

Q1.

Freshwater marshes have one of the highest rates of gross primary production (*GPP*) and net primary production (*NPP*) of all ecosystems.

Carbon use efficiency (*CUE*) is the ratio of *NPP*:*GPP*. Freshwater marshes have a high *CUE*.

- (a) Use your knowledge of *NPP* to explain why freshwater marshes have a high *CUE* **and** the advantage of this.

Do **not** refer to abiotic factors in your answer.

Explanation _____

Advantage _____

(2)

- (b) Freshwater marsh soils are normally waterlogged. This creates anaerobic conditions.

Use your knowledge of the nitrogen cycle to suggest why these soils contain relatively high concentrations of ammonium compounds and low concentrations of nitrite ions and nitrate ions.

(2)

A student investigated the growth rate of a freshwater marsh plant.

The growth rate (*R*) of a plant can be determined using this equation.

$$R = \frac{(\ln W_2 - \ln W_1)}{t}$$

Where

ln = natural logarithm

t = duration of the investigation in days

*W*₁ = plant biomass at the start of the investigation

*W*₂ = plant biomass at the end of the investigation

The student used the equation above; however, she substituted height for biomass. This was because she did not want to destroy the plants to measure their biomass.

- (c) State the assumption the student has made **and** suggest why this assumption might **not** be valid.

(2)

- (d) At the end of the investigation, the student noted the freshwater marsh plant had grown 268 mm in height, and now measured 387 mm. She calculated the rate of growth (R) to be $0.097 \text{ mm m}^{-1} \text{ day}^{-1}$

Use this information and, **substituting height for biomass**, use the equation to calculate the duration of the student's investigation.

Give your answer to the nearest full day. Show your working.

_____ days

(2)

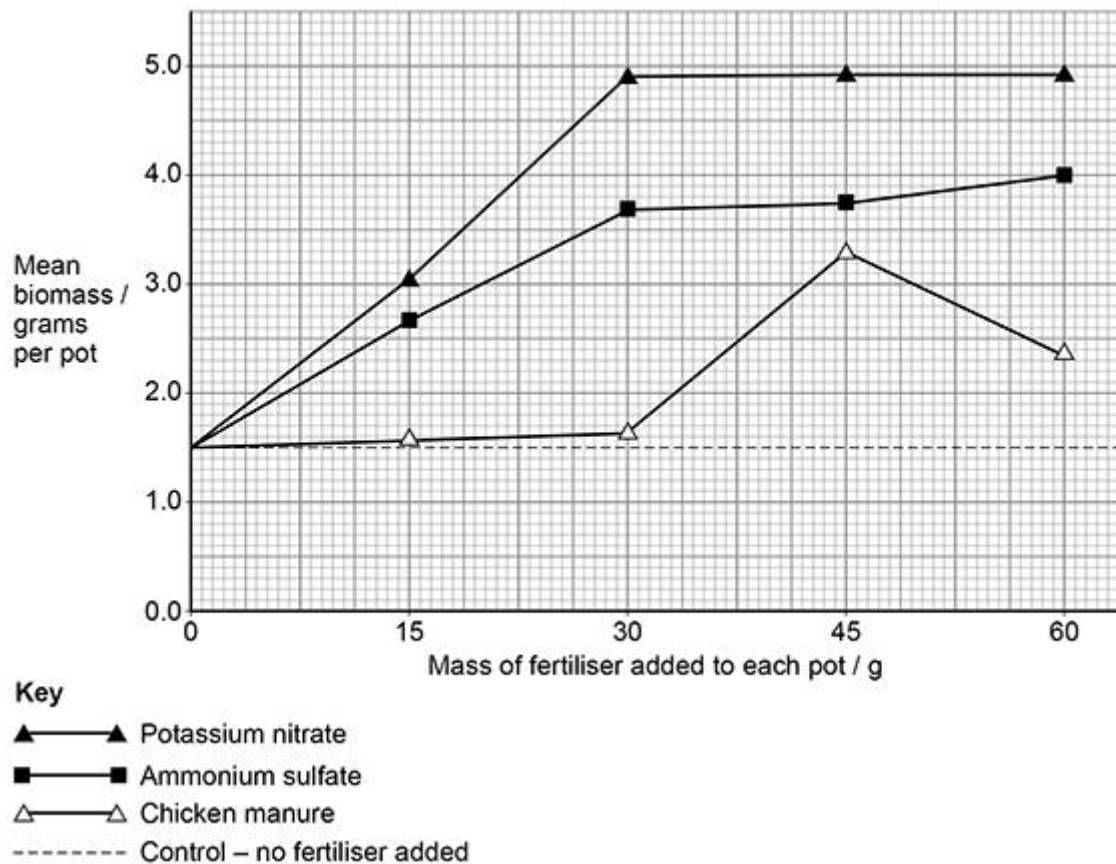
(Total 8 marks)

Q2.

A scientist investigated the effects of different fertilisers on the growth of spinach plants. The scientist:

- set up a large sample of identical pots of soil
- added different masses of different fertilisers to selected pots
- did not add fertiliser to the control pots
- planted the same number of young spinach plants in each pot
- after 20 days, determined the biomass of spinach plants in each pot.

The results the scientist obtained after 20 days are shown in the graph below.



- (a) Calculate how many times greater the mean growth rate per day was using 37.5 g potassium nitrate than using 37.5 g ammonium sulfate.

- (c) The scientist determined the dry mass of the spinach plants. First, he heated each sample at 80 °C for 2 hours.

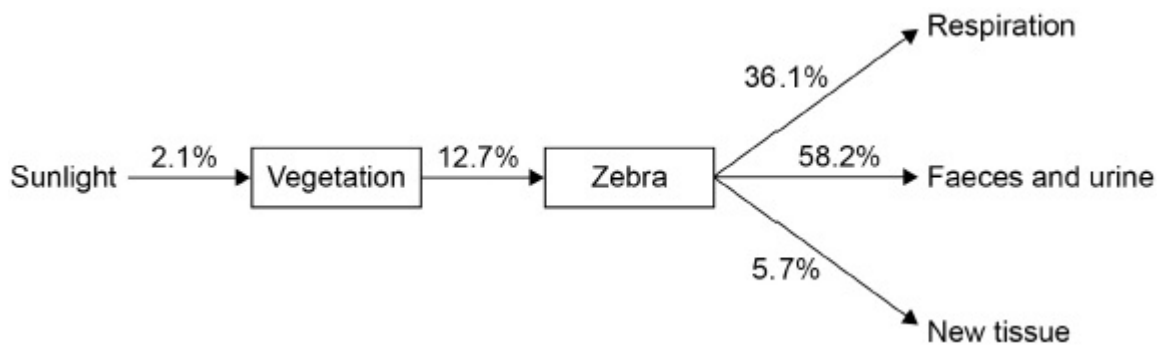
Suggest what the scientist should do to ensure that he has removed all the water from the sample.

(2)

(Total 8 marks)

Q3.

The diagram shows percentages of energy transferred from sunlight to a zebra in a grassland ecosystem.



- (b) Use the diagram to calculate the percentage of sunlight energy that would be transferred into the faeces and urine of a zebra. Give your answer to 3 significant figures.

Answer = _____ %

(1)

- (c) In this ecosystem the net productivity of the vegetation is $24\,525\text{ kJ m}^{-2}\text{ year}^{-1}$

Use this information and the diagram above to calculate the energy stored in new tissues of the zebra in $\text{kJ m}^{-2}\text{ year}^{-1}$

Answer = _____ $\text{kJ m}^{-2}\text{ year}^{-1}$ (2)

Q4.

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.

- (a) Suggest **one** way in which an increase in the uptake of phosphate could increase plant growth.

(1)

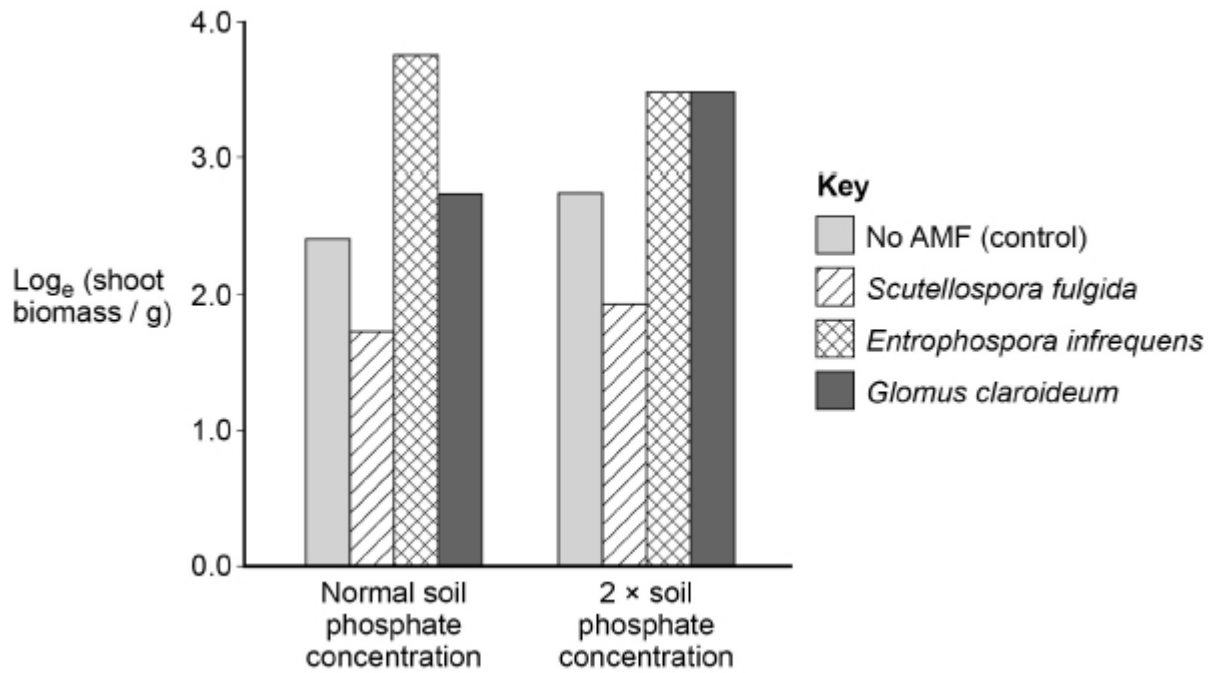
- (b) Suggest **one** way in which AMF may benefit from their association with plants.

(1)

- (c) 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 the graph.



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

(2)

(d) Using the data from the graph in part (c), evaluate the effect on plant productivity of adding AMF species and adding phosphate to the soil.

(4)

- (e) Using the e^x button on your calculator, determine the rate of shoot biomass production in grams per day for the control plot in soil with normal phosphate concentration.

Answer = _____ g day⁻¹

(2)

(Total 10 marks)

Q5.

Ecologists developed a method for estimating the biomass of trees in a plantation.

The plantation consisted of trees of the same species.

They collected samples of wood from trees. For each sample they:

- determined the density of the freshly cut wood
- dried the wood in an oven at 103 °C for 24 hours
- determined the volume of the dried wood sample
- determined the density of the dried wood.

The table below shows data about one wood sample.

Volume of freshly cut wood sample / dm ³	Density of freshly cut wood / g per dm ³	Volume of dried wood sample / dm ³	Density of dried wood sample / g per dm ³
1.345	993.0	1.125	769.0

- (a) The loss of mass of the wood sample was due to loss of water. Water has a density of 1 g per cm³.

Use the data in the table to calculate the percentage of water in the freshly cut wood sample. Show your working.

Percentage of water = _____

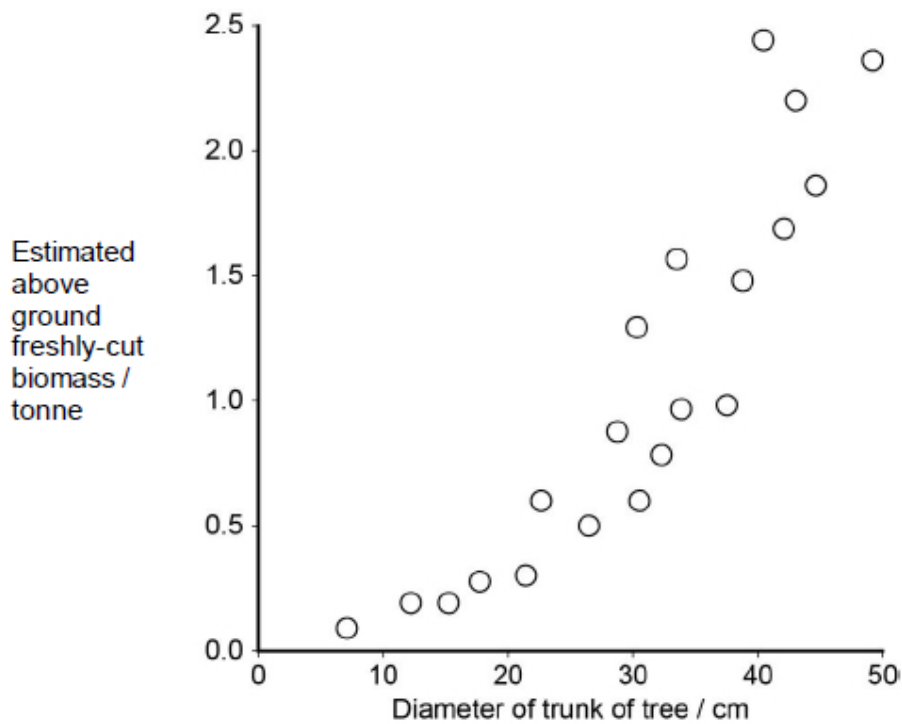
(2)

- (b) The ecologists dried the samples in an oven at 103 °C for 24 hours. Describe how the ecologists could have determined whether or not this drying removed all the water from a sample of wood.

(2)

- (c) Ecologists then investigated the relationship between the diameter of the trunk of the trees and their biomass.

The graph below shows their results. Each point is the result for **one** tree.



What does the graph show about the relationship between the diameter of the trunk of the trees and their biomass?

(2)

- (d) Plantations of trees are often created to remove carbon dioxide from the atmosphere, to help to balance the carbon dioxide released by burning fossil fuels.

For different species of tree, information is available for:

- the relationship between diameter of trunk and freshly cut biomass
- the percentage of water in fresh-cut wood
- the mean dried density of wood.

Using only the information provided in part (c), suggest how the mass of carbon in the wood of a plantation of trees of a particular species could be estimated.

Start with measuring the diameter of a large number of trees.

Assume that the dry biomass of a tree consists of biological molecules that contain carbon.

(4)

(Total 10 marks)

