Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel Level 3 GCE

Time 2 hours

Paper reference **9BN0/01**

Biology A (Salters Nuffield)

Advanced

PAPER 1: The Natural Environment and Species Survival

You must have:
Ruler, pencil and calculator

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- **Show all your working out** in calculations and **include units** where appropriate.
- Answer the questions in the spaces provided – *there may be more space than you need.*

Information

- The total mark for this paper is 100.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- You may use a scientific calculator.
- In questions marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over

©2022 Pearson Education Ltd.

Answer ALL questions.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Mineral ions are required for plant growth.

(a) (i) Nitrate ions are required for the synthesis of

(1)

☐ **A** amino acids

☐ **B** cellulose

☐ **C** starch

☐ **D** sucrose

(ii) Phosphate ions are required for the synthesis of

(1)

☐ **A** cellulose

☐ **B** chlorophyll

☐ **C** nucleic acids

☐ **D** sucrose

(iii) Magnesium ions are present in the structure of

(1)

☐ **A** amino acids

☐ **B** cellulose

☐ **C** chlorophyll

☐ **D** starch

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(b) Mineral ions enter the plant through the roots.

Mineral ions in the soil are in lower concentrations than in the vacuoles of root hair cells.

Describe how mineral ions are taken up by root hair cells.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for Question 1 = 6 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

2 Anthropogenic activities are contributing to global warming.

Scientists from the IPCC (Intergovernmental Panel on Climate Change) say that changes to diet can have a major impact on greenhouse gas emissions. The method of farming affects the level of impact.

The Paris Agreement of 2015 committed countries to reduce carbon emissions.

(a) How many of the following statements about global warming are correct?

(1)

- global warming is caused by a reduction in greenhouse gases
- deforestation may contribute to global warming
- global warming is leading to the melting of sea ice
- global warming may lead to a change in rainfall patterns
- global warming is affecting only the ice caps

☒ **A** 2

☒ **B** 3

☒ **C** 4

☒ **D** 5

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

(b) The table shows the mass of greenhouse gas released in the production of one serving of a variety of sources of protein.

Source of protein	Mass of greenhouse gas released in the production of one serving of the protein / kg
Beef	7.0
Lamb	5.0
Chicken	2.5
Cheese	2.0
Tofu (from soya beans)	1.0
Nuts	0.5

(i) Explain why a diet based on plant protein produces lower greenhouse gas emissions than a diet based on animal protein.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(ii) Beef cattle are traditionally reared by grazing on natural pastures (grassland).

In recent years, large areas of rainforest have been cleared to produce beef.

Explain why the farming of beef cattle on deforested land produces more greenhouse gas emissions than from those reared on natural pastures.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

(Total for Question 2 = 7 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

BLANK PAGE

3 Peat bogs are formed over millions of years from the remains of plants and animals.

Waterlogging and acidic conditions prevent the decomposition of plants and animals in peat bogs.

The photograph shows peat being cut from a peat bog.

(Source: © Reimar/Shutterstock)

(a) (i) State how the age of the layers in a peat bog can be determined.

(1)

.....

.....

(ii) Explain why the conditions in peat bogs prevent decomposition.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(b) In the 1980s, there was a scheme to plant trees in areas of peat bog.

This dries out the bog and allows it to decompose, releasing the carbon dioxide locked in the peat bog.

Conservationists are cutting down trees and raising the water level to recreate the peat bog. It is estimated that the peat bogs will recover in 15 years.

The photograph shows sphagnum moss that grows on the surface of peat bogs and helps their formation.

(Source: © Jan Holm/Shutterstock)

Devise a procedure to measure the rate of recovery of the peat bog.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for Question 3 = 8 marks)

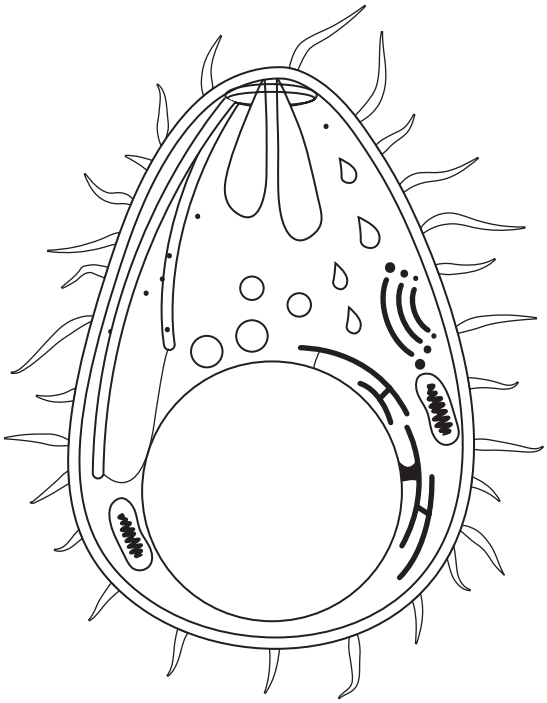
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

4 Malaria is a disease that kills more than 400 000 people every year.

It is caused by *Plasmodium*, a single-celled organism that lives in the blood.

Plasmodium is transmitted by mosquitoes.

The diagram shows a *Plasmodium* organism.



(a) State and justify two structures shown in the diagram that indicate that *Plasmodium* is a eukaryotic organism.

(2)

.....

.....

.....

.....

.....

.....

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(b) Malaria can be controlled by killing the mosquitoes that transmit the disease.

Scientists are genetically modifying *Metarhizium pingshaense*, a fungus that infects mosquitoes.

The genetically modified (GM) fungus contains a gene from a species of spider. This gene codes for a protein that kills mosquitoes.

(i) The GM fungus transcribes and translates the gene for this protein.

Describe the primary structure of a protein.

(2)

.....

.....

.....

.....

(ii) The primary structure of this protein is then converted into a tertiary structure and modified by organelles in the cell.

Describe the role of the organelles involved in these processes.

(5)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for Question 4 = 9 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

5 Porphyria is a life-threatening genetic disease. It is caused by a mutation in the gene coding for an enzyme involved in the production of haem.

In people with porphyria, haem cannot be produced.

(a) Explain why this mutation may prevent the enzyme involved in the production of haem from functioning correctly.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

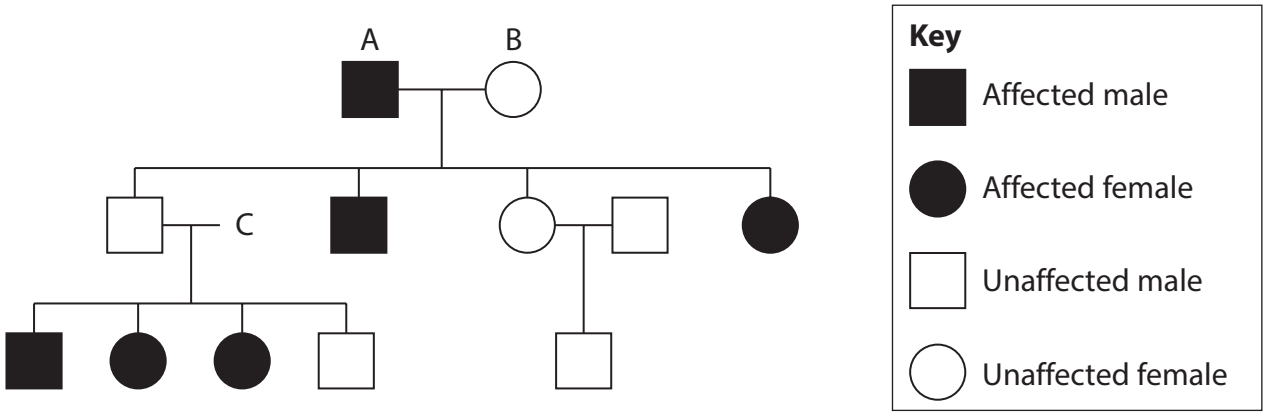
.....

.....

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(b) Porphyria is caused by a dominant allele and may not develop until later in life.

The pedigree diagram shows a family in which some individuals have porphyria.



(i) State the genotype and phenotype of person C.

(1)

.....

.....

(ii) Person A and Person B have one son with porphyria. What was the probability of them having a child that was male and had porphyria?

(1)

☒ **A** 0.00

☒ **B** 0.25

☒ **C** 0.50

☒ **D** 1.00

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(c) A new technique known as gene silencing has been developed to treat this disease.

Molecules known as small interfering RNA (siRNA) combine with mRNA to prevent translation.

Deduce how siRNA may be used to prevent the development of porphyria.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for Question 5 = 10 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

6 Leigh syndrome is a disease of the nervous system that affects the brain.

It is caused by a mutation in the DNA present inside mitochondria.

(a) Draw and label a mitochondrion.

(2)

(b) Mitochondrial diseases such as Leigh syndrome are passed on by the mother during fertilisation.

Explain why a fertilised egg cell will contain only maternal mitochondria.

(2)

.....

.....

.....

.....

.....

.....

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(c) Using IVF, it is possible to produce an embryo that does not have the mitochondrial disease.

The nucleus is removed from a donor egg cell from another individual.

The nucleus from a fertilised egg from a mother with the mutation is then placed in the egg cell from the donor.

(i) Explain why the resulting embryo does not develop mitochondrial disease.

(2)

.....

.....

.....

.....

.....

.....

.....

(ii) Comment on the inheritance of parental characteristics in offspring produced in this way.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for Question 6 = 9 marks)

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

7 Measles is a contagious disease that can be controlled by vaccination.

Not all parents choose to have their children vaccinated.

The table shows the number of cases of measles and the percentage of children vaccinated in the UK between 2012 and 2017.

Year	Number of cases of measles	Percentage of children vaccinated (%)
2012	1564	91.2
2013	1855	92.3
2014	135	92.7
2015	71	92.3
2016	556	91.9
2017	216	91.6

(a) (i) Calculate the percentage change in the number of cases of measles from 2013 to 2014.

Give your answer to three significant figures.

(2)

..... %

(ii) One conclusion from the data is that it takes time for an increase in vaccination rate to reduce the number of cases of measles in children.

Explain why this is a valid conclusion.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

(b) The incidence of measles has risen by 300% worldwide in recent years.

A study has found that some B memory cells and antibodies are destroyed by the measles virus.

(i) Antibodies are released into the blood when

(1)

☒ **A** B cells are activated to become killer cells

☒ **B** B cells are activated to become plasma cells

☒ **C** macrophages are activated to become B cells

☒ **D** plasma cells are activated to become memory cells.

(ii) Vaccinations are carried out against many serious diseases.

Vaccination leads to the production of antibodies and memory cells.

Which kind of immunity is provided by this type of vaccination?

(1)

☒ **A** active artificial

☒ **B** active natural

☒ **C** passive artificial

☒ **D** passive natural

(iii) Explain why, following a measles infection, it may be advisable for children to repeat other vaccinations they have had.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for Question 7 = 11 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

8 Tuberculosis (TB) is a disease that affects the lungs. It is caused by the bacterium *Mycobacterium tuberculosis*. When these bacteria enter the body an immune response is triggered.

(a) The initial response when bacteria enter the body is a

(1)

☒ **A** non-specific response and bacteria are destroyed by antibodies

☒ **B** non-specific response and bacteria are destroyed by phagocytes

☒ **C** specific response and bacteria are destroyed by antibodies

☒ **D** specific response and bacteria are destroyed by phagocytes.

(b) *M. tuberculosis* bacteria can remain dormant in the body after infection.

Explain why these dormant bacteria are not destroyed by the immune system.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

(c) The Human Immunodeficiency Virus (HIV) affects the immune system. People infected with HIV are more likely to develop TB.

A study investigated the relationship between TB infections and HIV status.

In 2008, the number of people in the world estimated to have TB was 9.4 million.

The table shows the percentage of these people who were either HIV positive or HIV negative. The estimated number of deaths due to TB is also shown in the table.

HIV status	Percentage of people with TB in 2008 (%)	Estimated number of patients with TB who died in 2008	Percentage of deaths due to TB (%)
HIV positive	15	521 700	
HIV negative	85	1 278 400	16

(i) Calculate the percentage of TB patients infected with HIV who died of TB.

(2)

..... %

(ii) Describe the effect of HIV on the number of deaths from TB.

(2)

.....

.....

.....

.....

.....

.....

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

*(iii) There are increased numbers of deaths from TB as a result of HIV infection.

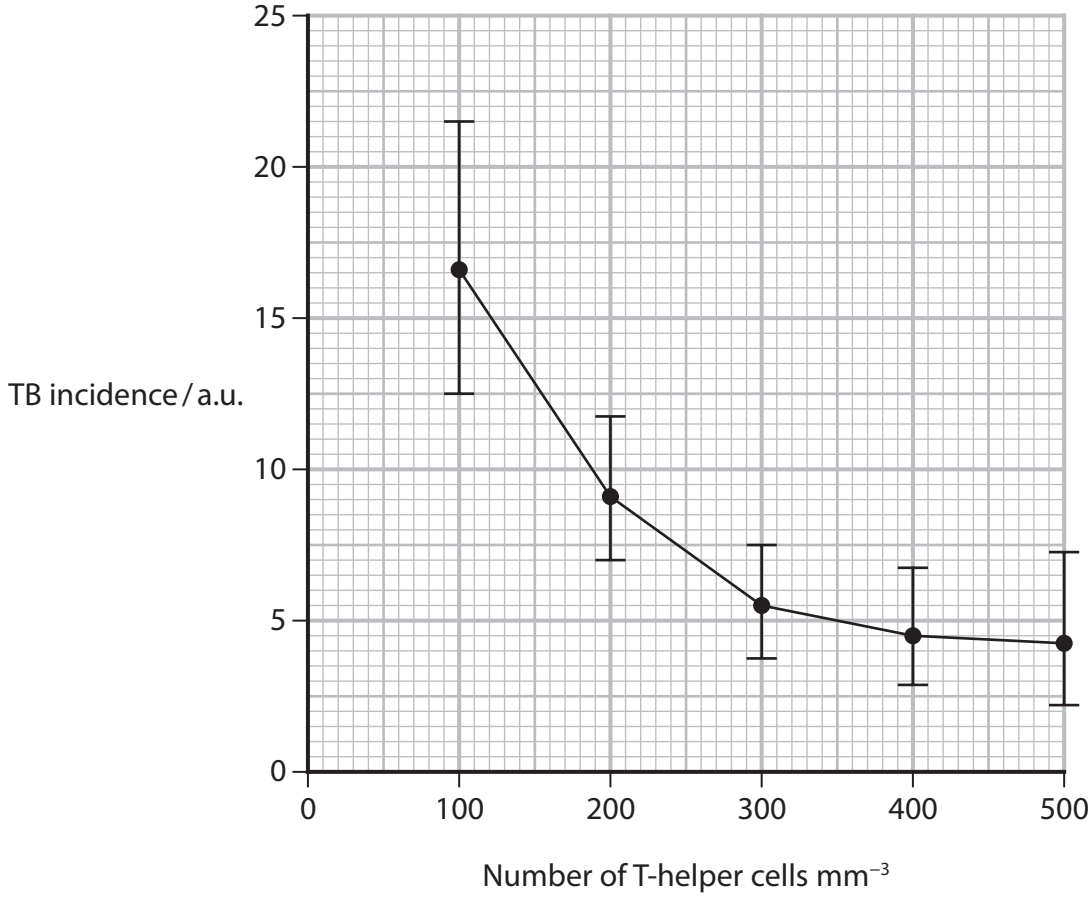
The table shows data for deaths worldwide from HIV and TB in 2016.

Type of infection	Number of deaths
TB only	1 300 000
HIV only	826 000
TB and HIV	374 000

Treatment of HIV with anti-viral drugs has reduced the incidence of TB associated with HIV infection.

The replication of HIV reduces the T-helper cell count. These anti-viral drugs reduce the replication of the virus in the body.

The graph shows the effect of this on the incidence of TB.



P 6 7 0 9 0 R A 0 2 2 3 2

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Explain the effect of using anti-viral drugs to treat HIV on the number of deaths from TB.

(6)

(Total for Question 8 = 14 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

BLANK PAGE

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

9 A biodiversity hotspot is a region that is both highly diverse and threatened with destruction.

(a) Biodiversity can be measured by the number of

(1)

☒ **A** different genes in a population.

☒ **B** different species in a habitat.

☒ **C** homozygotes in a habitat.

☒ **D** individuals in a population.

(b) Biodiversity hotspots have at least 1500 endemic plant species.
These hotspots have lost at least 70% of their natural vegetation.

Explain how protection of these hotspots can affect global biodiversity.

(2)

.....

.....

.....

.....

.....

.....

(c) A population of white-tailed deer *Odocoileus virginianus* was introduced from North America into Finland in 1934. There were four females and one male. The population has since increased rapidly.

A study in 2012 compared the genetic diversity of the population in Finland with the population in North America.

Ten genes were compared from 72 deer in each population. The allele richness (number of alleles in the population) of each gene was measured.

A χ^2 test was carried out to compare the two populations.

(i) The null hypothesis for this investigation is

(1)

☒ **A** the allele richness in the population from Finland is higher than the USA.

☒ **B** the allele richness in the population from the USA is higher than Finland.

☒ **C** the population in the USA is more genetically diverse than the population in Finland.

☒ **D** there is no difference in allele richness between the two populations.

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

(ii) The values from the population in the USA can be taken as the expected values and a χ^2 test can be carried out.

Gene	Allele richness (Finland population) X (observed)	Allele richness (USA population) Y (expected)	X – Y	$(X – Y)^2$	$(X – Y)^2 / Y$
1	6	14	8	64	4.57
2	4	5	1	1	0.2
3	7	13	6	36	2.77
4	7	15	8	64	4.27
5	6	6	0	0	0
6	8	12	4	16	1.33
7	2	3	1	1	0.33
8	4	4	0	0	0
9	4	9			
10	3	4			

Complete the table to calculate the χ^2 value, using the formula

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

(3)

Answer .....

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(iii) The table shows the critical values of chi-squared at different levels of probability.

Degrees of freedom	Probability	
	p=0.10	p=0.05
1	2.706	3.841
2	4.605	5.991
3	6.251	7.815
4	7.779	9.488
5	9.236	11.070
6	10.645	12.592
7	12.017	14.067
8	13.362	15.507
9	14.684	16.919
10	15.987	18.307

Deduce the effect of a small founder population on the allele richness in the population of white-tailed deer in Finland.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(d) The table shows the heterozygosity index for each population of white-tailed deer.

Heterozygosity index for Finland population	Heterozygosity index for North American population
0.692	0.742

Climate change may affect the habitat of both populations of deer.

Explain which population is more likely to adapt to changing conditions.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for Question 9 = 14 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

10 Some plants are adapted to grow in shady conditions.

A study was carried out to compare the effect of growing in different light intensities on rates of photosynthesis of plants.

The plants are rated for levels of shade tolerance.

Plant seedlings of nine species were grown in either 25% or 5% of full sunlight. All other abiotic factors were controlled.

These seedlings were grown for six weeks and then exposed to full sunlight for 15 minutes. The rate of photosynthesis was measured during the exposure to full light.

The table shows the results of this investigation for four species of plant.

Species	Shade tolerance	Rate of photosynthesis / a.u.	
		Seedlings grown in 25% of full sunlight	Seedlings grown in 5% of full sunlight
A	Intolerant	410	415
B	Intermediate	300	275
C	Tolerant	180	210
D	Very tolerant	150	215

(a) (i) Determine which species had the greatest percentage change in rate of photosynthesis when grown in lower light intensities.

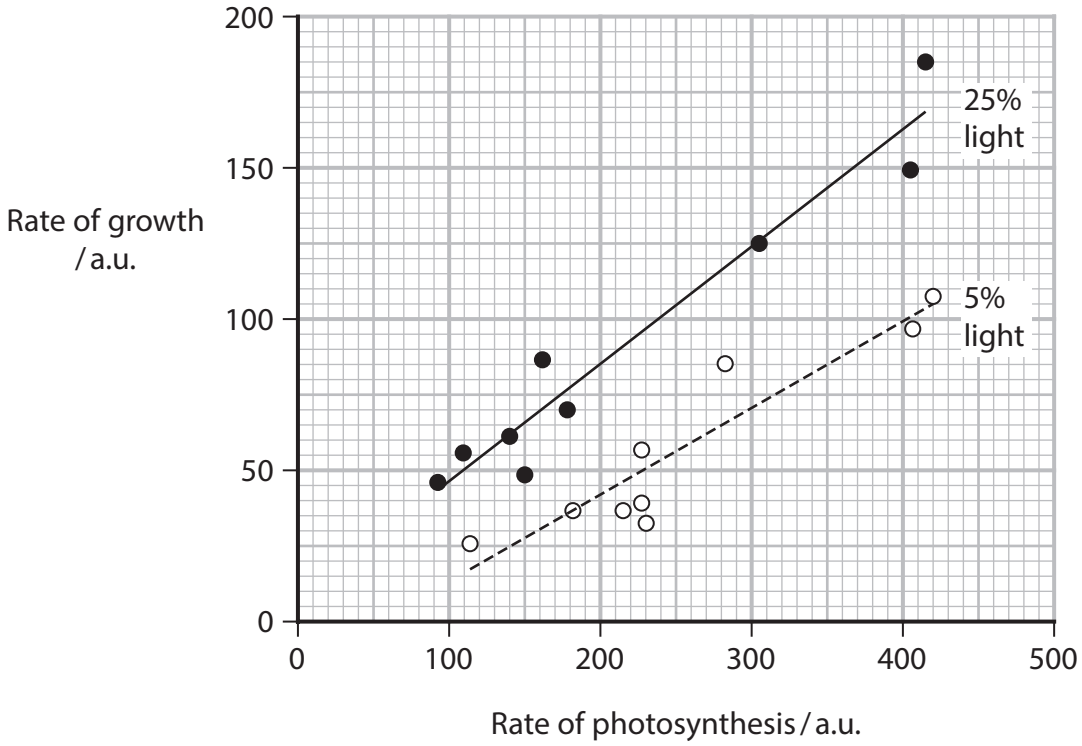
(2)

Answer .....

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(ii) The rate of growth for all nine species of plant was also measured.

The graph shows the effects of the rate of photosynthesis on the rate of growth of these plants.



Explain the effect of light intensity during the first six weeks of growth on the growth rate of these species of plant.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

*(b) Differences in the rate of photosynthesis may be due to the light-dependent reactions in chloroplasts.

Devise an investigation to compare the rate of the light-dependent reaction in shade tolerant and shade intolerant plants grown at different light intensities.

(6)

(Total for Question 10 = 12 marks)

TOTAL FOR PAPER = 100 MARKS

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA