EXAM PAPERS PRACTICE

Energy and Ecosystems

These practice questions can be used by students and teachers and is

Suitable for AQA A Level 7402 Biology Topic Question

Level: AQA A LEVEL 7402

Subject: Biology

Exam Board: AQA A Level 7402

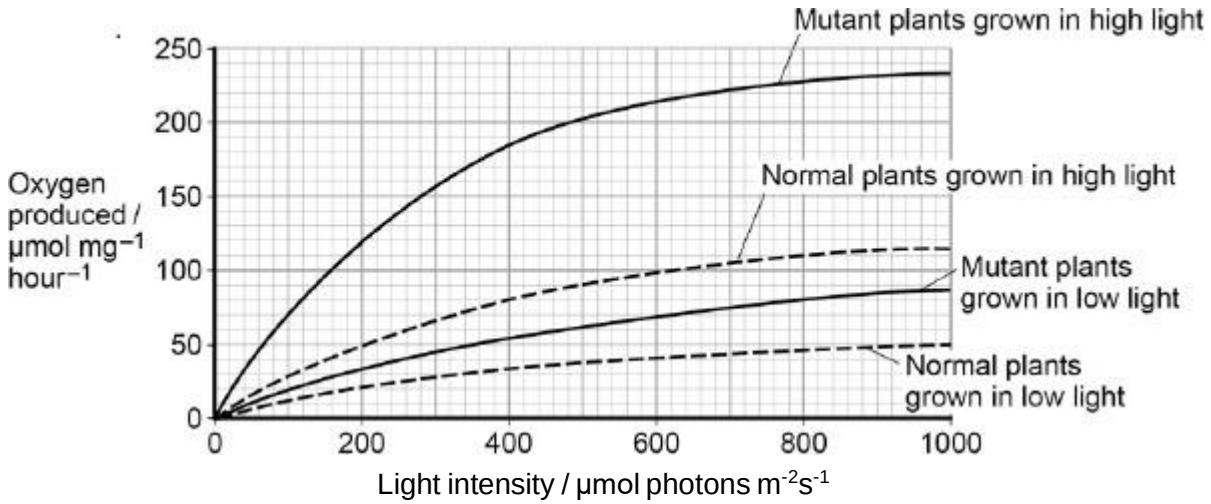
Topic: Energy and Ecosystems

1 Chloroplasts contain chlorophyll a and chlorophyll b. Scientists found tobacco plants with a mutation that caused them to make more chlorophyll b than normal tobacco plants. They investigated the effect of this mutation on the rate of photosynthesis.

The scientists carried out the following investigation.

- They grew normal and mutant tobacco plants. They grew some of each in low light intensity and grew others in high light intensity.
- They isolated samples of chloroplasts from mature plants of both types.
- Finally, they measured oxygen production by the chloroplasts they had isolated from the plants.

The figure below shows the scientists' results.



(a) Explain why the scientists measured the rate of production of oxygen in this investigation.

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(2)

In each trial, the scientists collected oxygen for 15 minutes.

(b) Calculate the difference in the oxygen produced by the chloroplasts from mutant plants grown in low and high light intensities at a light intensity of 500 µmol photons m^{-2} s^{-1}.Show your working.

Difference_____µmol O_2 mg^{-1} $hour^{-1}$

(2)

(c) The scientists suggested that mutant plants producing more chlorophyll b would grow faster than normal plants in all light intensities.

Explain how these data support this suggestion.

(Extra space) _____

(4)

(Total 8 marks)

2 Scientists investigated the effect of a mycorrhizal fungus on the growth of pea plants with a nitrate fertiliser or an ammonium fertiliser. The fertilisers were identical, except for nitrate or ammonium.

The scientists took pea seeds and sterilised their surfaces. They planted the seeds in soil that had been heated to 85 °C for 2 days before use. The soil was sand that contained no mineral ions useful to the plants.

(a) Explain why the scientists sterilised the surfaces of the seeds and grew them in soil that had been heated to 85 °C for 2 days.

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(2)

(b) Explain why it was important that the soil contained no mineral ions useful to the plants.

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(1)

The pea plants were divided into four groups, **A**, **B**, **C** and **D**.

- **Group A** – heat-treated mycorrhizal fungus added, nitrate fertiliser
- **Group B** – mycorrhizal fungus added, nitrate fertiliser
- **Group C** – heat-treated mycorrhizal fungus added, ammonium fertiliser
- **Group D** – mycorrhizal fungus added, ammonium fertiliser

The heat-treated fungus had been heated to 120 °C for 1 hour.

(c) Explain how groups **A** and **C** act as controls.

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(2)

After 6 weeks, the scientists removed the plants from the soil and cut the roots from the shoots. They dried the plant material in an oven at 90 °C for 3 days. They then determined the mean dry masses of the roots and shoots of each group of pea plants.

(d) Suggest what the scientists should have done during the drying process to be sure that all of the water had been removed from the plant samples.

_____

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(2)

The scientists' results are shown in the table below.

Treatment	Mean dry mass / g per plant (± standard deviation)	
	Root	Shoot
A – heat-treated fungus and nitrate fertiliser	0.40 (±0.05)	1.01 (±0.12)
B – fungus and nitrate fertiliser	1.61 (±0.28)	9.81 (±0.33)
C – heat-treated fungus and ammonium fertiliser	0.34 (±0.03)	0.96 (±0.26)
D – fungus and ammonium fertiliser	0.96 (±0.18)	4.01 (±0.47)

(e) What conclusions can be drawn from the data in the table about the following?

The effects of the fungus on growth of the pea plants.

The effects of nitrate fertiliser and ammonium fertiliser on growth of the pea plants.

(4)

The scientists determined the dry mass of the roots and shoots separately. The reason for this was they were interested in the ratio of shoot to root growth of pea plants. It is the shoot of the pea plant that is harvested for commercial purposes.

(f) Explain why determination of dry mass was an appropriate method to use in this investigation.

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(2)

(g) Which treatment gave the best result in commercial terms? Justify your answer.

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(2)

(Total 15 marks)

3 Algae are photosynthesising organisms. Some grow on rocky shores. Scientists investigated the abundance of different species of algae at two sites, **A** and **B**, on a rocky shore. Site **A** was on the upper shore and site **B** was on the lower shore. The diagram shows the location of sites **A** and **B** on the rocky shore.

Table 1 shows some of the results the scientists obtained.

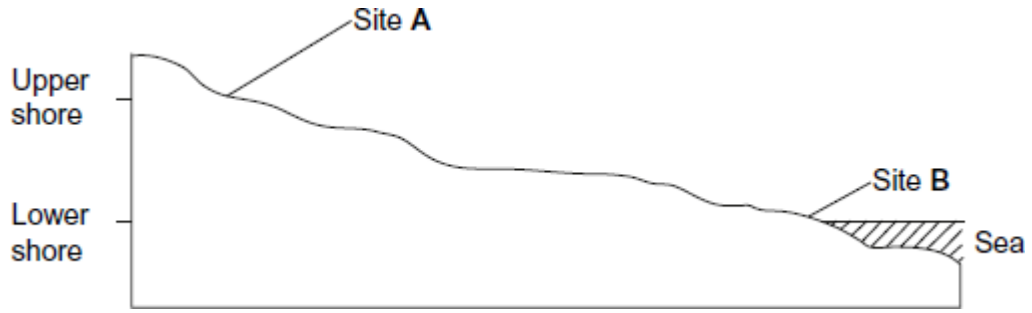

Table 1

	Site A **Upper shore**	**Site B** **Lower shore**
Species of algae with percentage cover more than 1%	*Gigartina leptorhynchos* *Gigartina canaliculata* *Gelidium coulteri* *Rhodoglossum affine*	*Gigartina spinosa* *Rhodoglossum affine* *Laurencia pacifica* *Gastroclonium coulteri* *Centroceros clavulatum* *Gigartina canaliculata* *Corallina vancouveriensis*

(a) The scientists recorded data from 40 large rocks at each site.

Describe **one** method that the scientists could have used to ensure that the large rocks were chosen without bias.

_____

_____

_____

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(2)

(b) The scientists used percentage cover rather than frequency to record the abundance of algae present

Suggest why.

_____

_____

(1)

(c) Apart from availability of water, describe and explain how **two** abiotic factors may have caused differences in the species of algae growing at sites **A** and **B**.

Factor 1 _____

Explanation _____

_____

Factor 2 _____

Explanation _____

_____

(2)

(d) Use the information provided in **Table 1** to explain why the diversity of consumers will be greater at site **B**.

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(2)

(e) The scientists also investigated the algae eaten by two consumers found on the rocky shore, the sea slug and the shore crab. The scientists carried out their investigation in a laboratory.

- They put each consumer into a separate tank through which aerated seawater flowed slowly.
- Each tank contained 5 grams of one species of alga.
- After 50 hours, they measured the mass of the alga remaining in each tank.
- They repeated this procedure several times using a different sea slug and a different shore crab each time.

The scientists then calculated the mean mass of each species of alga eaten by the consumers. They used a statistical test to determine the P value.

Table 2 shows some of the results they obtained.

Table 2

Species of alga	**Mean mass eaten / g**		**P value**
	Sea slug	**Shore crab**	
Laurencia pacifica	4.42	0.22	<0.01
Egregia leavigata	0.12	0.08	>0.05
Microcystis pyrifera	0.19	0.14	>0.05
Cystoseira osmondacea	0.17	0.04	<0.05

(i) The consumers were starved for 5 days before the investigation.

Explain why.

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(2)

(ii) The data in **Table 2** for the mean mass of alga eaten were adjusted for loss of mass by the alga due to respiration.

Suggest how the scientists were able to determine the loss of mass due to respiration of a sample of alga.

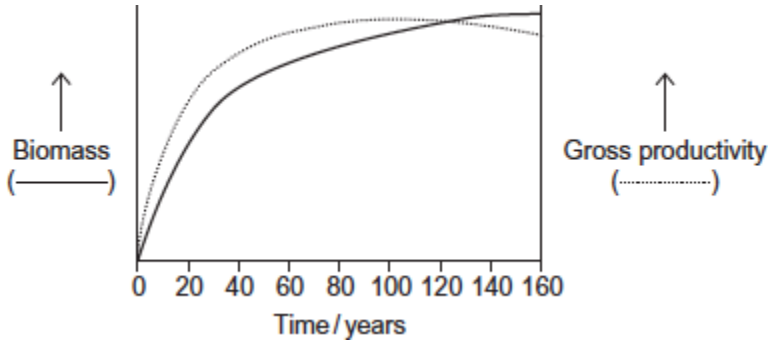
(3)

(iii) Suggest what conclusions the scientists could have made from this investigation when using the probability values in **Table 2**.

(3)

(Total 15 marks)

4 The graph shows how gross productivity and biomass in an area changed with time in the succession from bare soil to mature woodland.



(a) (i) Suggest appropriate units for gross productivity.

(1)

(ii) Explain the decrease in gross productivity as the woodland matures.

(2)

(b) Use your knowledge of succession to explain the increase in biomass during the first 20 years.

[Extra space]

(3)

(c) Use the information in the graph and your knowledge of net productivity to explain why biomass shows little increase after 100 years.

(2)

(d) Suggest **one** reason for conserving woodlands.

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(1)

(Total 9 marks)

5 Upwelling is a process where water moves from deeper parts of the sea to the surface. This water contains a lot of nutrients from the remains of dead organisms.

(a) (i) Nitrates and phosphates are two of these nutrients. They provide a source of nitrogen and phosphorus for cells.

Give a biological molecule that contains:

1. nitrogen _____

2. phosphorus _____

(2)

(ii) Describe the role of microorganisms in producing nitrates from the remains of dead organisms.

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(Extra space) _____

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(3)

(b) Upwelling often results in high primary productivity in coastal waters.
Explain why some of the most productive fishing areas are found in coastal waters.

(2)

(Total 7 marks)

6 Farmland previously used for growing crops was left for 30 years and developed into woodland.
During this period, ecologists recorded an increase in the diversity of birds in the area.

(a) Name the process that resulted in the development of woodland from farmland.

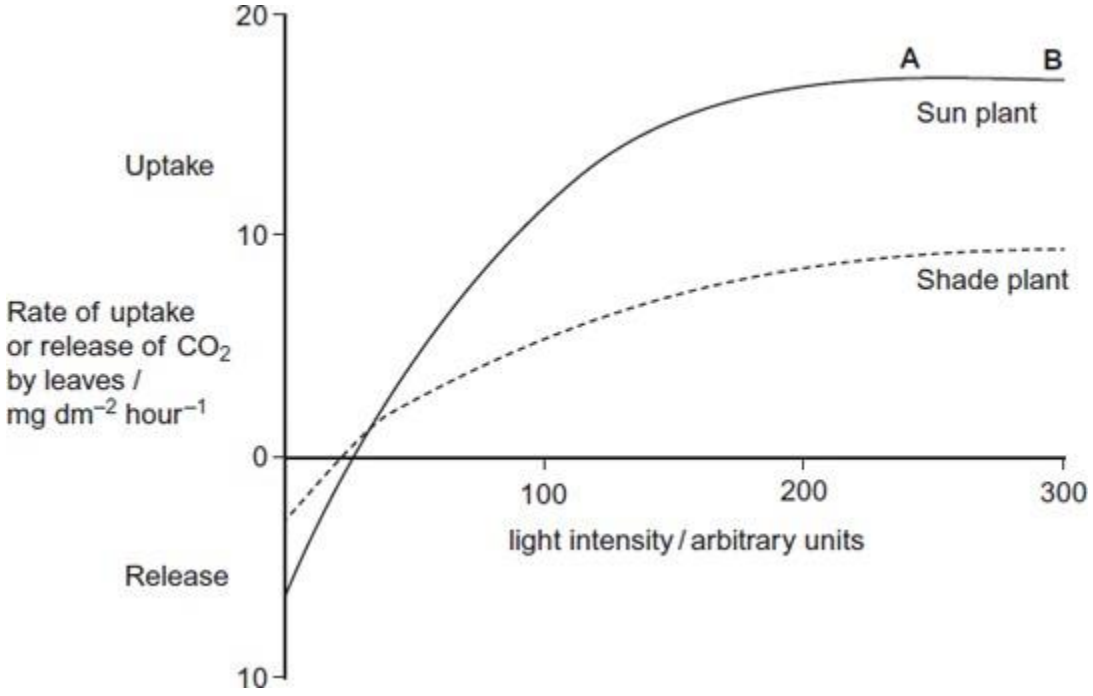
(1)

(b) Explain the increase in the diversity of birds as the woodland developed.

(Extra space)

(3)

(c) The ecologists also investigated photosynthesis in two species of plant found in the woodland. One of the species was adapted to growing in bright sunlight (sun plant) and the other was adapted to growing in the shade (shade plant). The ecologists' results are shown in the figure below.



(i) Give **two** factors which could be limiting the rate of photosynthesis in the sun plant between points **A** and **B** on the figure.

1. _____

2. _____

(1)

(ii) Explain why CO_2 uptake is a measure of net productivity.

_____

_____

(Extra space) _____

_____

(1)

(iii) Use the information in the figure to explain how the shade plant is better adapted than the sun plant to growing at low light intensities.

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(Extra space) _____

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(2)

(Total 8 marks)

7 Scientists measured the rate of respiration in **three** parts of an ecosystem.

They did this by measuring carbon dioxide released into the air by:

- leaves of plants
- stems and roots of plants
- non-photosynthetic soil organisms.

The table below shows the scientists' results for these three parts of the ecosystem.

Part of ecosystem	**Mean rate of carbon dioxide production / $cm^3\ m^{-2}\ s^{-1}$**	**Percentage of total carbon dioxide production measured by the scientists**
Leaves of plants	0.032	25.0
Stems and roots of plants	0.051	
Non-photosynthetic soil organisms	0.045	

(a) Complete the table to show the percentage of total carbon dioxide production by each part of the ecosystem.

Show your working.

(2)

(b) A student who looked at the data in the table concluded that plants carry out more respiration than non-photosynthetic organisms in the ecosystem.

Use the information provided to suggest why these data may **not** support the student's conclusion.

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(2)

(c) What measurements would the scientists have made in order to calculate the rate of carbon dioxide production?

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(2)

(d) The scientists calculated the mean rate of carbon dioxide production of the leaves using measurements of carbon dioxide release in the dark.

Explain why they did **not** use measurements taken in the light.

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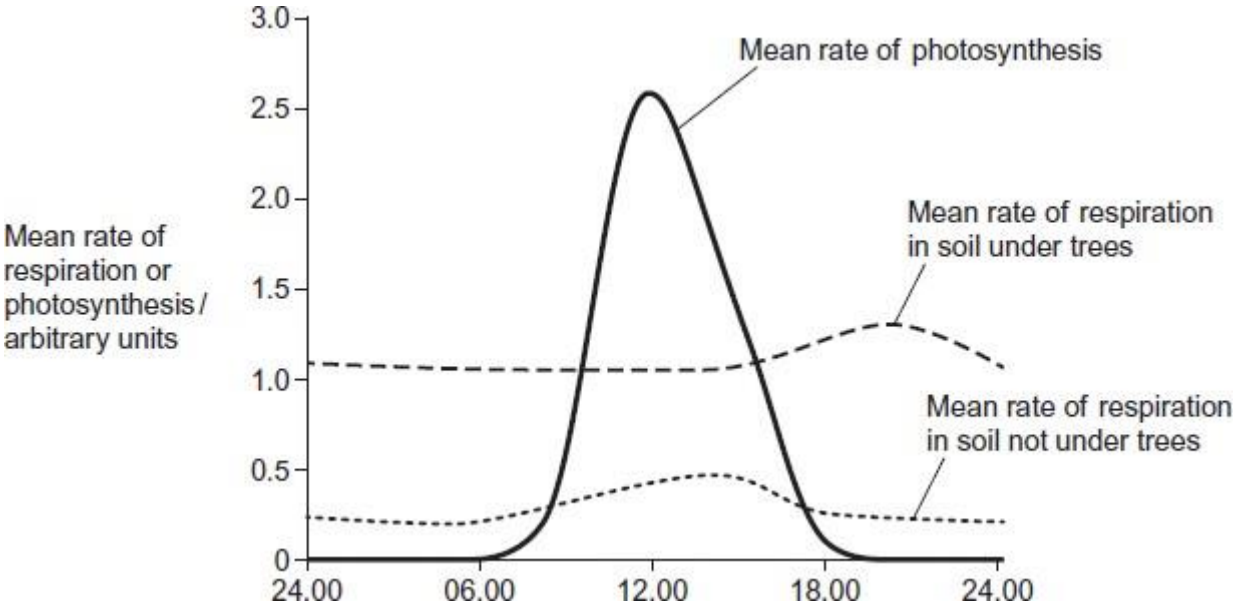
(2)

Another group of scientists measured the mean rate of respiration in soil under trees and soil not under trees in the same wood. They also measured the mean rate of photosynthesis in the trees.

They took measurements at different times of day during the summer.

The figure below shows the scientists' results.



(e) (i) Describe **two** ways in which the mean rate of respiration in soil under trees is different from soil not under trees.

1. _____

_____

2. _____

_____

(2)

(ii) Suggest **one** explanation for the differences in the mean rate of respiration in soil under trees and soil not under trees between 06.00 and 12.00.

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(2)

(f) The scientists suggested that the rise in the mean rate of photosynthesis was the cause of the rise in the mean rate of respiration in soil under trees.

(i) Suggest how the rise in the mean rate of photosynthesis could lead to the rise in the mean rate of respiration in soil under trees.

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(2)

(ii) Suggest why there is a delay between the rise in the mean rate of photosynthesis and the rise in the mean rate of respiration.

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(1)

(Total 15 marks)

8 Nitrate from fertiliser applied to crops may enter ponds and lakes. Explain how nitrate may cause the death of fish in fresh water.

(Total 5 marks)

9 **Essay**

You should write your essay in continuous prose.

Your essay will be marked for its scientific accuracy. It will also be marked for your selection of relevant material from different parts of the specification and for the quality of your written communication.

The maximum number of marks that can be awarded is

Scientific	16
Breadth of knowledge	3
Relevance	3
Quality of written communication	3

Write an essay on the following topic:

There are many different types of relationships and interactions between organisms.

(Total 25 marks)

10 (a) Energy enters most ecosystems through the light-dependent reaction of photosynthesis. Describe what happens during the light-dependent reaction.

(5)

(b) Changes in ecosystems can lead to speciation. A high concentration of copper in soil is toxic to most plants. In some areas where the soil is polluted with copper, populations of grasses are found to be growing. These populations of grass belong to a species also found growing on unpolluted soils.

It has been suggested that a new species of grass may evolve on soil that has been polluted with copper. Explain how this new species might evolve.

(5)

(Total 10 marks)

11 Biofuels are fuels which can be produced from plants. Scientists have developed a standard method called net life-cycle carbon dioxide production (NLP) to find the overall effect of producing and using particular biofuels on carbon dioxide production.

(a) Petroleum is used as a comparison when evaluating NLPs of biofuels. Suggest **two** reasons why.

1. _____

_____

2. _____

_____

(2)

(b) Biofuels are produced by a variety of different companies. The scientists who developed the method of calculating NLPs are funded by the government's environmental agency. Suggest **two** advantages of this method being developed by these scientists.

1. _____

_____

2. _____

_____

(2)

Scientists compared the percentage change in carbon dioxide production if different biofuels replaced petroleum. Their results are shown in the table.

Biofuel	Percentage change in carbon dioxide production if this fuel replaced petroleum
Corn ethanol	–18
Soy-based biodiesel	+4
Switch-grass ethanol	–124
Sugar-cane ethanol	–26

(c) Producing and using biofuels from corn ethanol results in a negative percentage change in carbon dioxide production. Explain why.

(2)

(d) Ethanol can be produced from cellulose. It is produced by anaerobic respiration of cellulose-based biomass by microorganisms. The cellulose is pre-treated by adding cellulose-digesting enzymes before it is used in anaerobic respiration. Suggest why pre-treatment is necessary.

(Extra space)

(3)

(e) Large areas of land have to be used to grow the plants to make biofuels. Ecologists have suggested that changes in land use could lead to a decrease in biodiversity.
Suggest how changes in land use could lead to a decrease in biodiversity.

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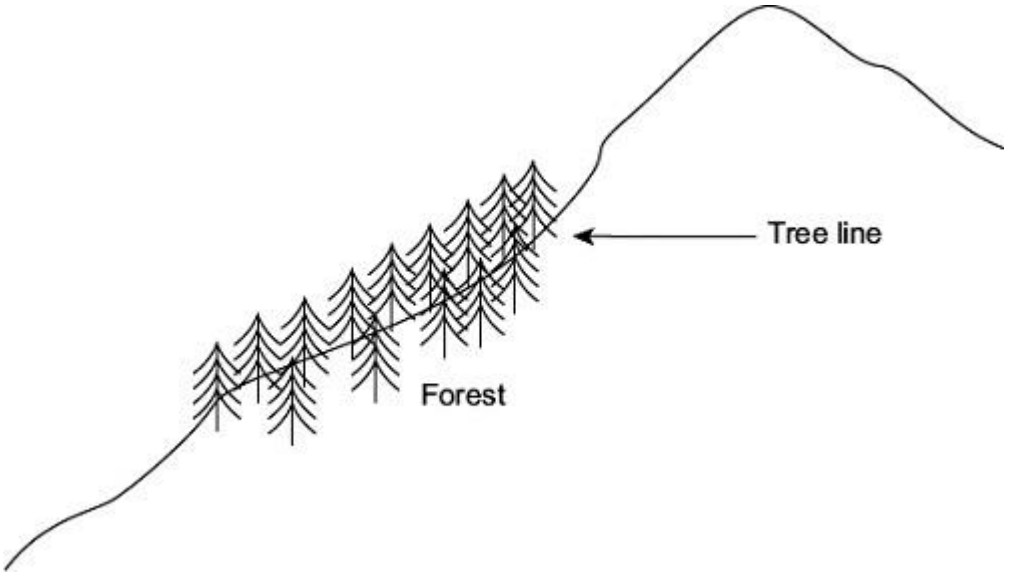
(2)

(Total 11 marks)

12 Mountains are harsh environments. The higher up the mountain, the lower the temperature becomes. The diagram shows a forest growing on the side of a mountain.
The upper boundary of the forest is called the tree line. Trees do not grow above the tree line.



(a) (i) The position of the tree line is determined by abiotic factors.
What is meant by an abiotic factor?

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(1)

(ii) Other than temperature, suggest **one** abiotic factor that is likely to affect the position of the tree line on the mountain.

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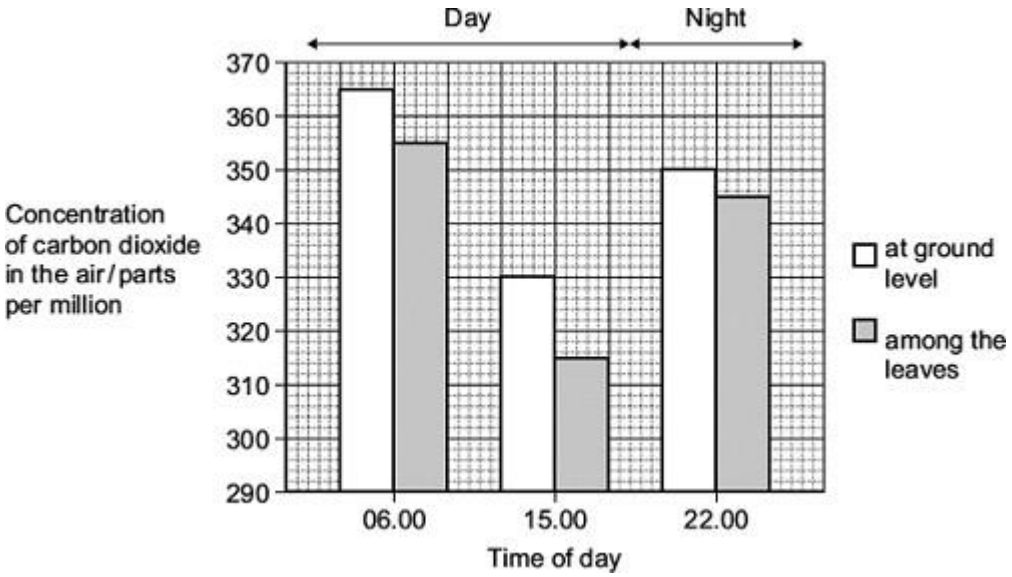
(1)

(b) Scientists measured the concentration of carbon dioxide in the air in one part of the forest. They took measurements at different times of day and at two different heights above the ground. Their results are shown in the bar chart.



Use your knowledge of photosynthesis and respiration to explain the data in the bar chart.

(Extra space)

(4)

(c) The population of trees in the forest evolved adaptations to the mountain environment. Use your knowledge of selection to explain how.

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*(Extra space)*_____

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(3)

(Total 9 marks)

13 In some countries, pigs are reared in intensive units in which the temperature is controlled. Agricultural scientists investigated the effect of temperature on pig growth and on the efficiency with which the pigs converted food to biomass.

(a) (i) In the investigation, the scientists used pigs of the same breed, with similar genotypes.
Explain why.

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(2)

(ii) The pigs were allowed to eat as much food as they wanted.
How could this have decreased the reliability of any conclusions drawn from the investigation?

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(2)

The table shows the results of this investigation.

Temperature / °C	Mean growth rate / kg per day	Efficiency of conversion of food to biomass /%
0	0.54	19
10	0.80	42
20	0.85	48
30	0.45	37
35	0.31	37

(b) (i) Describe the effect of temperature on mean growth rate.

_____

_____

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(1)

(ii) A student concluded from these data that the mean growth rate of the pigs was fastest at 20 °C.
Do you agree with this conclusion? Explain your answer.

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(2)

(c) (i) Pigs can survive at temperatures above 35 °C. Use the data to suggest why scientists did **not**
carry out any investigations at temperatures higher than 35 °C.

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(2)

(ii) The efficiency of conversion of food to biomass is lower at 0 °C than it is at 20 °C.
Suggest an explanation for the lower efficiency.

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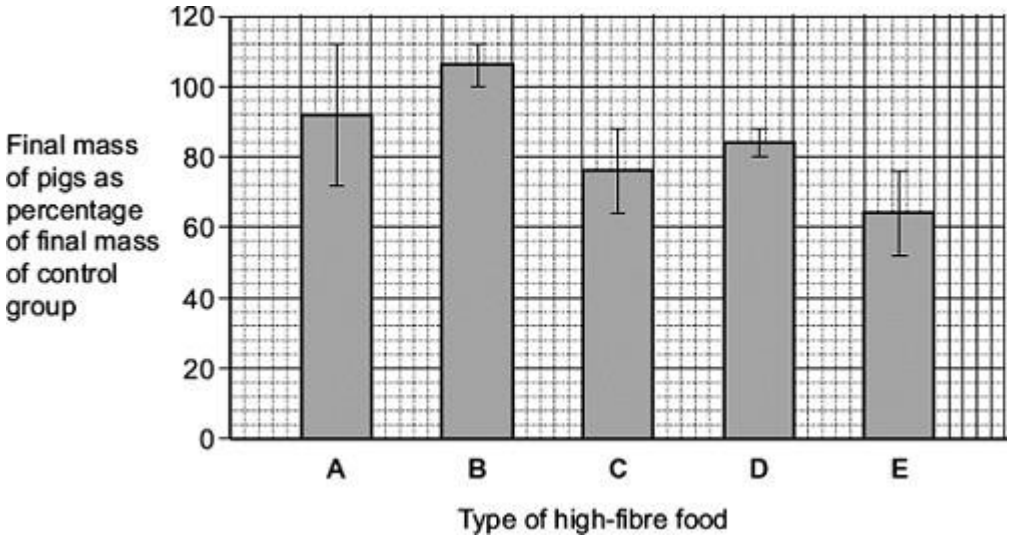
(2)

(d) Pigs require a mixture of fibre and protein in their food. The greater the ratio of fibre to protein, the less
the food costs.

Scientists took five large groups of pigs. They fed each group a different high-fibre food. Each of the foods contained fibre from different plant species, but they all had the same energy content. The scientists fed a control group of pigs a low-fibre food with the same energy content. After 10 days, the scientists compared
the masses of the pigs fed on high-fibre food to those fed on low-fibre food.

The graph shows the results of the investigation. The bars represent ±2 standard errors of the mean.



A farmer saw these results and concluded that he should replace his pigs' usual food with food **B**.
Evaluate this conclusion.

(Extra space)

(4)

(Total 15 marks)

14 Scientists measured the mean temperature in a field each month between March and October. The table shows their results.

Month	Mean temperature /°C
March	9
April	11
May	14
June	17
July	20
August	18
September	16
October	14

(a) The gross productivity of the plants in the field was highest in July.

Use the data in the table to explain why.

(2)

(b) (i) Give the equation that links gross productivity and net productivity.

(1)

(ii) The net productivity of the plants in the field was higher in August than in July. Use the equation in part (b)(i) and your knowledge of photosynthesis and respiration to suggest why.

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(2)

(c) A horse was kept in the field from March to October. During the summer months, the horse was able to eat more than it needed to meet its minimum daily requirements.

Suggest how the horse used the extra nutrients absorbed.

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(1)

(d) The horse's mean energy expenditure was higher in March than it was in August. Use information in the table to suggest why.

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(2)

(Total 8 marks)

15 Residual food intake (RFI) is the difference between the amount of food an animal actually eats and its expected food intake based on its size and growth rate. Scientists have selectively bred cattle for low RFI.

(a) (i) Explain the advantage to farmers of having cattle with a low RFI.

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(2)

(ii) When RFI is calculated, low values are negative. Explain why they are negative.

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(1)

(b) Scientists have developed a standard procedure for comparing RFI in cattle. They control **two** factors. These are type of food and environmental temperature. Explain why each of these factors needs to be controlled.

Type of food

_____

_____

_____

_____

Environmental temperature

_____

_____

_____

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(4)

(c) Bacteria in the digestive systems of cattle break down food and produce methane. Scientists investigated the relationship between RFI and methane production. They measured the rate of methane production of 76 cattle over a fifteen-day period. Some of the results are shown in **Table 1**.

Table 1

	Low RFI	**High RFI**
Mean rate of methane production / g day^{-1}	142.3	190.2

Suggest a null hypothesis for this investigation.

_____

_____

(1)

(d) Other scientists investigated the release of methane from rice fields. They investigated the effect of adding organic material (straw) and inorganic substances on the release of methane from rice fields. The results are shown in **Table 2**.

Table 2

Inorganic substance added to soil	**Total methane released over 30 days / μmol kg^{-1} soil**	
	Without straw	**With straw**
None	1179	25 492
Nitrate	63	764
Sulfate	19	144
Iron oxide	39	313
Manganese oxide	53	475

(i) Which treatment is most effective in reducing release of methane from rice fields?

_____

_____

(1)

(ii) Research findings are not always of direct use to farmers. What else would rice farmers need to know before acting on the results of this investigation?

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(2)

(iii) Methane is produced by anaerobic microorganisms in the soil. The scientists found that rice fields that are not flooded do not produce large amounts of methane.

Suggest why.

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(2)

(Total 13 marks)

16 Yield can be determined by measuring the dry mass of plants.

(a) Suggest how you could determine the dry mass of a sample of plant material.

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(2)

(b) What is the advantage of using dry mass and not fresh mass to compare the yield of plants?

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(2)

(Total 4 marks)

17 Tomato plants were grown in two glasshouses, each with an area of 2000 m^2. The table shows the mean number of hours of sunshine per month during fruit production.

	1995 – 1997 (no extra carbon dioxide	**1998 – 2000 (extra carbon dioxide)**
Mean number of hours of sunshine per month	148.91	147.00

- The scientists used heating to maintain the tempera ture inside the glasshouses above 18 °C. They opened the windows to keep the tempera ture below 30 °C.
- From 1998 to 2000 they maintained the carbon dioxide concentration between 0.06 % and 0.08 % when the windows were closed and between 0.04 % and 0.05 % when the windows were open.
- The carbon dioxide concentra tion in the air outside the glasshouse was 0.04 %.

(a) The scientists monitored the number of hours of sunshine per month. Explain why they monitored the number of hours of sunshine.

_____

_____

_____

_____

_____

_____

(2)

(b) The temperature, the use of fertiliser and the number of insect pests were controlled during this investigation. Name one other factor which should have been controlled during the investigation. Explain why variation in this factor would affect yield.

Factor _____

Explanation _____

_____

(2)

(Total 4 marks)

18

Introduction

Resource A – D relate to a single investigation.

Scientists investigated the effect of supplying extra carbon dioxide on the yield of tomatoes growing in a glasshouse. They compared the mean yield of tomatoes from 1995 to 1997 when no extra carbon dioxide was supplied with the mean yield of tomatoes from 1998 to 2000 when extra carbon dioxide was supplied.

Resource A

Tomato plants were grown in two glasshouses, each with an area of 2000 m^2. Figure 1 shows the mean number of hours of sunshine per month during fruit production.

Figure 1

	1995 - 1997 (no extra carbon dioxide)	**1998 - 2000 (extra carbon dioxide)**
Mean number of hours of sunshine per month	148.91	147.00

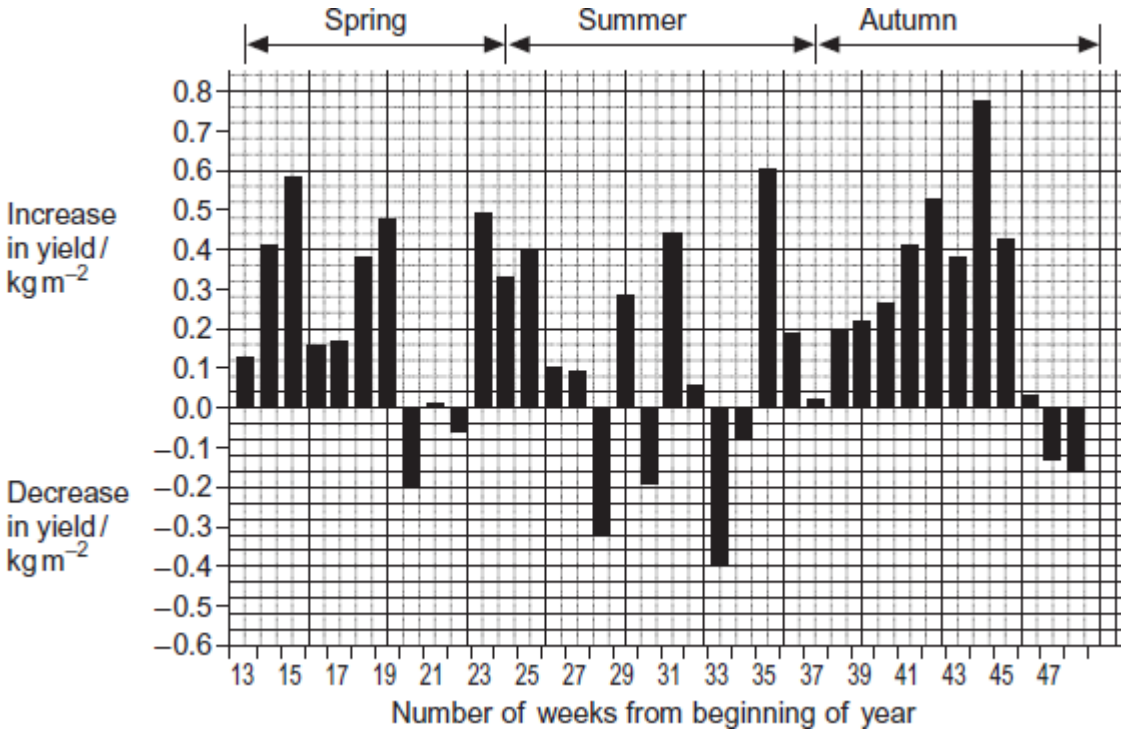
- The scientists used heating to maintain the tempera ture inside the glasshouses above 18 °C. They opened the windows to keep the tempera ture below 30 °C.
- From 1998 to 2000 they maintained the carbon dioxide concentration between 0.06 % and 0.08 % when the windows were closed and between 0.04 % and 0.05 % when the windows were open.
- The carbon dioxide concentra tion in the air outside the glasshouse was 0.04 %.

Resource B

Figure 2 shows the mean difference between the yield of tomatoes with extra carbon dioxide and the yield with no extra carbon dioxide for each week during the harvesting period.

If the yield is greater when extra carbon dioxide is supplied, the difference in yield is shown as an increase. If the yield is lower when extra carbon dioxide is supplied, the difference is shown as a decrease.

Figure 2



Resource C

Figure 3 shows the relationship between the time when the tomatoes were harvested and the yield.

Figure 3

Number of weeks from beginning of year	Mean yield per week with extra carbon dioxide / kg m^{-2}	Mean yield per week without extra carbon dioxide / kg m^{-2}
13 – 19	1.25	0.83
20 – 25	1.62	1.47
26 – 48	1.23	1.06

The commercial price for tomatoes varies with the time of year. The highest price is paid for tomatoes between weeks 13 and 19. The lowest price is paid between weeks 26 and 48.

Resource D

Whiteflies are an important insect pest of tomatoes. The adults can fly from plant to plant. Their young do not have wings. The adults and young feed on the plant sap and introduce viruses into the tomato plants. Feeding and the introduction of viruses both reduce the yield of tomatoes. The scientists controlled the number of whitefly in the glasshouses by releasing parasitic wasps. The wasps lay their eggs in the young of the whitefly. The wasp eggs hatch and feed on the young whitefly, killing them.

(a) (i) An increase in carbon dioxide concentration affected the yield of tomatoes in week 35. Use **Figure 2** to describe how.

_____

_____

(1)

(ii) There was a decrease in yield when extra carbon dioxide was supplied during some weeks of the year. Use information from **Resource A** to suggest why.

_____

_____

(1)

(b) Using **Figure 3**, calculate the percentage increase in yield when extra carbon dioxide was added for weeks 13 to 19. Show your working.

Percentage increase _____

(2)

(c) Additional information is required for tomato growers to decide whether it is economically profitable to add extra carbon dioxide to produce very early tomatoes.

Give **two** pieces of information that the growers would require.

1. _____

_____

2. _____

_____

(2)

(d) Adding extra carbon dioxide during the summer (weeks 24 – 36) is unlikely to be profitable. Use data from the resource sheet explain why.

_____

_____

_____

_____

(2)

(e) The control experiment in this investigation was when data were collected with no extra carbon dioxide added. Some scientists said this control experiment was not satisfactory. Explain how you could improve the control experiment.

_____

_____

_____

_____

(2)

(Total 10 marks)

Mark schemes

1

(a) 1. Oxygen produced in light-dependent reaction;
2. The faster (oxygen) is produced, the faster the light-dependent reaction.

(b) 35–36 µmol Oxygen per mg chlorophyll.

Correct difference at 500 µmol photons m^{-2} s^{-1} or incorrect difference but division by 4 shown = 1 mark.

(c) At all light intensities, chloroplasts from mutant plants:
1. Have faster production of ATP and reduced NADP;
2. (So) have faster / more light-independent reaction;
3. (So) produce more sugars that can be used in respiration;
4. (So) have more energy for growth;
5. Have faster / more synthesis of new organic materials.

Accept converse points if clear answer relates to non-mutant plants

2

(a) 1. To kill any fungus / bacteria on surface of seeds or in soil;
2. So only the added fungus has any effect.

(b) So that only nitrate or ammonia / type of fertiliser affects growth.

(c) 1. So that effects of nitrate or ammonium alone could be seen;
2. So that effects of fungus can be seen.

(d) 1. Weigh samples at intervals during drying;
2. To see if weighings became constant (by 3 days).

(e) With live fungus – showing effects of the fungus:
1. Fungus increases growth of roots and shoots in both;
2. Produces greater growth with nitrate.

With heat-treated fungus – showing effects of fertiliser:

3. Similar dry masses for roots and shoots;
4. (Probably) no significant difference because SDs overlap.

(f) 1. Dry mass measures / determines increase in biological / organic material;
2. Water content varies.

(g) 1. Fungus with nitrate-containing fertiliser gave largest shoot: root ratio;
2. And largest dry mass of shoot;

2 max

2

2

4 max

[8]

2

1

2

2

4

2

[15]

3

(a) 1. (Use) coordinates / number the rocks/sites/squares;

Ignore: references to grid, tape measures, metre rulers etc.

2. Method of generating/finding random numbers e.g. calculator/computer/random number generator/random numbers table;

Accept: numbers out of a hat / use of dice.

(iii) 1. F

(b) Difficult/too many to count / individual organisms not identifiable / too small to identify/count / grows in clumps;

Ignore: easier/quicker/representative/ more accurate, unless qualified.

(c) Any suitable factor with valid explanation = 1 mark

1. Wave action - firmer grip on rock is necessary (at either site);
2. Wind/air movement/less humid - more evaporation at site A / more (physical) damage;
3. Light – (linked to) photosynthesis (at either site);
4. Temperature – (linked to) photosynthesis/respiration/enzymes/ evaporation (at either site);
5. pH – (linked to) enzymes/proteins;

Note: other common factors include salt (salinity) linked to water potential / named nutrient e.g. nitrate linked to protein/DNA.

Ignore: carbon dioxide/oxygen/pollution/rainfall/food/nutrients.

Reject: biotic factors e.g. predation.

(d) 1. Greater variety of food / more food sources;

Ignore: more food.

2. More/variety of habitats/niches;

Ignore: homes/shelters.

Accept: different habitats.

(e) (i) 1. (So they were) hungry/not full;

Accept: description of hunger e.g. appetite / 'empty stomach'/'so they eat'.

2. (Allows) comparison;

(ii) 1. Alga without consumer/named consumer/animal;

Accept: repeat experiment without consumer.

Accept: in separate tank / in tank where not eaten.

2. (Find change in mass) in dark;
3. For 50 hours;

Accept: 'same time as in experiment'.

Accept: For lower time period then scaled up to 50.

2

1

2 max

2

2

3

(difference in results) significant /reject null hypothesis / not due to chance / less than 5%/0.05 probability due to chance;

Accept: for Laurencia pacifica 'less than 1%/0.01 probability'.

2. For *Egregia leavigata* **and** *Microcystis pyrifera* no significant (difference in results)/accept null hypothesis / is due to chance/more than 5%/0.05 probability due to chance;

Accept: 'insignificant' for 'no significant difference'.

3. (Difference in results) for *Laurencia pacifica* is the most significant;

Note: reference to probabilities on their own is not sufficient.

1, 2 and 3. Accept: abbreviations for all species.

3

[15]

4

(a) (i) Unit of energy / mass, per area, per year.

1

(ii) 1. Less light / more shading / more competition for light;

Neutral: references to animals

2. Reduced photosynthesis.

Accept: no photosynthesis

2

(b) 1. Pioneer species;

2. Change in abiotic conditions / less hostile / more habitats / niches;

Accept: named abiotic change or example of change e.g. formation of soil / humus / organic matter / increase in nutrients

Neutral: reference to change in environment unqualified

Neutral: more hospitable / habitable / homes / shelters

3. Increase in number / amount / diversity of species / plants / animals.

Accept: other / new species (colonise)

3

(c) 1. Net productivity = gross productivity minus respiratory loss;

2. Decrease in gross productivity / photosynthesis / increase in respiration.

2

(d) 1. Conserving / protecting habitats / niches;

2. Conserving / protecting (endangered) species / maintains / increases (bio) diversity;

3. Reduces global warming / greenhouse effect / climate change / remove / take up carbon dioxide;

4. Source of medicines / chemicals / wood;

5. Reduces erosion / eutrophication.

Accept: tourism / aesthetics / named recreational activity

1 max

[9]

5

(a) (i) 1. Amino acid / protein / enzyme / urea / nucleic acid / chlorophyll / DNA / RNA / / ATP / ADP / AMP / NAD / NADP;

2. DNA / RNA / nucleic acid / ATP / ADP / AMP / NADP / TP / GP / RuBP / phospholipids;

1. and 2. Accept any named equivalent examples e.g. nucleotides.

Neutral: ammonia / nitrite / nitrate / phosphate.

2

(ii) 1. Saprobiotic (microorganisms / bacteria) break down remains / dead material / protein / DNA into ammonia / ammonium;

Accept: saprobionts / saprophytes / saprotrophs

Neutral: decomposer

2. Ammonia / ammonium ions into nitrite and then into nitrate;

Allow correct chemical symbols.

Accept: correct answers which use incorrect bacteria e.g. nitrogen-fixing but then reject m.p. 3.

3. (By) Nitrifying bacteria / nitrification;

3

(b) 1. Nitrate / phosphate / named ion / nutrients for growth of / absorbed / used by plants / algae / producers;

2. More producers / consumers / food **so** more fish / fish reproduce more / fish grow more / fish move to area;

Must have idea of more plants related to some increase in fish.

6

(a) Succession;

Ignore any word in front of succession e.g. secondary / ecological succession.

Neutral 'forestation'.

(b) 1. Greater variety / diversity of plants / insects / more plant / insect species;

Neutral: more plants.

2. More food sources / more varieties of food;

Neutral: more food / more / greater food source (singular).

3. Greater variety / more habitats / niches;

Accept: more nesting sites.

Q *Neutral: more homes / shelters.*

(c) (i) Temperature and carbon dioxide;

.

2

[7]

1

3

1

(ii) Shows (gross) photosynthesis / productivity minus respiration / more carbon dioxide used in photosynthesis than produced in respiration;

Correct answers are often shown as: net productivity = (gross) photosynthesis – (minus) respiration.

1

(iii) 1. (Shade plant) has lower (rate of) respiration / respiratory losses / less CO2 released at 0 light intensity / in dark;

Accept use of figures.

Accept: lower compensation point.

2. Greater (net) productivity / less sugars / glucose used / more sugars / glucose available;

Neutral: any references to rate of photosynthesis.

2

[8]

7 (a)

Part of ecosystem	**Mean rate of carbon dioxide production / $cm^3\ m^{-2}\ s^{-1}$**	**Percentage of total carbon dioxide production measured by the scientists**
Leaves of plants	0.032	25.0
Stems and roots of plants	0.051	**39.8**
Non-photosynthetic soil organisms	0.045	**35.2**

2 correct = 2 marks;;

Adding rates to get 0.128 = 1;

If rounded to 40 and 35 in table;

- *but working shows decimal points, then award 2 marks*
- *but no working shown, then 1 max*

2 max

(b) 1. Data only include (heterotrophic) soil organisms;

2. Doesn't include animals (above ground) / other (non-soil) organisms;

3. Doesn't take into account anaerobic respiration;

Award points in any combination

Accept for 1 mark idea that CO_2 for leaves doesn't take into account photosynthesis – not told in dark until part (d)

2 max

(c) **All three** of following = 2 marks;;

Two of them = 1 mark;

Volume of carbon dioxide given off

(From known) area / per m^2 / m^{-2}

In a known / set time

Ignore 'amount' / concentration of CO_2

Accept per second / per unit time

2

(d) 1. (In the light) photosynthesis / in the dark no photosynthesis;

2. (In light,) carbon dioxide (from respiration) being used / taken up (by photosynthesis);

2

(e) (i) (Rate of respiration)

Assume "it" means soil under trees

1. In soil under trees (always) higher;

Accept converse for soil not under trees

Accept 'in the shade' means under the trees

2. In soil under trees does not rise between 06.00 and 12.00 / in the middle of the day / peaks at 20:00-21.00 / in the evening;

3. In soil **not** under trees, peaks at about 14:00-15:00 / in middle of day;

2. and 3. No mm grid, so accept 'between 18.00 and 24.00' or 'between 12.00 and 18.00'

2 max

(ii) (Between 06.00 and 12.00, (No Mark))

Respiration higher in soil under tree, (No mark)

Do not mix and match mark points

No list rule

1. Tree roots carry out (a lot of) respiration;

2. More / there are roots under tree;

Accept converse for soil not under trees

OR

3. More food under trees;

4. So more active / greater mass of / more organisms (carrying out respiration);

Accept converse for soil not under trees

OR

Soil not under trees respiration increases (No mark)

5. Soil in sunlight gets warmer;

6. Enzymes (of respiration) work faster;

Accept converse for soil under trees

2 max

(f) (i) 1. Photosynthesis produces sugars;

2. Sugars moved to roots;

Do not penalise named sugars other than sucrose

3. (Sugars) are used / required for respiration;

2 max

(ii) Takes time to move sugars to roots;

Look for movement idea in (i) – can carry forward to (ii)

1

[15]

8

1. Growth of algae / surface plants / algal bloom blocks light;
2. Reduced / no photosynthesis so (submerged) plants die;
3. Saprobiotic (microorganisms / bacteria);

   3. Accept: Saprobiont / saprophyte / saprotroph

   3. Neutral: decomposer
4. Aerobically respire / use oxygen in respiration;
5. Less oxygen for fish to respire / aerobic organisms die;

[5]

9

1.P Pathogens and effects on host

2.T Taxonomy

2.C Classification and evolution.

2.I Inheritance and evolution

2.Gc Genetic code, universal

2.B Behaviour

2.Ev Populations and evolution, variation between individuals within a species

3.BP Relationships within ecosystems − eg predator / prey

3.E Energy transfer in ecosystems

3.N Nutrient cycles, the organisms involved

3.S Succession, biodiversity, species and individuals in a community

4.H Human impacts on the environment and its effect on relationships between organisms − including farming

4.Gt Gene technology and GMO and selective breeding

4.Ar Antibiotic resistance

Examiners are free to select other letters if they wish

The emphasis in answers should be on the relationships and interactions between organisms not just the topics themselves

Breadth, one mark for use of an example from each of the following approaches − 3 max:

1. Pathogen and host

2. Evolution (related topics)

3. Ecological

4. Human intervention in relationships

[25]

10

(a) 1. Chlorophyll absorbs light energy;

Accept light energy 'hits' chlorophyll

Accept photon for light energy

2. Excites electrons / electrons removed (from chlorophyll);

Accept higher energy level as 'excites'

3. Electrons move along carriers / electron transport chain releasing energy;

Accept movement of H^+ / protons across membrane releases energy

4. Energy used to join ADP and Pi to form ATP;

Negate 'produces energy' for either mark but not for both

Accept energy used for phosphorylation of ADP to ATP

Do not accept P as Pi

5. Photolysis of water produces protons, electrons and oxygen;

3. and 4.

6. NADP reduced by electrons / electrons and protons / hydrogen;

Accept NADP to NADPH (or equivalent) by addition of electrons / hydrogen

Do not accept NADP reduced by protons on their own

5 max

(b) 1. Variation / variety;

2. Mutation;

Do not accept answers which suggest the mutation is caused by copper

3. Some plants have allele to survive / grow / live in high concentration of copper / polluted soils;

Reference to immunity disqualifies this mark

Do not disqualify mark for references to allele providing resistance to copper

4. (Differential) reproductive success / adapted organisms reproduce;

5. Increase in frequency of allele;

6. No interbreeding (with other populations) / separate gene pool / gene pool differs (from other populations);

Accept reproductive isolation

5 max

[10]

11

(a) 1. Is widely / commonly used;

2. Provides a standard / benchmark / reference;

Allow a variety of descriptors for marking point 2 e.g. 'provides a base line',

'produces known amount of carbon dioxide'

Mark point 2, do not accept 'for comparison' on its own as 'comparison' is in stem of question

3. Produces large amount of carbon dioxide;

4. Is a decreasing resource / could be replaced by biofuel;

Ignore reference to a control

2 max

(b) 1. Independent / no bias / trustworthy;

2. Non-profit making;

3. (Focused on) effect on environment / climate;

2 max

(c) 1. CO_2 taken up in photosynthesis;

2. More taken up than produced (when it is used) with less CO_2 produced than petrol;

2

(d) 1. (These microorganisms) don't have (cellulose-digesting) enzymes;

Accept 'don't make enough of these enzymes' for mark point 1

2. (Cellulose) is a polysaccharide / polymer / long (molecule / chain);

Accept 'large' for mark point 2

3. (Cellulose) is insoluble / glucose / product of digestion is soluble;

4. Broken down into glucose / monomers / monosaccharides;

Ignore (alpha) glucose for mark point 4.

Do not accept sugars for mark point 4

5. Sugars / glucose used in glycolysis / glucose can be converted to pyruvate;

6. Produces more ethanol / fuel produces ethanol / fuel quicker;

Accept 'speeds up process' for mark point 6

3 max

(e) 1. Removes species / fewer species / growth of single crop / single plant species / monoculture;

Deforestation or removal of hedges on its own should not be credited

2. Removes habitats / fewer habitats / niches / only one habitat;

3. Removes variety of food sources / fewer food sources / only one food source;

2 max

[11]

12 (a) (i) Non-living / physical / chemical factor / non biological;

Do not accept named factor unless general answer given.

1

(ii) Accept an abiotic factor that may limit photosynthesis / growth;

Reject altitude / height

Water

Named soil factor

Not "soil" / "weather"

Light

Carbon dioxide

Accept Oxygen

Incline / aspect

Wind / wind speed

1

(b) 1. Correct explanation for differences between day and night e.g. photosynthesises only during the daytime / no photosynthesis / only respiration at night;

2. Net carbon dioxide uptake during the day / in light

OR

No carbon dioxide taken up at night / in dark / carbon dioxide released at night / in dark;

3. At ground level more respiration / in leaves more photosynthesis;

4. Carbon dioxide produced at ground level / carbon dioxide taken up in leaves;

Principles

Comparing day and night / light and dark

1. Explanation in terms of photosynthesis / respiration

2. Effect on carbon dioxide production / uptake

Comparing leaves with ground level

3. Explanation in terms of photosynthesis / respiration

4. Effect on carbon dioxide production / uptake

2 and 4 must relate to why the change occurs

4

(c) 1. Variation in original colonisers / mutations took place;

2. Some better (adapted for) survival (in mountains);
2. Allow "advantage so able to survive"

3. Greater reproductive success;

4. Allele frequencies change;
4. Reject gene / genotype

3 max

[9]

13 (a) (i) 1. Same breed so similar alleles;
1. Allow different alleles have different effects

2. Controls / removes variable / so genes not a factor / only temperature affects results / rate of growth affected by genes;
2. Accept idea worded in such terms as inherited.

2

(ii) 1. Different growth rates / gained different biomass / grew different amount;
Allow "more food for growth"
Ignore references to efficiency of conversion.

2. Not due to temperature / the independent variable;

2

(b) (i) Rise then fall with peak at 20 °C;
Do not accept 0.85 as alternative to 20.

1

(ii) 1. Temperature may be between 10 and 30 / 10 and 20 / 20 and 30;
No mark for yes or no.

2. Intervals are 10°C / large / not small / should be smaller / should be intermediates;

2

(c) (i) 1. Growth rate decreasing / conversion staying same / decreasing;

2. (Scientists would be) looking for high growth rate / conversion / data shows unlikely to improve growth / yield;

3. Wastes time / resources / would not relate to farming conditions;
3. Ignore cruelty to pigs

2 max

(ii) 1. Will lose more heat / not as much energy used to maintain body temperature;

1. Must be a comparative statement

Accept energy as equivalent to heat in the context of this question

2. Heat resulting from respiration / more respiration;

2. Do not credit answers relating to energy made in respiration

3. More food used in respiration;

2 max

(d) In support

Read standard deviation as standard error

1. Food **B** produces greater mass than control / greater than 100%;

1. Must refer to control

But

2. Error bars for **B** mean **B** could be no better / not different from control;

3. Overlap of error bars for **B** and **A**;

4. A no better than / not different from **B**;

4.** Neutral: "Results not significant". Mark must compare **A** to **B

Experimental limitations

5. Experiment only ran for 10 days;

6. Experimental conditions / breed of pig may not be the same as on the farm;

7. No information about cost;

14 (a) 1. High temperature allows enzymes to work faster / allows more collisions / allows more e-s complexes to be formed

OR

A lot of light so light not limiting;

2. Photosynthesis reactions are faster / more photosynthesis;

Accept enzymes more effective. Ignore references to respiration. Ignore references to optimum (temperature or light).

(b) (i) Gross productivity = net productivity + respiratory loss / respiration;

Accept any correct rearrangement of this equation

ons

Reject respiratory rate.

4 max

[15]

2

1

(ii) 1. Respiration slower / less respiration;

Unspecified references refer to August. Allow converse of respiration faster but must specify July / higher temperature

2. Light-dependent reaction / photosynthesis less affected by temperature increase;

3. Lower (energy) loss;

Unspecified references refer to August. Allow converse of higher loss but must specify July

"Lower respiratory losses (in August)" can meet both points 1 and 3 and gain 2 marks.

2 max

(c) 1. Stored as fat / glycogen / biomass;

Reject stored energy. Ignore respiration

2. Used for growth / movement / reproduction / process involved in growth / movement / reproduction;

2 max

(d) 1. More heat / energy is lost (in March) / colder (in March);

2. Maintain / regulate body temperature / more heat generated;

Accept keep warm.

3. By respiration / metabolism;

15 (a) (i) Reduced cost;

Less feed / less land use / more growth rate with same amount of food;

Allow is 'cost effective'

(ii) Amount of food taken in less than expected.

Allow 'expected food intake is higher,

Allow 'food intake is lower than it should be'

(b) Type of food (not a mark)

1. May vary in protein / fat / carbohydrate / fibre / roughage / vitamins / minerals;

2. May affect absorption / digestibility / energy value / tastiness / growth / overall food intake;

For mark point 1 allow appropriately named food compound e.g. cellulose, glucose

tors are affected bythe type of food.

2 max

[8]

2

1

Temperature (not a mark)

3. Will affect heat loss / gain / respiration / metabolism;

4. More food / energy can be used for growth;

Note: two maximum marks for effect of temperature.

4

(c) RFI does not affect methane production /

There is no difference in the rate of methane production for low and high RFI values /

The difference between the rates of methane production is due to chance /

No correlation / relationship / link between RFI and methane production;

Any clear statement that there is no link between RFI and methane production should be credited.

1

(d) (i) Sulfate without straw;

1

(ii) 1. May affect yield / damages rice crop;

2. Substance / treatment may affect other organisms / environment;

3. Cost of substance / application / labour;

4. Method / frequency / timing of application / amount of substance required;

2 max

(iii) Not flooded aerobic conditions / more oxygen / with flooding anaerobic conditions / less oxygen;

Not flooded fewer / less active anaerobic microorganisms / respiration / not flooded more / more active aerobic microorganisms / respiration;

2

[13]

16 (a) Heat at 100°C / heat to temp to evaporate water;

Value which would not burn material

Weigh and heat until no further change in mass;

2

(b) Amount of water present will vary;

This will affect fresh mass / will not affect dry mass;

2

[4]

17 (a) To see if a difference in hours of sunshine was present / because it is necessary to monitor factors which cannot be controlled;
So that they could eliminate this factor from affecting the yield (with /without extra carbon dioxide);
OR
Duration of light influences length of time for photosynthesis / temperaturein glasshouse;
Higher photosynthesis results in higher yield / more carbohydrates /sugars / proteins produced;

2 max **2**

(b) Named factor;
Explanation of why the factor is important;
E.g.
Density of planting;
Competition for named resource;
or
Same variety of tomato;
Yield will vary with different varieties / with different genotypes;
or
Water (application);
Water needed for expansion of fruit / maintain leaf turgidity / maintain stomatal opening / replace water lost in transpiration / water used in photosynthesis;

For named resourceaccept 'nutrient' but not 'food'

2

18 (a) (i) Yield increases by 0.6 kg m^{-2} (when extra carbon dioxide present);

1

(ii) Temperature / light intensity so could be lower in these weeks (as temperature / light insensity not fully controlled / monitored) (over period 1998 – 2000);

1

(b) Two marks for correct answer of 50.6%;;
One mark for incorrect answer in which candidate has shown clearly that calculation based on an increase / 0.42 and original mass / 0.83

2

(c) Cost of supplying carbon dioxide;
Price of (very early) tomatoes;

2

(d) Lowest price paid for tomatoes;
Some carbon dioxide lost as windows open in summer;
Little / no mean increase in yield in summer;

2 max

(e) Grow with extra carbon dioxide in one glasshouse and without carbon dioxidein other glasshouse at same time;
So all environmental conditions / light and temperature same for experiment and control;

[4]

[10]