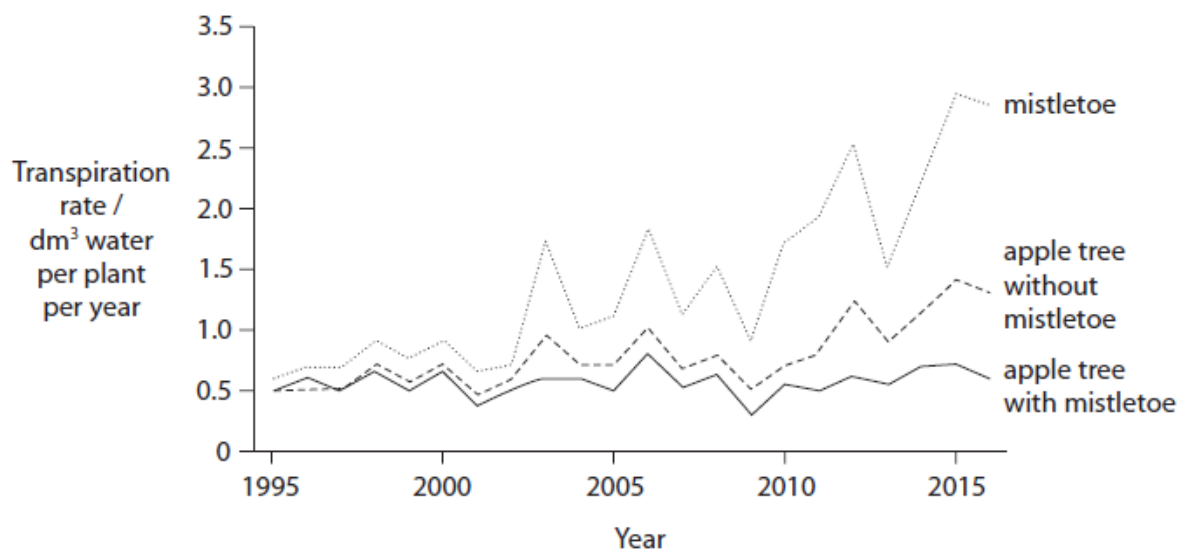
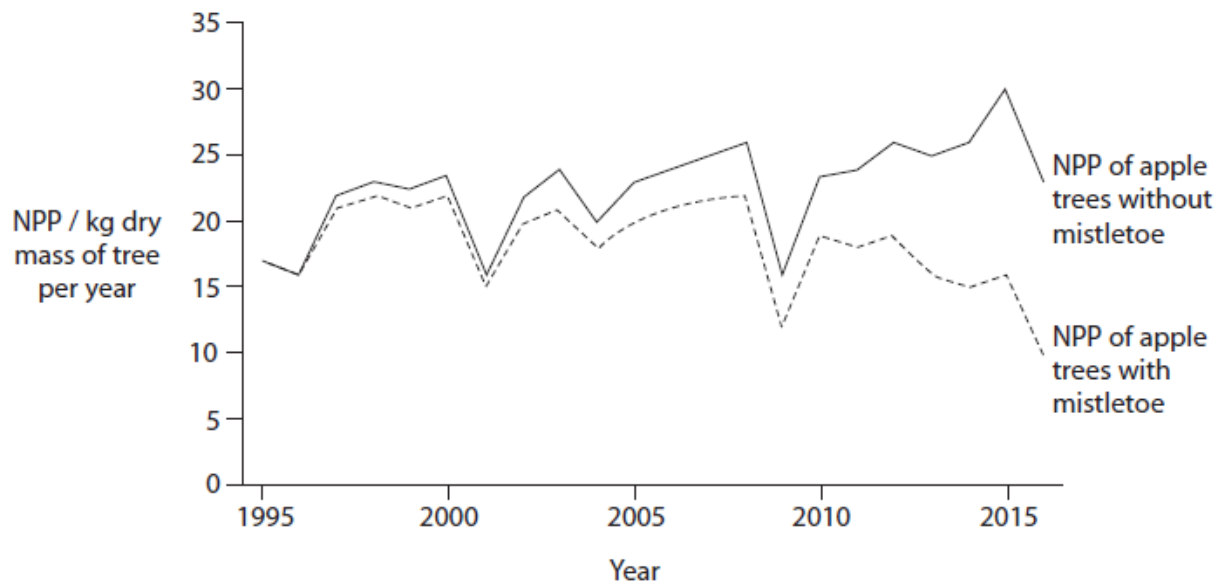
the:

- 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.

[illegible]

(Total for question = 6 marks)

Q12.

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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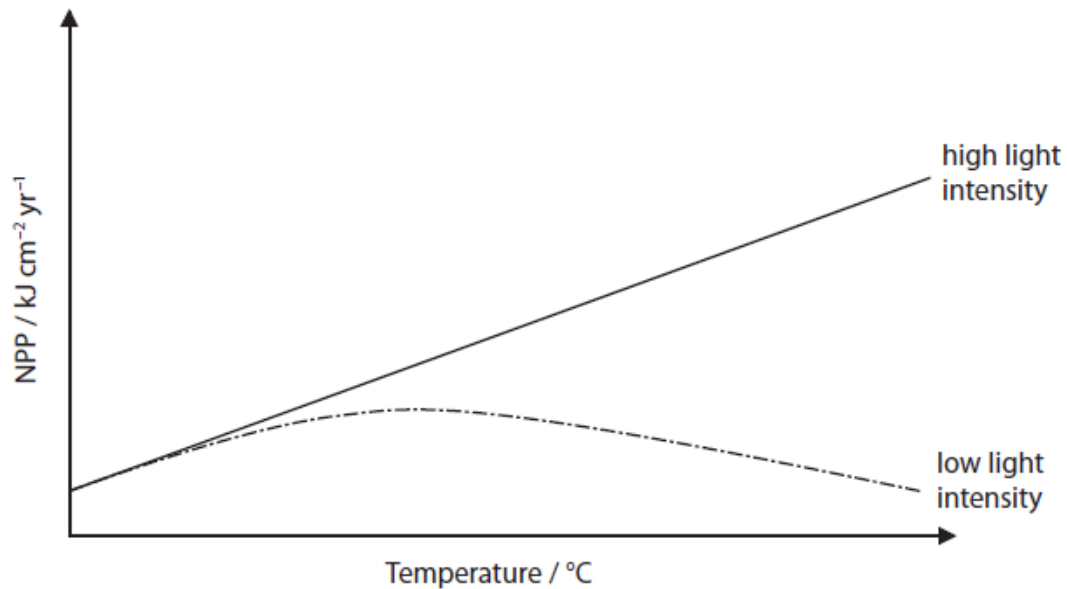
Q13.

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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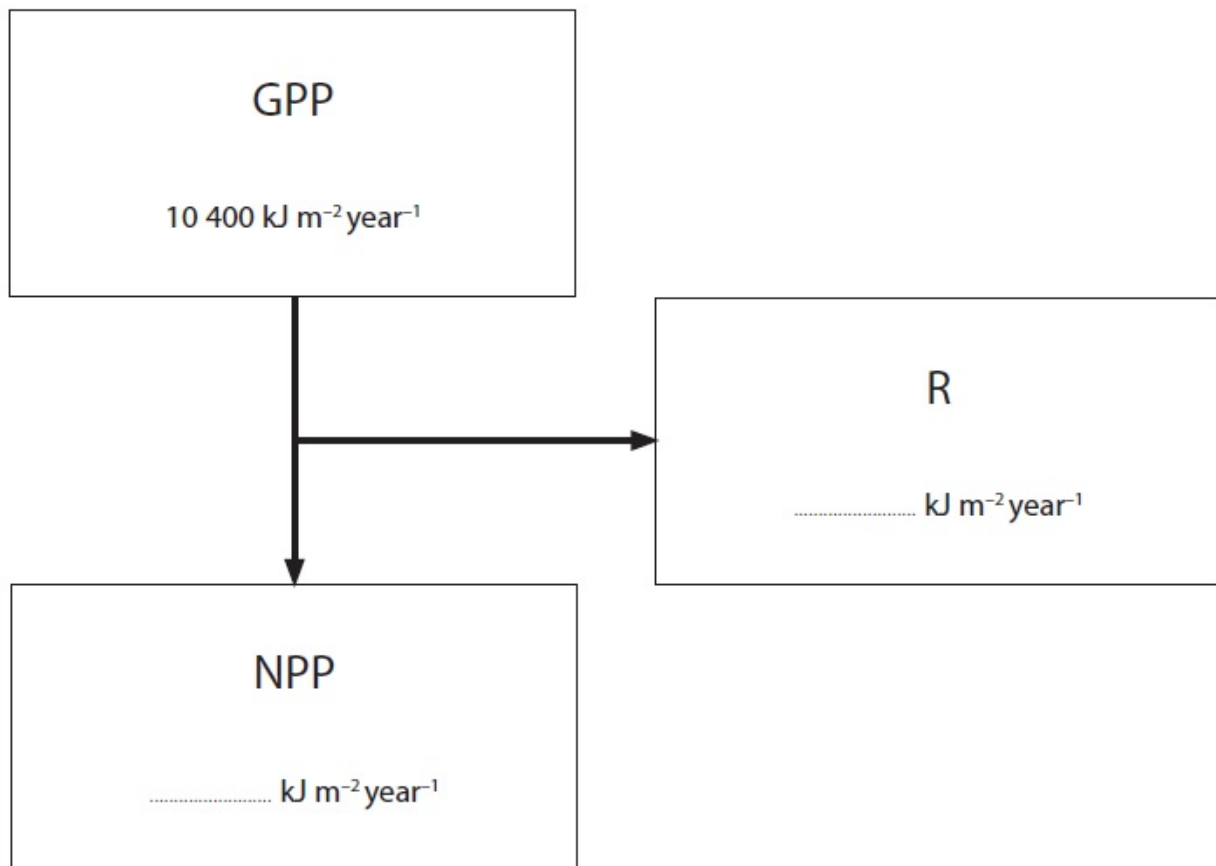
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(Total for question = 3 marks)

Q14. Farmers find it helpful to know the productivity of their land.

The diagram below shows the relationship between GPP (gross primary productivity), NPP (net primary productivity) and R (plant respiration) for an area of grassland.



(a) The efficiency of the transfer of energy from GPP to NPP for this grassland is 45%.

(i) Calculate the values for NPP and R. Write your answers in the diagram above.

(2)

(ii) Using the information given, explain the relationship between GPP and NPP.

(3)

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(b) Suggest why NPP values would be of use to a farmer who wanted to use this land for cattle.

(3)

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(c) The units ($\text{kJ m}^{-2} \text{ year}^{-1}$) used in the diagram show a rate of energy production. Suggest why this is more useful than measurements of biomass in the grassland on a particular day.

(2)

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(Total for Question = 10 marks)

Q15.

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)

Mark Scheme

Q1.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to four of the following: - increase in number of species in 1974 and increase in number of species after 1985 / 1989 (1) - no increase in number of species between 1978 and 1985 (1) - birds bring seeds (1) - birds release {waste / faeces / organic waste} containing minerals (1) - seagulls reduce number of herbivores / create new niches (1)	ACCEPT Number of species increases after both seagull species arrive	4

Q2.

Question Number	Answer	Mark
	B NPP = GPP - R	(1)

Q3.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes reference to the following: • add losses and subtract from 127 503 (1) • calculate percentage (1)	Correct answer gains full marks Correct answer: 8% $127\,503 - 117\,303 = 10\,200$ $(10\,200 \div 127\,503) \times 100 = 8(\%)$ If answer wrong award one mark for 10 200 or division by 127 503 x 100	(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference three of the following: • different {organisms / trophic levels} {use / lose} different proportions of energy (1) and two from: • 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)	ACCEPT different {organisms / trophic levels} {use / lose} energy in different ways ACCEPT heat loss ACCEPT material is lost as faeces ACCEPT shedding of skin	(3)

Q4.

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

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to one of the following: - light reflected (from leaf) (1) - light misses {chloroplast / chlorophyll} (1) - only certain wavelengths absorbed (1)	Accept transmitted / not absorbed by {chloroplast / chlorophyll} Accept limiting factors eg lack of CO₂, water etc may reduce rate	(1)

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to two of the following: - 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)	- 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: (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 levelsof movement /heat loss	3

Q6.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to two of the following: - fungi colonise new areas (1) - fungi cause decomposition (1) - so mineral ions are recycled within the ecosystem (1)		(2)

Q7.

Question Number	Indicative content
*	Answers will be credited according to candidates' deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. 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. <u>Succession (S):</u> • succession begins with seeds / roots (from previous crops etc), followed by herbaceous plants, shrubs and trees • increased plant diversity increases number of niches for animals, resulting in an increase in index of diversity • steep increase in diversity at approximately 20 years with herbaceous plants / shrubs providing high numbers of niches • index of diversity stabilises and then decreases as trees shade area • shade reduces herbaceous / shrub plant species reducing niche number and index of diversity <u>NPP (N):</u> • NPP increases as more herbaceous plants and shrubs with higher leaf areas grow • NPP reduces as the community ages due to increase in proportion of non-photosynthetic tissue (wood / roots) reducing photosynthesis rate compared to respiration rate • reduced mineral ion content due to lack of decay of leaves may reduce NPP <u>Mineral ions (M):</u> • starting mineral ions are low due to farming • mineral ions in soil increase with time due to humus / dead organic material from plants and animals • organic material is decomposed by microbes to release minerals • mineral ion content decreases in climax community as few leaves are dropped from pine trees so there is less decay

Level	Marks	Descriptor
0	0	No awardable content
1	1-2	Limited scientific judgement made with a focus on mainly just one method, with a few strengths/weaknesses identified. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made. Level 1: Description of succession (S) with little / no reference to graph
2	3-4	A scientific judgement is made through the application of relevant evidence, with strengths and weaknesses of each method identified. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made. Level 2: Explanation of succession (S) as shown in the graph linked to either N or M with some errors.
3	5-6	A scientific judgement is made which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information. A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made. Level 3: Detailed explanation of succession (S) as shown in the graph over 50 years using N and M with only minor errors.

Q8.

Question Number	Answer	Additional Guidance	Mark
(a)	1. (rate of) { energy incorporated into / production of / eq } {biomass / organic material} ; 2. in {plants / producers} ;	2. Accept from photosynthesis	(2)

Question Number	Answer	Additional Guidance	Mark
(b)(i)	1. very little GPP in seagrass / majority present in {microphytobenthos and phytoplankton / phytoplankton} ; 2. (roughly) equal distribution (of GPP) between microphytobenthos and phytoplankton ;	1. Accept only 2.5 to 5% in seagrass, 95% in micro and phyto, more than 50% or about 55% of phyto 2. Accept about 50% in each Accept idea that GPP in microphytobenthos is slightly lower than in phytoplankton	(2)

Question Number	Answer	Additional Guidance	Mark
(b)(ii)	1. idea of obtaining a value from the chart e.g. percentage, area, degrees, ratio ; 2. idea of how to use this to calculate GPP ;	Ignore units 1. Accept appropriate figures in range 50 – 55 % 2. Accept e.g. (percentage) multiplied by 8.4×10^6 NB $\frac{\text{angle} \times 840 \times 10^6}{360} = 2 \text{ marks}$ $\frac{\text{area of segment} \times 840 \times 10^6}{\text{area of circle}} = 2 \text{ marks}$	(2)

Question Number	Answer	Additional Guidance	Mark
(b)(iii)	1. {more / fast / high / eq} photosynthesis ; 2. water less {cloudy / churned up } / shallow water / high light penetration / eq ; 3. high {nutrient / carbon dioxide} levels in the sea / eq ; 4. {high / optimum} temperatures ; 5. high light intensity (in this area) / eq ; 6. idea of less respiration ;	2. Accept less current, less tidal	(2)
Question Number	Answer	Additional Guidance	Mark
(c)	1. $\text{NPP} = \text{GPP} - \text{R}$ / eq ; 2. energy lost as heat / eq ; 3. named use of energy (released by respiration);	1. Accept correct description in words 3. Accept e.g. movement, opening of flowers, glycolysis, metabolic processes	(2)

Q9.

Question Number	Answer	Additional Guidance	Mark
	An answer that includes the following - the rate at which producers make organic material (by photosynthesis) / the rate at which light energy is incorporated into organic matter (by plants / producers) / rate at which carbon is fixed into organic matter (by photosynthesis) (1) - suitable units of biomass per area per time or energy per area per time (1)	Accept organic matter / carbon compounds/ biomass Accept plants / autotrophs Do not accept: energy produced Accept energy converted / turned into Accept eg $\text{g m}^{-2} \text{year}^{-1}$, $\text{kg m}^{-2} \text{year}^{-1}$, $\text{kJ m}^{-2} \text{year}^{-1}$ g (of carbon) $\text{m}^{-2} \text{year}^{-1}$ Accept cm^{-2} or min^{-1} as units Accept m^3	Exp (2)

Q10.

Question Number	Answer	Mark
	C $\text{kJ m}^{-2} \text{year}^{-1}$	(1)

Q11.

Question Number	Indicative content
*	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. 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. - 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 an 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) - 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) - calcium content of the apple trees is lower (D) - so there is less production of cell walls / calcium pectate (E) 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

Level	Marks	
Level	Marks	
0	0	No awardable content
1	1-2	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. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.
2	3-4	An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows some linkages and lines of scientific reasoning with some structure.
3	5-6	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. The explanation shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer the 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: - 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)

Q13.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes reference to the following {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)	An explanation that makes reference to the following: • (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)	Accept increasing temperature increases rate of photosynthesis more than respiration Accept photosynthesis rate {does not increase / is limited by light} but respiration rate does increase	(2)

Q14.

Question Number	Answer	Additional Guidance	Mark
(a)(i)	NPP = 4680 ; R = 5720 ;	NB If there are no answers in the box, look for answers in the space below question If answers are the wrong way round, award 1 mark If both answers are wrong, accept R = 10168.9 / 10169	(2)

Question Number	Answer	Additional Guidance	Mark
(a)(ii)	1. NPP = GPP – R / eq ; 2. 55% (GPP energy) is lost / eq ; 3. energy lost as heat / eq ; 4. to provide energy for {active transport / any other named energy-requiring process} ; 5. NPP is {(stored) energy / energy available for next trophic level / eq} ;	Accept correct description in words eg movement (opening of flowers, turning of leaves), glycolysis Ignore idea that energy is used for respiration unqualified Accept biomass	(3)

Question Number	Answer	Additional Guidance	Mark
(b)	1. cattle {are primary consumers / herbivores / eat grass / eat plants / eq} ; 2. (therefore) gain energy (available as NPP) ; 3. idea of grazing capacity of the grassland ; 4. idea of affect on yield of {meat / milk / eq} ; 5. idea of changing to a more {efficient / NPP yielding} crop ;	Accept idea that farmer is ensuring that there is enough NPP available for his cattle Accept growth rate	(3)

Question Number	Answer	Additional Guidance	Mark
(c)	1. idea of variation over short periods of time; 2. idea that whole year gives an {average / overall / eq} value ; 3. idea that biomass includes {all / undigestible / inedible / eq} organic material ; 4. idea that rate of productivity may influence how much grazing is possible ;	eg more NPP on a sunny day, seasonal	(2)

Q15.

Question Number	Answer	Additional Guidance	Mark
	A description that includes two of the following: • (energy passes) to other animals (1) • (energy remains) in plant biomass (1) • (energy) released in respiration (in plants) (1)	Accept eaten by insects / rabbits etc Accept plants grow / energy stored in plants (remain in the field and) broken down by decomposers remains in humus in the soil Accept lost as heat from respiration used for active transport / other correct metabolic processes	Exp (2)

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