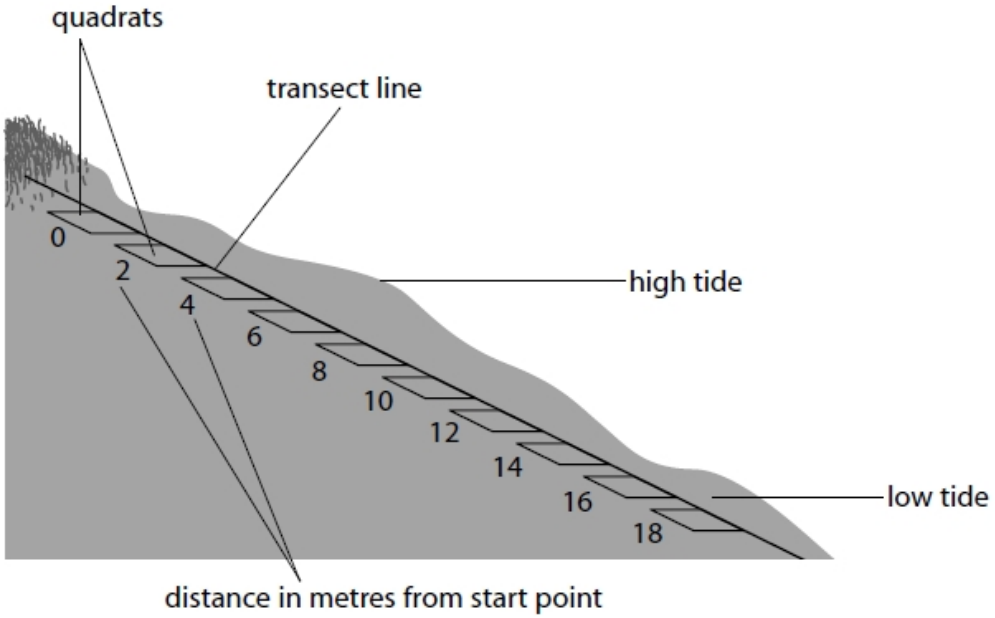
Q1.

The distribution and abundance of species on a rocky shore were investigated using a systematic sampling technique.

(a) The diagram shows the placing of the transect and quadrats on a rocky shore.



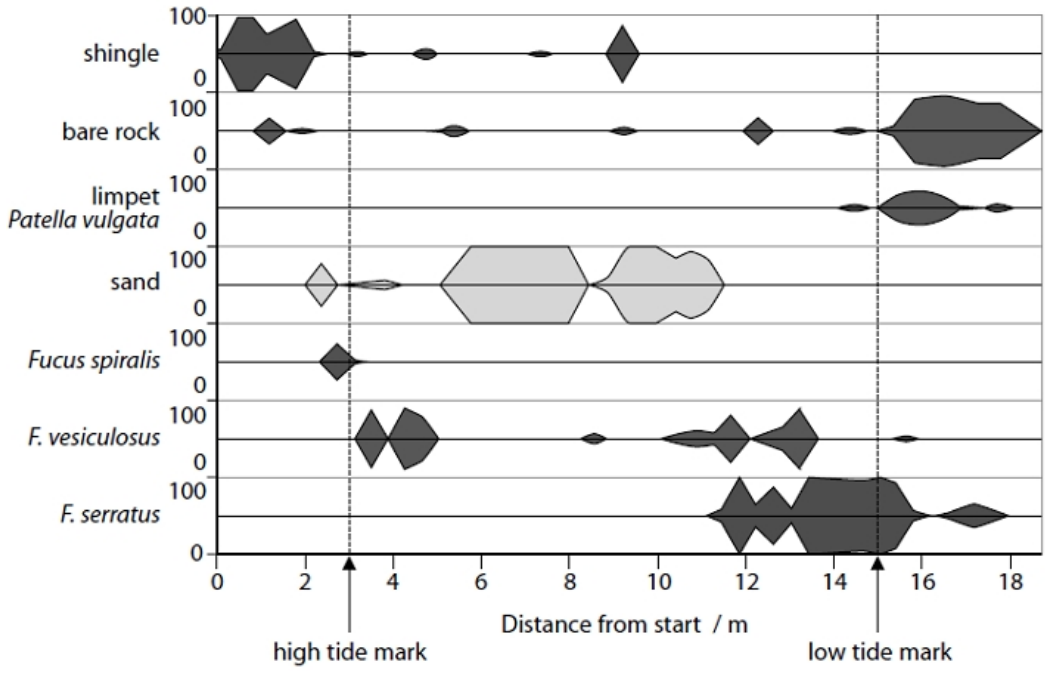
Not to scale

(i) Give a reason why systematic sampling, rather than random sampling, was used in this investigation. **(1)**

_____

_____

*(ii) The diagram shows the distribution of some of the abiotic and biotic components of a sea shore. There are three species of seaweed (*Fucus*) and one species of limpet (*Patella vulgata*). Limpets feed on seaweed.



Analyse the data to explain how the distribution patterns of *Fucus spiralis*, *Fucus vesiculosus* and *Fucus serratus* are affected by abiotic and biotic factors.

(6)

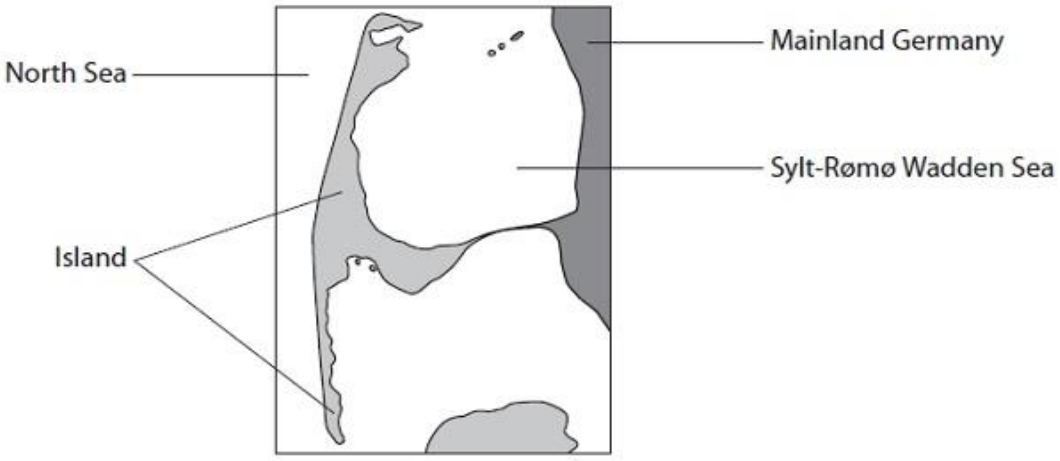
(Total for question = 7 marks)

Q2.

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)

_____

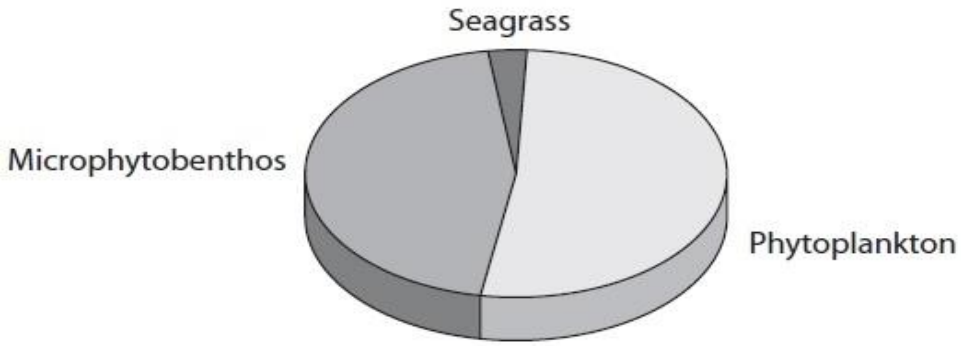
_____

_____

_____

(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)

_____

_____

_____

_____

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

Explain how GPP for the phytoplankton could be calculated.

(2)

_____

_____

_____

_____

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

(2)

_____

_____

_____

_____

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

(2)

_____

_____

_____

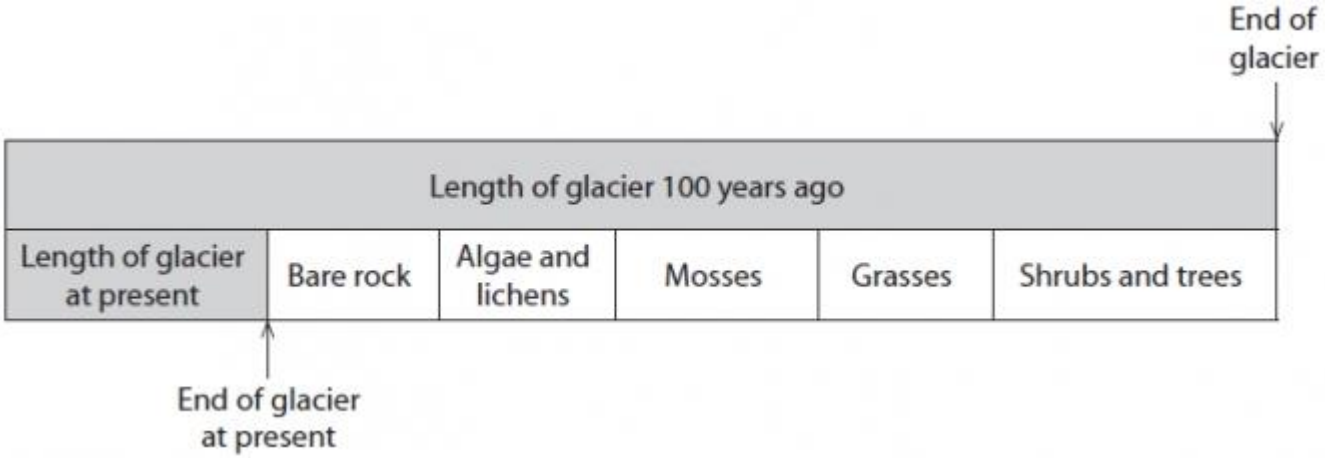
_____

(Total for Question = 10 marks)

Q3.

Glaciers are long, large masses of ice that formed thousands of years ago. As a result of warmer climates, more ice is melting. This is reducing the length of the glaciers. As a result, bare rock that was once covered by the glacier becomes exposed.

The diagram below shows the length of a glacier 100 years ago and the glacier at present. It also shows what is now found in a transect taken from where the front edge of the glacier is at present.



(a) Using the information in the diagram, describe and explain the changes in the distribution of organisms with distance from the front edge of this glacier.

(3)

(b) *Epilobium latifolium* is a plant that occupies a niche in an area once covered by this glacier. It is a short flowering plant that grows in clumps.

The photograph below shows three clumps of *Epilobium latifolium*.

Magnification ×0.2

(i) Explain what is meant by the term **niche**, using the plant *Epilobium latifolium* as an example.

(3)

(ii) Describe how to carry out a study of the distribution of *Epilobium latifolium* from the front edge of this glacier.

(4)

(iii) Suggest **one** abiotic factor that might affect the abundance of *Epilobium latifolium* and describe how this factor could be measured.

(3)

_____

_____

_____

_____

_____

_____

_____

_____

_____

(Total for question = 13 marks)

Q4.

Following the extraction of coal from the ground in the United Kingdom, the unwanted material was usually deposited in large heaps known as bings. Most of the material in a bing is shale fragments composed of minerals and clay.
There have been a number of studies of the colonisation and the development of plant communities on bings. In these studies, the approximate age of the bing can be estimated by reference to the type of plant community growing on the bing. This is shown in the table below.

Type of plant community	Approximate age of bing / years
Lichens and mosses	3 – 15
Grasses and small herbs	15 – 40
Grasses, small herbs and large herbs	40 – 70
Small trees and shrubs	60 – 80
Large trees, small trees and shrubs	80 – more than 100

(a) Place a cross ☒ in the box next to the mineral ion that would need to be present if plants, such as grasses and herbs, are to grow successfully on a bing.

(1)

- ☒ **A** Copper
- ☒ **B** Nitrates
- ☒ **C** Sodium
- ☒ **D** Sulphites

(b) Place a cross ☒ in the box that describes the gradual change in the type of plant community growing on a bing.

(1)

- ☒ **A** Endemism
- ☒ **B** Evolution
- ☒ **C** Phylogeny
- ☒ **D** Succession

*(c) Suggest why these scientists do not agree that a reduction in the use of fossil fuels will prevent further global warming.

(5)

_____

_____

_____

_____

_____

_____

_____

_____

_____

(d) After 100 years, the community on a bing becomes stable.
State the term used to describe this type of community and explain why it is stable.

(4)

_____

_____

_____

_____

_____

_____

_____

_____

_____

(Total for question = 11 marks)

Q5.

Clear areas with no trees can be found within many forests. These areas usually have communities of animals and plants which are different from those found in the wooded parts of the forest. These clear areas are maintained by the grazing of animals such as rabbits and deer.

(a) Describe what might happen to the clear areas in forests, over a long period of time, if the numbers of rabbits and deer decreased.

(3)

_____

_____

_____

_____

_____

_____

_____

(b) The butterfly *Boloria selene* (Small Pearl-bordered Fritillary) can be found in many of the clear areas of British forests.

Small Pearl-bordered Fritillary Magnification ×1.5

This butterfly lays its eggs on low-growing plants such as *Viola riviniana* (Dog Violet), on which the caterpillars feed when they hatch.

The adult butterflies feed on nectar from plants such as *Ajuga reptans* (Bugle) and other low-growing species.

Since the plants on which the butterfly depends are able to grow only in forest clearings, small reproductively-isolated populations of *B. selene* can be identified in many forests.

(i) The distribution of plants in a forest is affected by many abiotic factors.

Name **one** of these factors and suggest how this factor could affect the distribution of the low-growing plants within the clear areas of a forest.

(3)

(ii) Explain what is meant by the term **reproductively-isolated populations** of *B. selene*.

(3)

(iii) Suggest why it is unlikely that any individuals within a population of *B. selene* would survive if the numbers of rabbits and deer decreased.

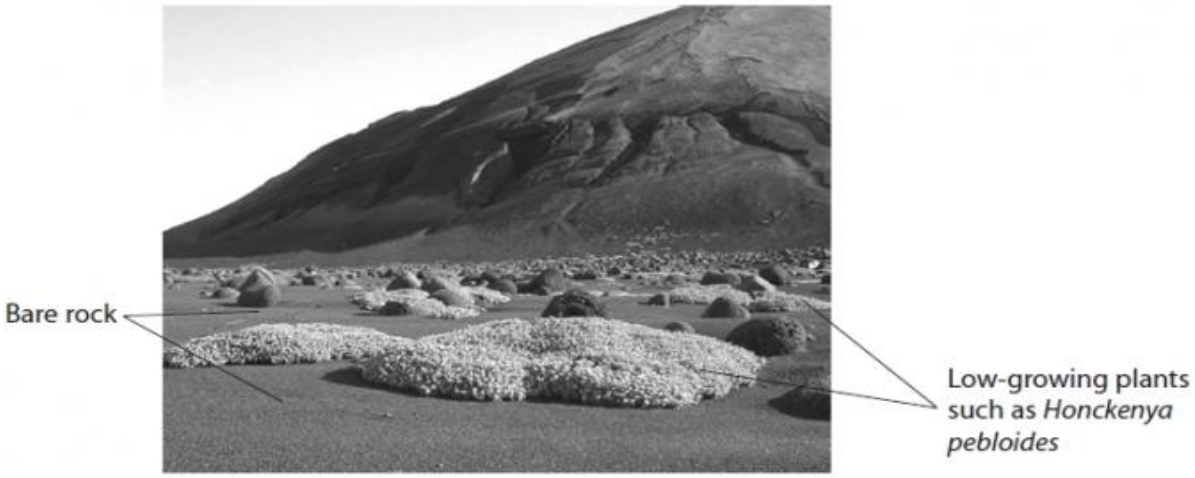
(3)

(Total for question = 12 marks)

Q6.

Surtsey is a newly-formed volcanic island. The volcanic eruption finished in 1967. The island is protected so that it can be used to study succession on volcanic islands.

The photograph below shows the plants on part of the island about 10 years after the island was formed.



(a) State what is meant by the term **succession**.

(1)

_____

_____

(b) Suggest how this part of the island may have appeared five years before and five years after this photograph was taken. Give reasons for your answer.

(4)

Five years before

_____

_____

_____

_____

Five years after

_____

_____

_____

_____

(c (i) Describe how to carry out a study to compare the distribution of *Honckenya pebloides* on two different parts of the island.

(4)

(ii) Water availability affects the distribution of *Honckenya pebloides*.

Describe how water availability could be investigated in these two parts of the island.

(2)

(d) In 1985, the lesser black-backed gull colonised this island.

A large increase in the number of species of plants was recorded after these birds colonised the island. Suggest an explanation for this increase in the number of species of plants.

(Total for question = 13 marks)

Q7.

Tropical rainforests play a role in maintaining biodiversity and in storing carbon.

In a mature tropical rainforest, there is no net increase in biomass.

(i) Which statement describes the role of photosynthesis in the carbon cycle?

(1)

- ☒ **A** carbon dioxide is oxidised to form organic molecules
- ☒ **B** carbon dioxide is reduced to form organic molecules
- ☒ **C** organic molecules are combusted to produce carbon dioxide
- ☒ **D** organic molecules are decomposed to release carbon dioxide

(ii) The gross primary productivity (GPP) for one mature tropical rainforest was found to be 24 800 kJ m^{-2} $year^{-1}$. It was estimated that 65% of GPP was used in respiration.

Calculate the energy transferred to the next trophic level.

(2)

..... kJ m^{-2} $year^{-1}$

Q8.

The distribution and abundance of an organism within its habitat can be influenced by both abiotic and biotic factors.
(a) Explain the difference between **abiotic** and **biotic** factors.

(1)

_____

_____

_____

(b) Periwinkles are similar to snails and are one of the common invertebrates found on many seashores around Britain. A study of the distribution of two species of periwinkle, *Littorina littorea* and *Littorina obtusata*, was carried out.
Areas of a sloping seashore were selected at different heights above sea level. Within each of these areas, the mean density (individuals per m^2) of each of the periwinkle species was recorded.

(i) Place a cross ☒ in the box next to the name of the most suitable piece of apparatus for obtaining the data for the density of the periwinkles.

(1)

- ☒ **A** quadrant
- ☒ **B** quadrat
- ☒ **C** quadrille
- ☒ **D** quartile

*(ii) Explain how this piece of apparatus would be used to obtain the mean density of the two species of periwinkle in each area.

(3)

_____

_____

_____

_____

_____

_____

(iii) Suggest **one** abiotic factor and **one** biotic factor that may influence the distribution of the periwinkles on the seashore.

(2)

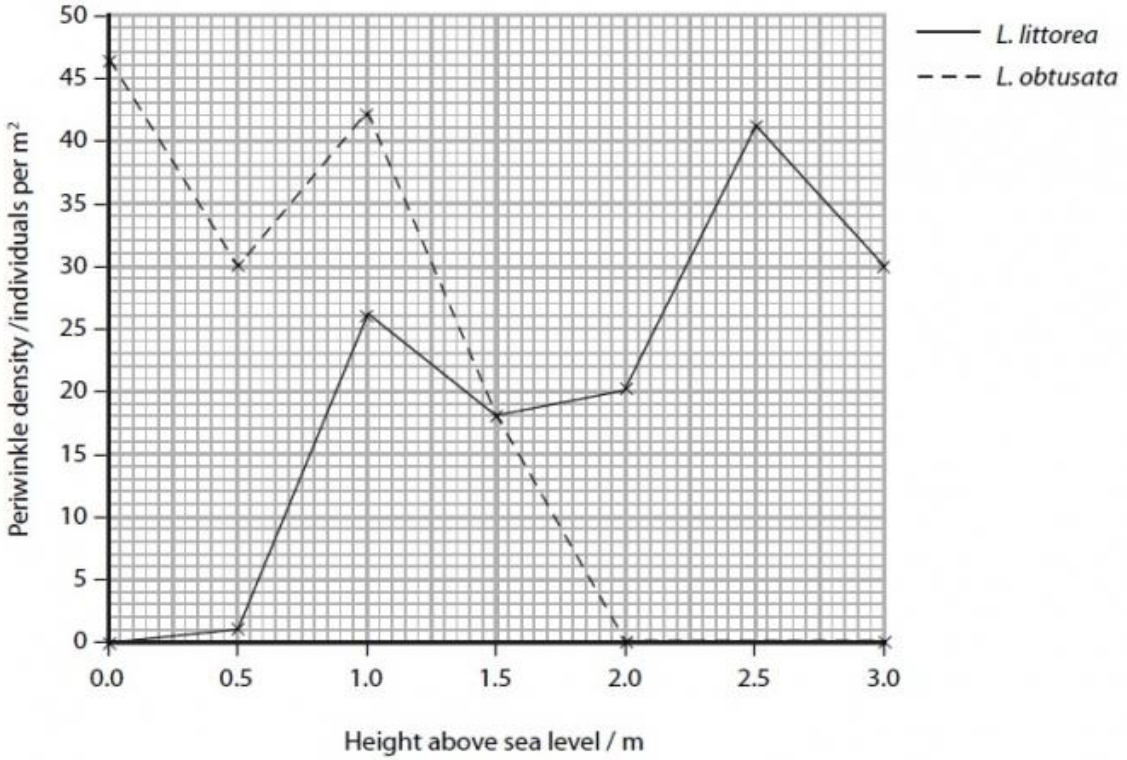
Abiotic

_____

Biotic

_____

(iv) The results of this study into periwinkle density are shown in the graph below.



The three statements below show the conclusions recorded by different students following the seashore study of periwinkles.
Place a cross ☒ in the box next to one statement that could form a valid conclusion using the information shown in the graph opposite.

(1)

☐ **A** All periwinkles are affected by the height above sea level

☐ **B** The height above sea level influences the distribution of different species of periwinkle

☐ **C** Neither of the species of periwinkle is affected by the height above sea level

(v) With reference to the data in the graph, discuss the validity of statements **A**, **B** and **C**.

(4)

_____

_____

_____

_____

_____

_____

_____

_____

_____

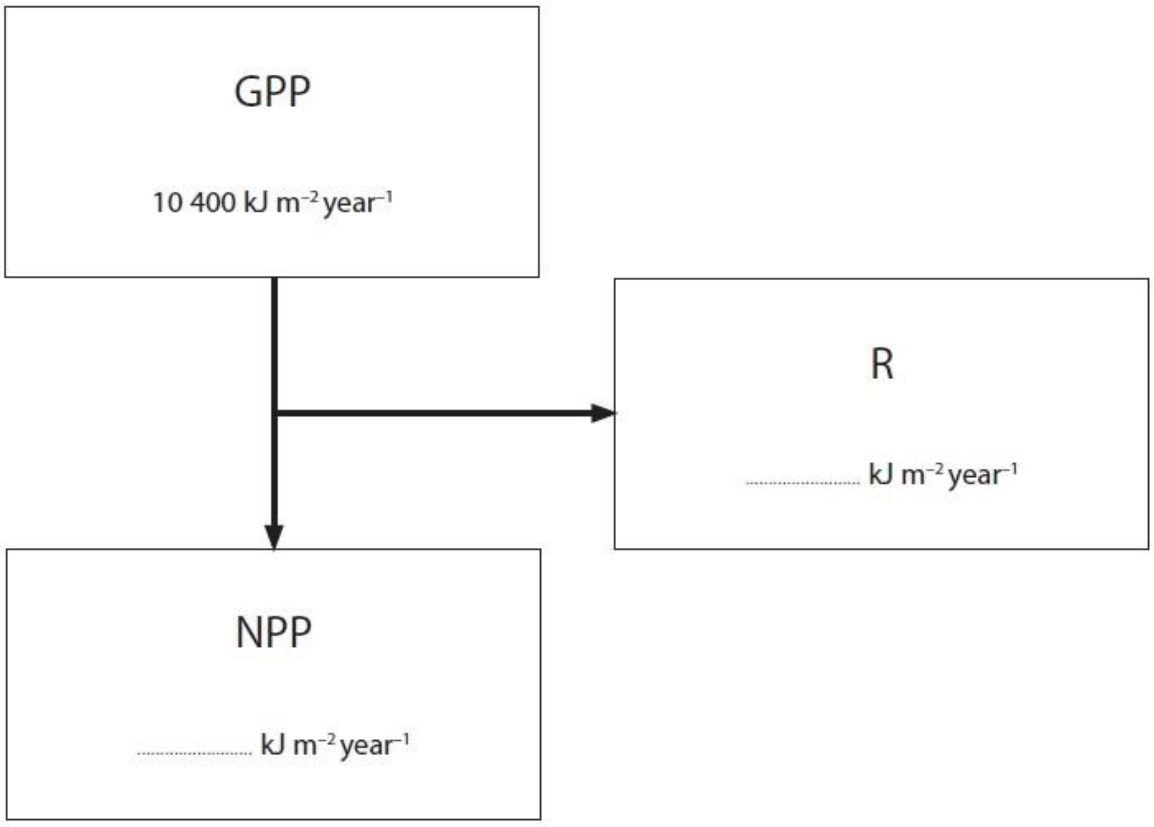
_____

(Total for question = 12 marks)

Q9.

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)**

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

(3)

(c) The units (kJ m^{-2} $year^{-1}$) 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)

(Total for Question = 10 marks)

Q10.

The photograph shows heather, *Calluna vulgaris*, a plant that grows on moorland.

© C016/7131/Science Photo Library

In an investigation into the net primary productivity of heather, all the vegetation on an area of two different moorlands, A and B, was removed by burning. The dry biomass, in g m^{-2}, was then measured each year for a period of 20 years.

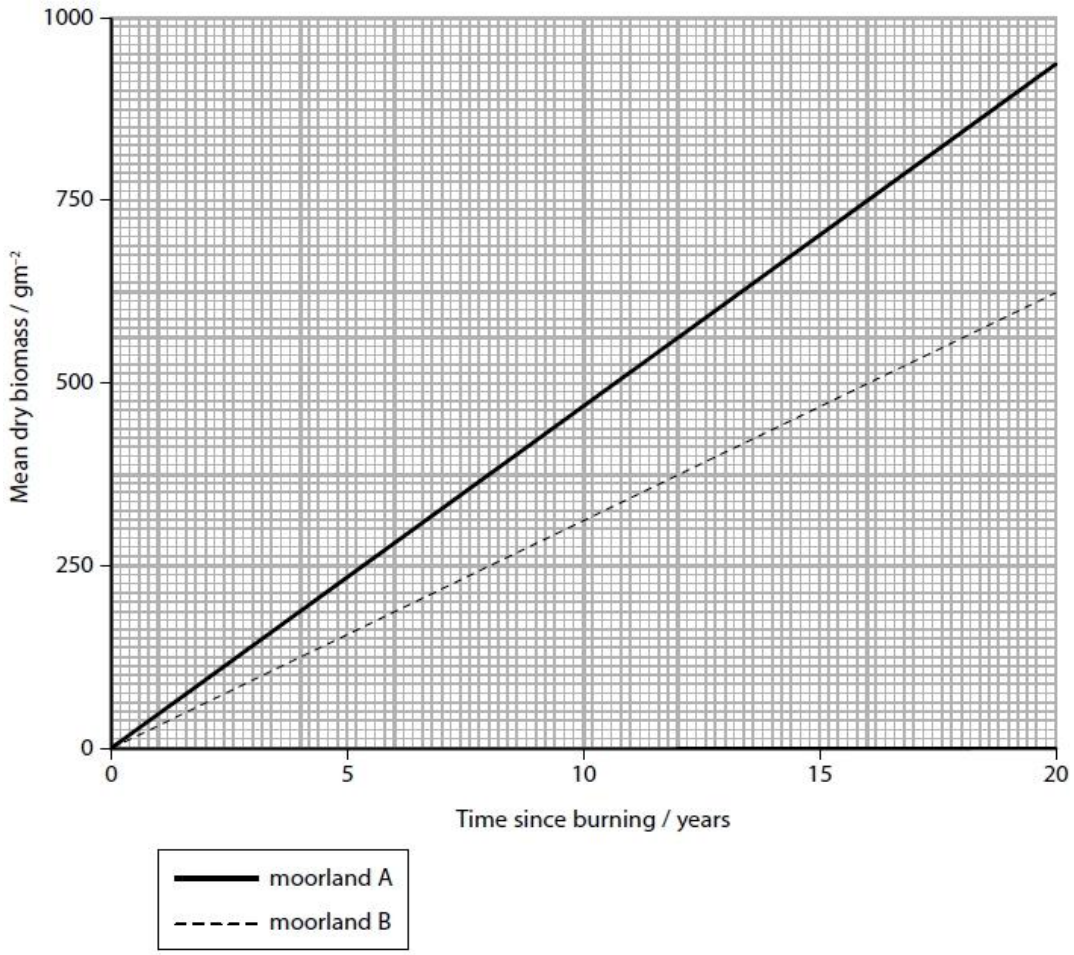
(a) Give an equation that shows the relationship between gross primary productivity, net primary productivity and respiration.

(1)

_____

_____

(b) The graph shows the change in the mean dry biomass of the heather plants during the 20 year period.



(i) Describe a method that could be used to obtain the mean dry biomass of the heather plants in year 20.

(2)

_____

_____

_____

_____

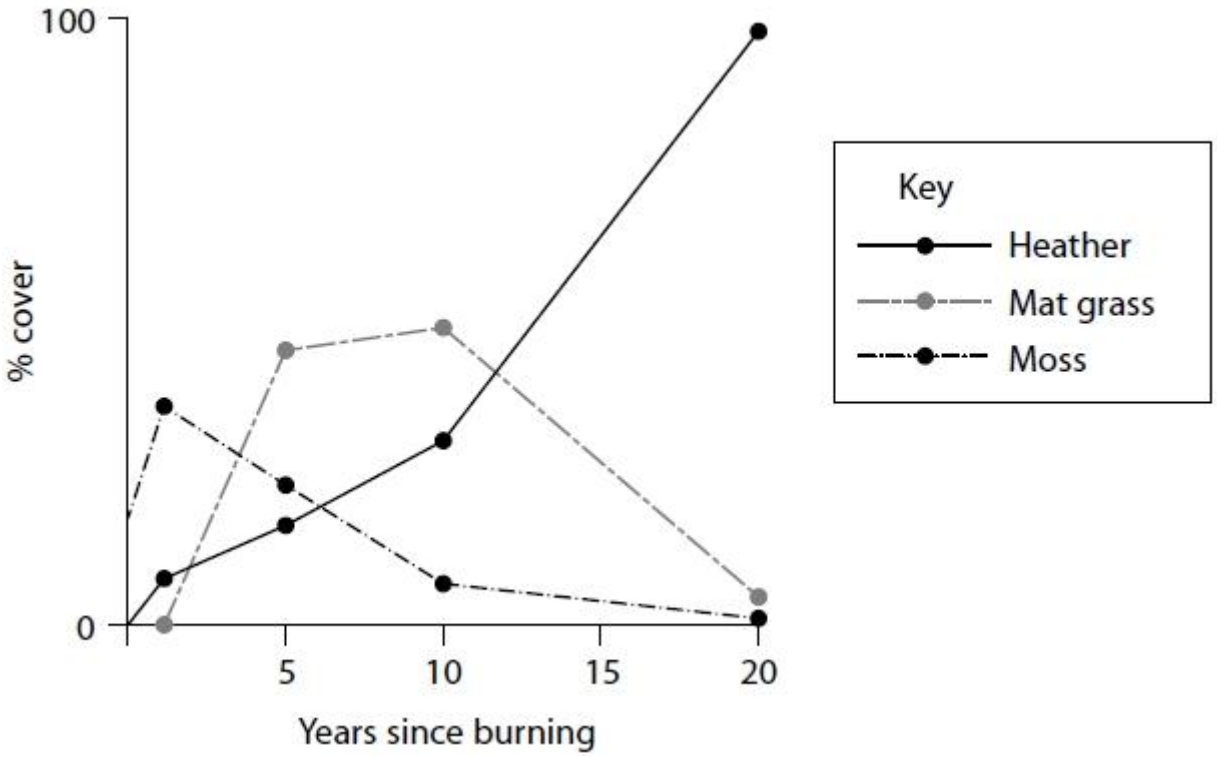
_____

(ii) The total solar radiation reaching moorland A was 3 144 000 kJ m^{-2} yr^{-1}. Each gram of dry heather contains 22.186 kJ.
Calculate the percentage efficiency of heather plants from moorland **A** at converting solar radiation into dry biomass.

(2)

Answer .....

(iii) After the burning of the moorland, a process of succession occurred.
The following information shows some of the changes found over the 20 years.



Analyse the data to explain the changes shown.

(3)

(Total for question = 8 marks)

Mark Scheme

Q1.

Question Number	Acceptable Answer	Additional guidance	Mark
(a)(i)	because there is environmental gradient (1)		**(1)**

Question Number	Indicative content		
(a)(ii)*	Answers will be credited according to candidate's 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. • reference to F. spir / F. ves at top and F. serr. at bottom / F. ves distributed from top to bottom / ranges of each of the three species quoted • reference to top of shore exposed to different levels of abiotic factors such as {water / temperature} than lower part of shore • reference to the F. spir / F. ves able to resist {dehydration / temperature fluctuations} more than F. serr. • reference to bare rock as an abiotic factor and that F. serr. {needs solid surface to {grow / attach} / not able to {grow / attach} in sand} • reference to competition between {Fucus species / other plants} for {space / light} on rocks in lower shore • reference to different distribution of {consumers / animals / limpets} that consume Fucus species /idea that different consumers live on rock than in sand		
Level	Mark	Descriptor	
	0	No awardable content	
Level 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 variable. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.	
Level 2	3-4	An explanation will be given with occasional evidence of analysis,	
		interpretation and/or evaluation of both variables. The explanation shows some linkages and lines of scientific reasoning with some structure.	
Level 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.	

Q2.

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 x 10^6 **NB** $\frac{\text{angle} \times 840 \times 10^6}{360}$ = 2 marks $\frac{\text{area of segment} \times 840 \times 10^6}{\text{area of circle}}$ = 2 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. NPP = GPP – 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)

Q3.

Question Number	Answer	Additional Guidance	Mark
(a)	1. idea that as the {distance from the front edge of the glacier / time} increases, the {complexity / biodiversity / size / eq } of the organisms increases ; 2. reference to (primary) succession ; 3. idea that {algae / lichens / pioneer species} are (the first) organisms to colonise bare rock / eq; 4. idea that {algae / lichen / pioneer species} improve conditions for plants ; 5. idea of competition (limiting species present) ;	1. ACCEPT idea that climax community only reached at distance from glacier edge 2. NOT secondary succession 4. including e.g. change rock into soil / increase humus content of soil / increase water content 5. e.g. newer species outcompete previous species	(3)

Question Number	Answer	Additional Guidance	Mark
(b)(i)	1. the {role / interaction / eq} of an { *Epilobium latifolium* / organism / species} within its { ecosystem / habitat / environment } ; 2. (*Epilobium latifolium*) is a producer ; 3. idea that *Epilobium latifolium* provides {food / energy} for other organisms (herbivores / primary consumers / decomposers) ; 4. idea that *Epilobium latifolium* improves soil e.g. holds soil structure together, increases nutrients ; 5. idea that *Epilobium latifolium* provides {shelter / (micro) habitat} for organisms ;	1. IGNORE community 3. NOT prey 4. IGNORE food in soil ACCEPT adds organic matter, humus 5. ACCEPT named organism e.g. insects	(3)

Question Number	Answer	Additional Guidance	Mark
(b)(ii)	1. idea of using a transect (from front edge of glacier); 2. credit method of sampling (along transect) ; 3. credit appropriate method of selecting sample sites (along transect) ; 4. description of estimate of abundance e.g. number of plants, percentage cover ; 5. idea of using more than one transect ; 6. credit appropriate method of recording quantitative data ;	2. e.g. clumps touching transect, quadrat (on transect), number of plants along perpendicular 3. e.g. set distance, regular, systematic, flip-flop quadrats NOT random 5. IGNORE references to repeating investigation 6. e.g. tally chart, table, graph	(4)

Question Number	Answer	Additional Guidance	Mark
(b)(iii)	1. credit appropriate named abiotic factor; 2. credit appropriate method of measurement of factor ; 3. credit appropriate description of where reading should be taken ; 4. idea of taking several readings and getting an average / eq ;	1. e.g. light, soil pH, water content, mineral content, temperature, salinity, wind IGNORE CO_2 , O_2, rainfall, humidity 2.CE applied e.g. light {probe / sensor / meter / data logger}, {water gauge / drying out soil samples} 3. CE applied e.g. reading taken at height of plant, soil sample around roots, quadrat	(3)

Q4.

Question Number	Answer	Mark
(a)	B ;	(1)

Question Number	Answer	Mark
(b)	D ;	(1)

Question Number	Answer	Mark
* (c) QWC	(QWC - Spelling of technical terms *(shown in italics)* must be correct and the answer must be organised in a logical sequence) succession described: 1. reference to lichens and mosses as pioneer community ; 2. able to grow in {little / no} soil / eq ; 3. (that) breaks up (rock) fragments / forms {thin / shallow / eq} soil; 4. reference to {plants / eq} with {small / short / eq} roots ; 5. (able to) grow in {thin / shallow / eq} soil / eq ; 6. idea that changes in soil structure enable {trees / shrubs} to grow / eq ; general points: 7. reference to soil able to {hold / retain / contain / eq} {water / minerals} ; 8. as plants {lose leaves / die / decay / eq} ; 9. reference to {organic matter / humus / eq} {increases / released / eq} ; 10. reference to competition effects ;	(5)

Question Number	Answer	Mark
(d)	1. climax (community) ; Any **three** from: 2. includes (both) animals and plants / has many species / has high biodiversity / eq ; 3. reference to {interaction / eq} between species / eq ; 4. idea of balanced equilibrium of species ; 5. reference to {dominant / codominant} (plant or animal) species ; 6. reference to stable if no {change to environment / human influence} ;	(4)

Q5.

Question Number	Answer	Mark
(a)	1. idea of taller (growing) plants could {develop / grow} in the clear areas ; 2. idea of loss of {low-growing plants / clear zones} ; 3. idea that different animals appear ; 4. reference to (secondary) succession ; 5. reference to climax community (of the taller plants) ;	**(3)**

Question Number	Answer	Mark
(b)(i)	1. named abiotic factor ; 2. appropriate description of how named factor affects the {number / distribution / growth / eq} of these plants ; 3. appropriate explanation ;	**(3)**

Question Number	Answer	Mark
(b)(ii)	1. idea of no {(inter) breeding / reproduction / mating / eq} (between the *B. Selene*); 2. (because) {geographical / physical} barrier / eq ; 3. idea of different behaviour ; 4. idea of incompatible genitalia ; 5. idea of each population having a {discrete / eq} gene pool e.g. restricted gene flow, different mutations, different alleles ;	**(3)**

Question Number	Answer	Mark
(b)(iii)	1. {low-growing plants would die out / eq } / {taller plants would outgrow the low-growing plants / eq} ; 2. idea of (*B. Selene*) unable to feed e.g. no nectar (for the adults) ; 3. (*B.selene*) unable to lay eggs / eq ; 4. no suitable plants for {caterpillars / eq } to feed on / eq ; 5. idea of very little {variation / genetic diversity / eq} in a small population ;	**(3)**

Q6.

Question Number	Answer	Additional Guidance	Mark
(a)	idea of a series of changes (that occur to the composition of species in the community) of organisms (present in an area) over a period of time ;		(1)

Question Number	Answer	Additional Guidance	Mark
(b)	Five years before: 1. idea that there are more { algae / lichens / mosses } present ; 2. because these are {simpler organisms / early colonisers / pioneer species / eq} ; 3. less *H. pebloides* present / eq ; 4. because recently colonised area / eq ; **max 3 marks** Five years after: 5. more *H. pebloides* present / eq ; 6. because had a longer period of time to become established / eq ; 7. idea that {grasses / ferns / small shrubs / eq} present ; 8. because these are {higher organisms / next group of colonisers} / eq OR idea of improvement in soil	1. ACCEPT no large plants 2. ACCEPT because only bare rock / don't need soil? 7. ACCEPT large plants	(4)

	structure ; **max 3 marks**		

Question Number	Answer	**Additional Guidance**	Mark
(c)(i)	1. idea of measuring off two areas of the same size ; 2. use of a {quadrat / eq} ; 3. use of random {coordinates / sampling / eq} ; 4. method of generating random coordinates ; 5. description of estimate of abundance e.g. number of plants, percentage cover ; 6. indication that several sample sites used ; 7. appropriate method of recording quantitative data ;	7. e.g. tally chart, table, graph	**(4)**

Question Number	Answer	**Additional Guidance**	Mark
(c)(ii)	1. idea of {using a moisture probe / drying out soil samples / eq} ; 2. idea of testing soil around plants ; OR 3. idea of using rain gauge / eq ; 4. idea of collecting water over a period of time ;		**(2)**

Question Number	Answer	Additional Guidance	Mark
(d)	1. idea that birds brought seeds with them ; 2. idea of bird droppings ; 3. adding nutrients to soil / eq ; 4. (therefore) supporting growth of {more / different} plants ; 5. idea that faeces will help maintain soil structure ;		(2)

Q7.

Question Number	Answer	Mark
(i)	**B** - carbon dioxide is reduced to form organic molecules *The only correct answer is **B*** ***A** is incorrect because carbon dioxide is not oxidised to form organic molecules* ***C** is incorrect because organic molecules are not combusted in photosynthesis* ***D** is incorrect because organic molecules are not decomposed in photosynthesis*	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	• correct percentage transferred • correct answer	Example of calculation 35 % / 0.35 = 8680 (kJ m^{-2} yr^{-1}) Correct answer without working gains full marks	(2)

Q8.

Question Number	Answer	Mark
(a)	ref to biotic factors involve {organisms / living} abiotic are {physical / chemical / non-living} (factors) / eq ;	(1)

Question Number	Answer	Mark
(b)(i)	B ;	(1)
* (b)(ii) QWC	(QWC - Spelling of technical terms *(shown in italics)* must be correct and the answer must be organised in a logical sequence) 1. ref to {several / many / more than 2} readings ; 2. ref to use of random quadrat positions ; 3. description of suitable process to give random positions / eq ; 4. ref to {known / stated} area of quadrat ; 5. number of individuals in each quadrat {counted/ recorded} / eq ; 6. description of how mean density calculated using total count e.g. total number (of each species) divided by total area sampled ;	maximum (3)
(b)(iii)	**(Abiotic)** light intensity / light duration / availability of oxygen(in rock pools) / length of exposure (to air) / length of submersion / temperature / presence of toxic chemicals / height above sea level / slope/ aspect / wave action / pH / any other suitable e.g. ; **(Biotic)** predators / availability of food organisms / disease / parasites / competition for a named resource / any other suitable e.g. ;	(2)

Question Number	Answer	Mark
(b)(iv)	B ;	(1)

Question Number	Answer	Mark
(b)(v)	**Statement A** 1. data on two species only / eq ; **Statement B** Accept any 3 of the following 2. idea of density of both species changes as height changes ; 3. as height increases *L. littorea* tends to increase, *L. obtusata* tends to decrease / eq ; 4. no *L. obtusata* above 2 m, {very few / almost no} *L. littorea* below 0.5 m ; 5. competition not a (significant) factor as both species can be found at same height ; 6. ref to both are {plentiful / high density} between 0.5 and 1.5 m ; **Statement C** 7. idea of density of species changes as height changes ; 8. ref to no {information / data} for other factors ;	**sub-max (3)** **maximum (4)**

Q9.

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)

Q10.

Question Number	Acceptable Answer	Additional guidance	Mark
(a)	NPP = GPP – R (1)		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
(b)(i)	A description that makes reference to the following: • use of several quadrats of stated area placed at random (1) • heather placed in drying oven until constant mass (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
(b)(ii)	• (gradient) 46.875 (g m^{-2} yr^{-1}) x 22.186 (kJ) = 1039.97 (g kJ m^{-2} yr^{-1}) (1) • (1037.97 ÷ 3 144 000) x 100 = 0.033% (1)	Example 750 g m^{-2} ÷ 16 years = 46.875 g m^{-2} yr^{-1}	**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
(b)(iii)	An explanation that makes reference to the following: • moss not all removed by burning so quickly re-grows (1) • mat grass colonises after 1 year and outcompetes moss for {light / minerals / water} so is the dominant plant after 5 years (1) • both decrease as heather colonises and becomes dominant as the heather outcompetes them both for {light / minerals / water} (1)		**(3)**