0 5 Arbuscular mycorrhiza fungi (AMF) are fungi which grow on, and into, the roots of plants. AMF can increase the uptake of inorganic ions such as phosphate.

0 5 . 1 Suggest **one** way in which an increase in the uptake of phosphate could increase plant growth.

[1 mark]

Explain why an increase in shoot biomass can be taken as a measurement of **net** primary productivity.

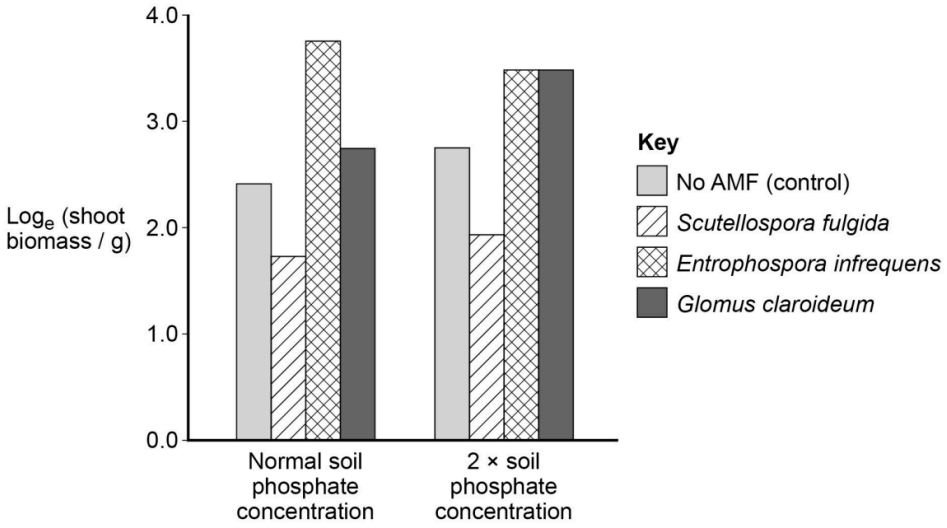
[2 marks]

0 5 . 3 Scientists investigated the effects of different AMF species on the productivity of the plant community of a prairie grassland ecosystem when growing in/on soil containing different phosphate concentrations.

The scientists set up identical plots of prairie grassland soil containing seeds of the plant species found in the ecosystem. The scientists added different AMF species and different concentrations of phosphate to particular plots. Control plots without AMF species were also set up. After 20 weeks the scientists determined the shoot biomass for each plot.

The results the scientists obtained are shown in **Figure 5**.

Figure 5



0 5 . 4 Using the data from **Figure 5**, evaluate the effect on plant productivity of adding AMF species and adding phosphate to the soil.

[4 marks]

21 This Question is about ecosystems in the Southern (Antarctic) Ocean.

(a) Observe the food chain:

phytoplankton (producers) → krill (shrimps etc.) → small fish → large fish → seals

Table 21.1 shows the transfers of energy and the quantities of energy stored as biomasses for the food chain. Magnitudes are given in kilojoules per square metre of sea surface per year.

	Phyto-plankton	**Krill**	**Small fish**	**Large fish**	**Seals**
Energy input, by photosynthesis or feeding ($kJ\ m^{-2}\ y^{-1}$)	900	80	11	1.4	
Energy lost to surroundings by respiration ($kJ\ m^{-2}\ y^{-1}$)	180	64	8.8	1.2	0.105
Energy input converted to biomass ($kJ\ m^{-2}\ y^{-1}$)	720	16	2.2	0.2	0.005
Biomass energy lost to other consumers or decomposers ($kJ\ m^{-2}\ y^{-1}$)	640	5	0.8	0.09	0.005

Table 21.1

(i) For larger and less numerous organisms, such as the seal, it is more appropriate to record energy flows per square kilometre.

Calculate the energy input to the seal population from large fish. Record your answer in kilojoules per square **kilometre** of sea surface per year.

Answer..... **[2]**

(ii) Calculate the percentage of energy stored in large fish biomass converted to energy in seal biomass.

Answer..... **[2]**

(b) (ii) Krill can also be harvested as a human food source.
The fishing industry aims to harvest large fish.
Some environmentalists say that krill harvesting should be increased.

Use this information and **Table 21.1** to put forward arguments for and against harvesting krill instead of large fish as a human food source.

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..... **[2]**

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

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)

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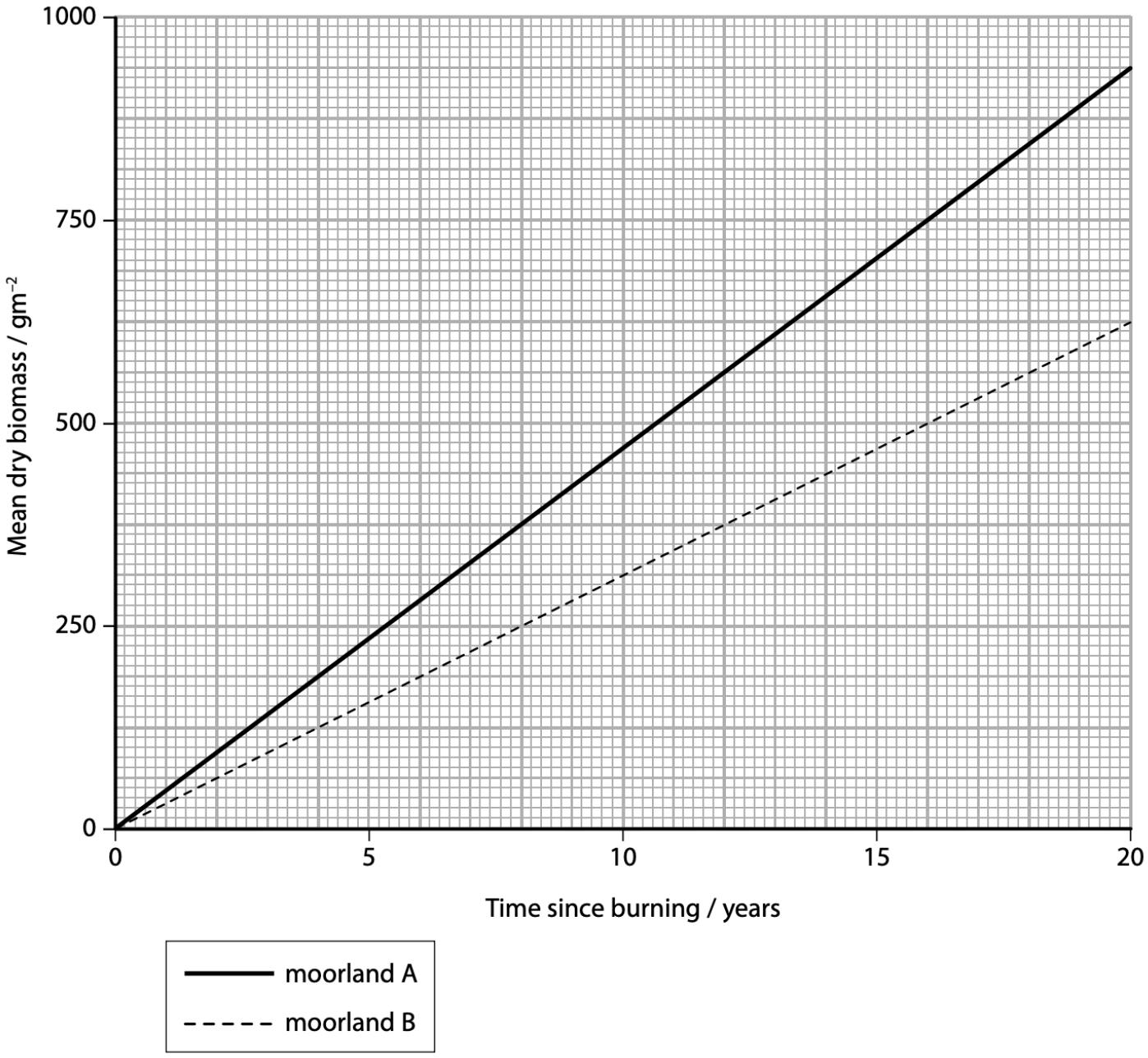
(b) The graph shows the change in the mean dry biomass of the heather plants during the 20 year period.



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

(2)

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(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.

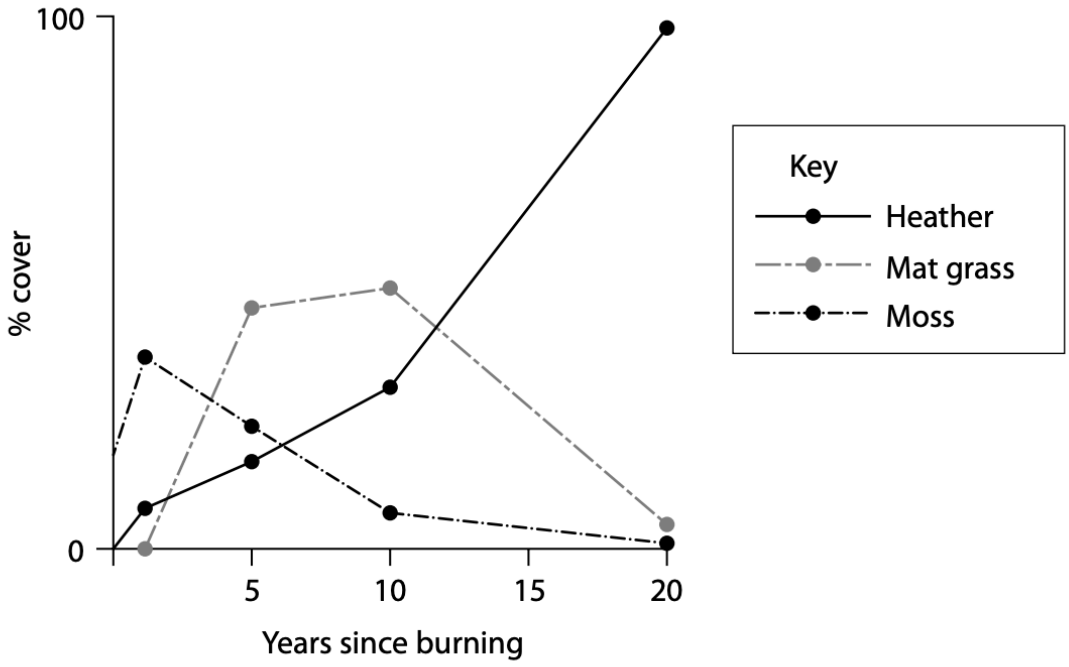
Calculate the percentage efficiency of heather plants from moorland **A** at converting solar radiation into dry biomass.

(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)

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05.1	Used to produce named phosphate compound in cells; e.g. ATP/ADP/phospholipids/DNA/ RNA/RuBP/TP /GP etc.	1	
05.3	1. Represents dry mass / mass of carbon; 2. Represents gross production minus respiratory losses;	2	2. Accept: NPP = GPP – R. 2. Accept: Chemical energy minus respiratory losses. 1 and 2. Chemical energy store minus respiratory losses = 2 marks.
05.4	1. For the control an increase in phosphate increases (plant) growth; 2. For *Entrophospora* an increase in phosphate reduces (plant) growth; 3. *Scutellospora* reduces (plant) growth (compared to control); 4. *Entrophospora and Glomus* increases (plant) growth(compared to control); 5. No SD/statistical test to determine significance; 6. Only 20 weeks of growth; 7. Underground/root growth not known;	4 max	5. Accept: no error bars. 7. Accept: only shows shoot growth.
05.5	1. Answer in range 0.07 to 0.09 = **2 marks**;; 2. Answer in range 9.97 to 12.2 OR Shows division by 140 or 20 x 7 = 1 mark;	2	

Question			Answer	Marks	Guidance
21	(a)	(i)	110 000 / 1.1×10^5 ✓ kJ km^{-2} y^{-1} ✓	2	**ALLOW** the word or any reasonable symbol for year **ALLOW** kJ y^{-1} km^{-2}
		(ii)	25 ✓✓	2	**ALLOW** correct answer in the working if the answer line is left blank. If answer is incorrect, **award 1 mark** for 0.05 ÷ 0.2 × 100
	(b)	(i)	*Measures* fishing quotas ✓ mesh size ✓ species restriction ✓ trawler size / days at sea ✓ penalties / sanctions ✓ monitoring / surveillance ✓ publicity / public education ✓ *Difficulties* area too large ✓ expense of monitoring ✓ monitoring hampered by, weather / seasons ✓ false reporting of, catches / trawler size / mesh size / days✓ death of fish caught but not kept (because of restrictions) ✓	4	**The difficulties should relate to the measures proposed.**
		(ii)	*argument for* comparison of the energy in large fish and krill shows humans would get 100x more kJ/energy from krill than large fish ✓ *argument against* would require large change to fishing industry / consumer habits **or** could impact ecosystem at first trophic level ✓	2	**ALLOW** the use of figures to illustrate the data comparison.
			Total	10	

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

Question Number	Acceptable Answer	Additional guidance	Mark
6(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
6(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
6(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)**