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Wednesday 15 June 2022 – Morning

GCSE (9–1) Biology B (Twenty First Century Science)

J257/02 Depth in Biology (Foundation Tier)

Time allowed: 1 hour 45 minutes

You must have:
- a ruler (cm/mm)

You can use:
- an HB pencil
- a scientific or graphical calculator

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Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **20** pages.

ADVICE
- Read each question carefully before you start your answer.

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Answer **all** the questions.

1 The circulatory system transports substances around the human body in the blood.

(a) State the name of the organ that pumps blood around the human body.

..... **[1]**

(b) Draw lines to connect each type of blood **vessel** with its correct **description**.

Vessel	Description
Artery	Has a thick, muscular wall to hold high pressure blood
Capillary	Has a thin elastic wall that enables the vessel to be squashed
Vein	Has a very thin wall only one cell thick

[2]

(c) State **two** nutrients that are absorbed into the blood in the digestive system.

1 .....

2 .....

[2]

(d) State **two** gases that are exchanged between the air and the blood in the gaseous exchange system.

1 .....

2 .....

[2]

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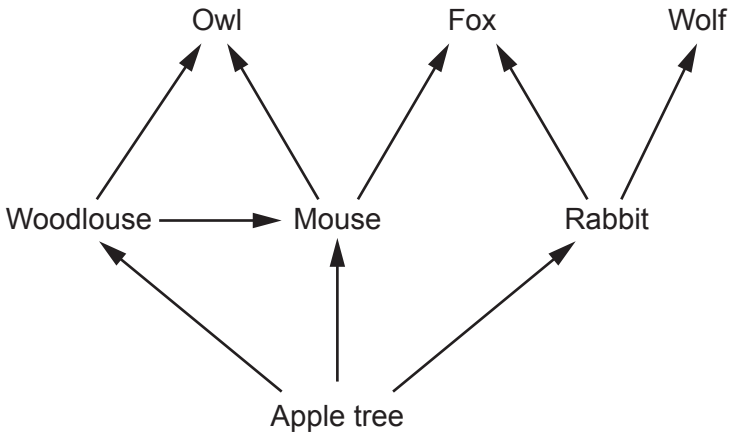
2 The diagram shows a woodland food web.



(a) Complete the sentences to describe the organisms in the food web.
Use the phrases in the list.

a community	**a population**	**an ecosystem**	**an individual**

One rabbit is ..... .

All of the rabbits in the woodland are ..... .

All of the organisms in the woodland are ..... .

All of the organisms and their environment are ..... .

[4]

(b) State **one** example of an organism in the first trophic level of the woodland food web.

..... **[1]**

(c) State **one** example of a producer in the woodland food web.

..... **[1]**

(d) How many trophic levels does the longest food chain in the woodland food web have?

Number of trophic levels ..... **[1]**

(e) State **one** example of an organism that is in more than one trophic level in the woodland food web.

..... **[1]**

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3 Antibiotics are used to treat some diseases.

(a) Beth has influenza.

Which **two** statements explain why antibiotics will **not** cure Beth's influenza?

Tick (✓) **two** boxes.

Antibiotics do not work against bacteria.	☐
Antibiotics do not work against viruses.	☐
Bacteria can become resistant to antibiotics.	☐
Beth's influenza was caused by a virus.	☐
Beth's influenza was caused by bacteria.	☐
Influenza mutates quickly.	☐

[2]

(b) Leo has cardiovascular disease.

Explain why antibiotics will **not** help to cure Leo's cardiovascular disease.

.....

.....

.....

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

(c) Many bacteria have become resistant to antibiotics.

Suggest why the spread of antibiotic-resistant bacteria is dangerous.

.....

.....

.....

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

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(d) Information about four different antibiotics is given in **Table 3.1**.

Antibiotic	Year when antibiotic was discovered	Year when bacteria resistant to the antibiotic appeared
A: Carbapenems	1985	1993
B: Macrolides	1948	1985
C: Penicillin	1928	1940
D: Tetracycline	1948	1953

Table 3.1

(i) Which antibiotic had the **shortest** amount of time between the discovery of the antibiotic and the appearance of resistant bacteria?

Tick (✓) **one** box.

Antibiotic **A** ☐ **B** ☐ **C** ☐ **D** ☐

Amount of time = ... years

[2]

(ii) Scientists can make changes to existing antibiotics. The scientists hope that it will take a long time for bacteria to develop resistance to the changed antibiotics.

Which antibiotic in **Table 3.1** is the best choice for scientists to make changes to?

Tick (✓) **one** box.

Antibiotic **A** ☐ **B** ☐ **C** ☐ **D** ☐

Give a reason for your choice.

Reason .....

.....

[2]

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(e) **Fig. 3.1** shows the number of infections (rounded to the nearest 100) with antibiotic-resistant bacteria in England over five years. The data for two of the years have **not** been plotted.

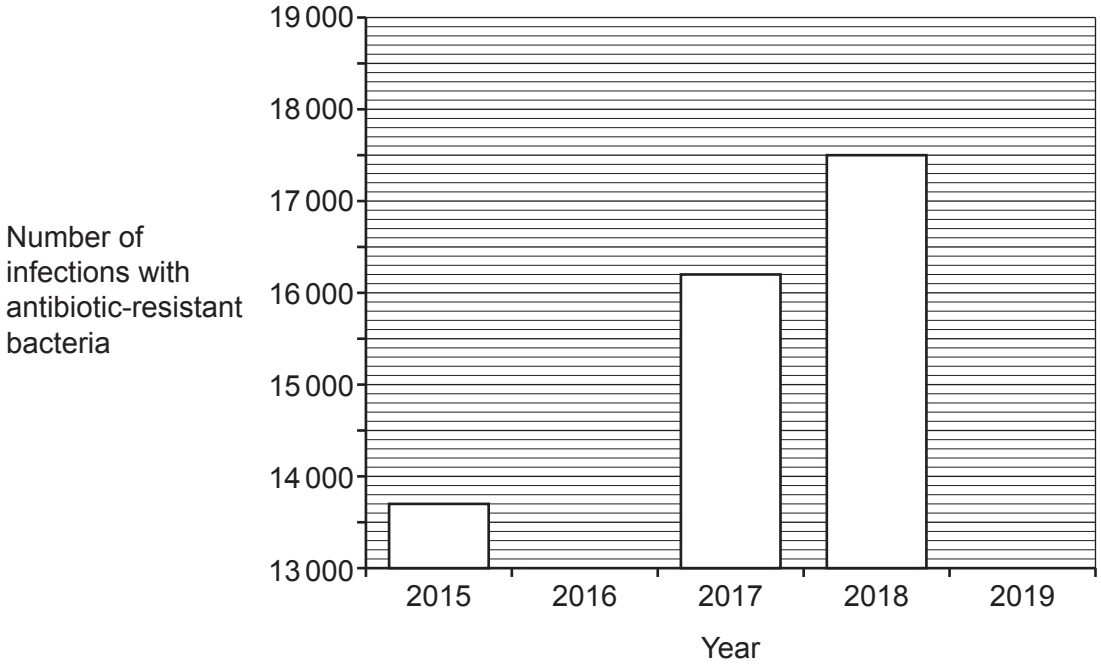

Fig. 3.1

(i) The number of infections with antibiotic-resistant bacteria in 2016 was 14 800.

Plot the data for 2016 on **Fig. 3.1**. **[1]**

(ii) Four students predict what the number of infections with antibiotic-resistant bacteria might have been in 2019. Their predictions are shown in **Table 3.2**.

Student	Prediction for 2019
Alex	23 000
Amit	18 600
Ling	16 000
Taylor	17 500

Table 3.2

Which student's prediction do you think is most likely to be correct?

Explain your answer.

Student .....

Explanation .....

.....

.....

[3]

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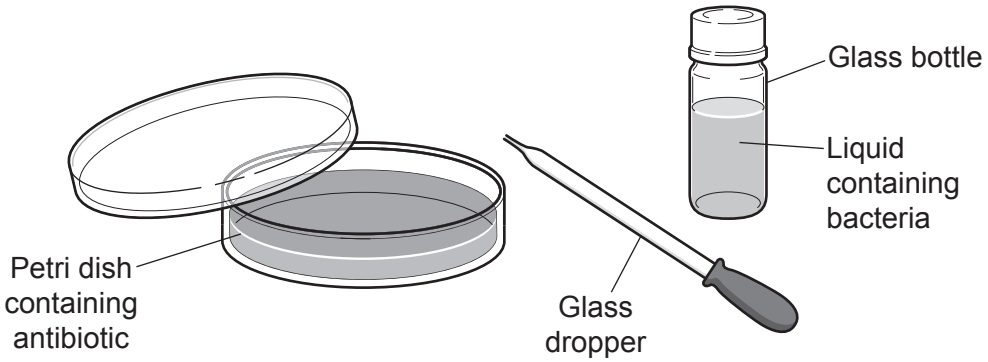
(f) Charlie investigates whether different antibiotics can affect the growth of a type of bacteria. The diagram shows the apparatus they use.



Charlie places a drop of liquid containing the bacteria in the centre of each of four Petri dishes. Each Petri dish already contains a different antibiotic.

The method Charlie uses is shown in **Fig. 3.2**.

1. Remove the lid from the Petri dish.
2. Remove the lid from the glass bottle containing bacteria.
3. Wipe the glass dropper with tissue to clean it.
4. Use the glass dropper to transfer a drop of liquid containing bacteria from the bottle to the centre of the Petri dish.

Fig. 3.2

(i) Describe **four** ways to improve Charlie's method to include aseptic techniques.

.....

.....

.....

.....

.....

.....

.....

..... **[4]**

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(ii) Charlie uses proper aseptic techniques to add a drop of liquid containing the bacteria to the centre of each Petri dish.

Fig. 3.3 shows the Petri dishes after they were incubated for 24 hours.

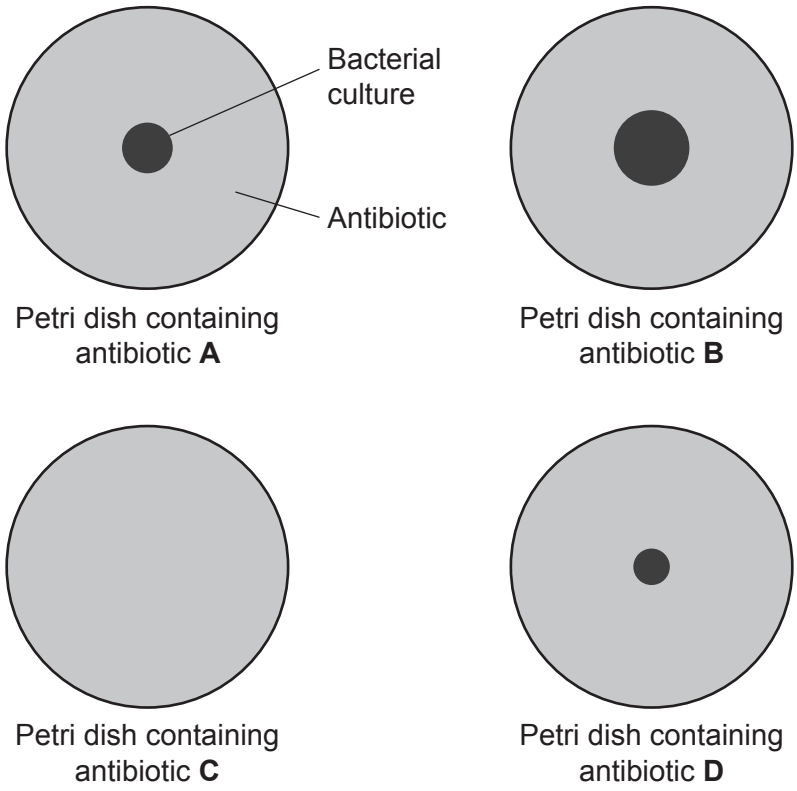

Fig. 3.3

In the Petri dish containing antibiotic **B**, the bacterial culture has a radius (r) of 5 mm.

Calculate the area of the bacterial culture in this Petri dish.

Use the equation: area = $3.14 \times r^2$

Area = ... mm^2 **[2]**

(iii) Charlie concludes that the bacteria are resistant to all of the antibiotics **except** antibiotic **C**.

Describe the evidence in **Fig. 3.3** that supports Charlie's conclusion.

.....

.....

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

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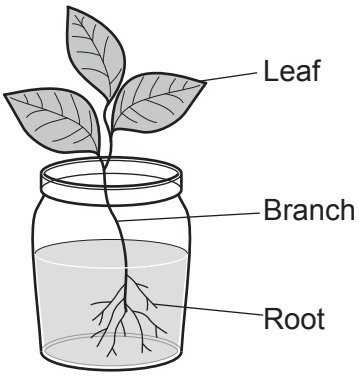
4 A cutting is taken from a leafy branch of a plant. When the cutting is placed in water, roots begin to grow from the branch.



(a) The cutting takes in substances from its surroundings to stay alive.

Complete the table to describe the substances taken into the cutting and what they are used for.

Substance	**Part of the cutting that takes in the substance from the surroundings**	**What the substance is used for**
Carbon dioxide	.....	Photosynthesis
Oxygen	Leaf stomata	.....
.....	Root hair cells	Photosynthesis
Mineral ions	.....	Making proteins and other biological molecules

[4]

(b) The cells that make up the cutting's leaves contain chloroplasts and mitochondria.

Explain how chloroplasts **and** mitochondria enable the cutting to grow.

Chloroplasts .....

.....

.....

Mitochondria .....

.....

.....

[4]

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(c) Although the cutting had no roots at first, it could grow new roots because it has meristem cells.

Explain what the meristem cells did to make roots.

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..... **[4]**

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5 Malaria is a disease that can be deadly. Around the world, there are hundreds of millions of cases of malaria every year.

The pathogen that causes malaria is spread by mosquitoes.

(a) Which type of pathogen causes malaria?

Put a (ring) around the correct answer.

Bacterium **Fungus** **Protist** **Virus**

[1]

(b) Mosquitoes can be killed with insecticide. However, in the case of mosquitoes that spread malaria, many of the mosquitoes have become resistant to insecticide.

The insecticide resistance was caused by a mutation in the mosquitoes' DNA.

Which statement about mutations is true?

Tick (✓) **one** box.

All mutations affect the organism's phenotype. ☐

All mutations are harmful. ☐

Mutations cannot be passed on to the organism's offspring. ☐

Mutations create new genetic variants. ☐

[1]

(c) The mutation that causes insecticide resistance is now very common in the mosquito population.

Statements **A**, **B**, **C** and **D** can be used to explain why the mutation has become so common. The statements are **not** in the correct order.

A	Insecticide was used in some places where the mosquitoes lived.
B	More mosquitoes in the next generation inherited the mutation.
C	Mosquitoes with the mutation were not killed.
D	These mosquitoes were able to produce more offspring.

(i) Write the letters of the statements in the correct order to explain why the mutation has become so common.

[3]

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(ii) What is the name of the process described by statements **A**, **B**, **C** and **D**?

..... **[1]**

(d) Scientists have genetically engineered a fungus to allow it to make a protein that is usually only made by spiders.

(i) Describe what is meant by a 'genetically engineered fungus'.

.....

.....

.....

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

(ii)* The spider protein made by the genetically engineered fungus can kill mosquitoes. Scientists could release the fungus in areas where malaria is common.

Explain the possible benefits **and** risks of releasing the fungus.

.....

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..... **[6]**

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6 In the 19th century, Gregor Mendel did experiments to investigate the inheritance of flower colour in pea plants.

(a) In his first experiment, Mendel bred two 'parent' plants.

He recorded the flower colour of the 'parent' plants and their offspring in the 'first generation', as shown in **Table 6.1**.

	Flower colour
'Parent' plant 1	The plant had red flowers
'Parent' plant 2	The plant had white flowers
'First generation' plants	All the plants had red flowers

Table 6.1

Scientists have now worked out which alleles the plants in this experiment had, as shown in **Fig. 6.1**.

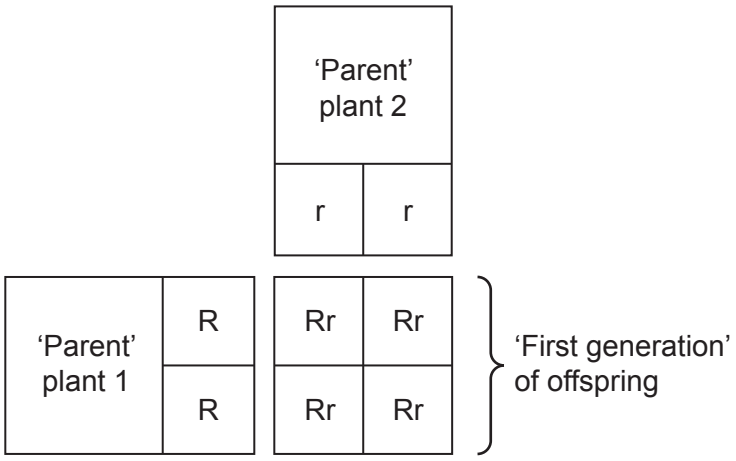

Fig. 6.1

(i) State the genotype of 'parent' plant 1.

..... **[1]**

(ii) Describe the phenotype of 'parent' plant 2.

..... **[1]**

(iii) What is the probability that a plant in the 'first generation' will have red flowers?

Put a (ring) around the correct answer.

0.25 **0.5** **1** **4**

[1]

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(iv) What can you conclude about the **R** and **r** alleles?

Use the information in **Table 6.1** and **Fig. 6.1** to help you.

R allele .....

r allele .....

[2]

(b) In his next experiment, Mendel bred plants from the 'first generation'. This created a 'second generation' of offspring.

The alleles of the plants are shown in **Fig. 6.2**.

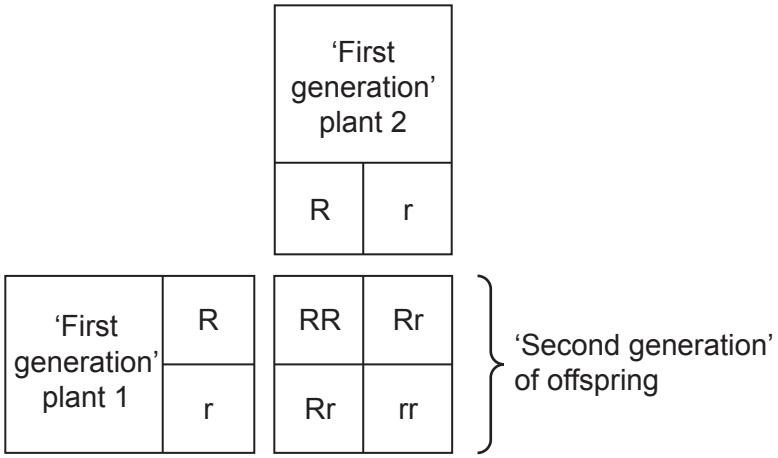

Fig. 6.2

(i) Describe the flower colours Mendel would have observed in the 'second generation' of offspring.

Flower colour of plants with alleles **RR** .....

Flower colour of plants with alleles **Rr** .....

Flower colour of plants with alleles **rr** .....

[1]

(ii) Calculate the percentage of plants in the 'second generation' that have the alleles **Rr**.

Percentage = ... % **[2]**

(iii) What can you conclude about the ratio of red flowered plants to white flowered plants in the 'second generation'?

Ratio of red flowered plants to white flowered plants = ... : ..... **[1]**

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7 The pupil of the human eye changes size in different light levels.

(a) A diagram of the eye is shown in **Fig. 7.1**.

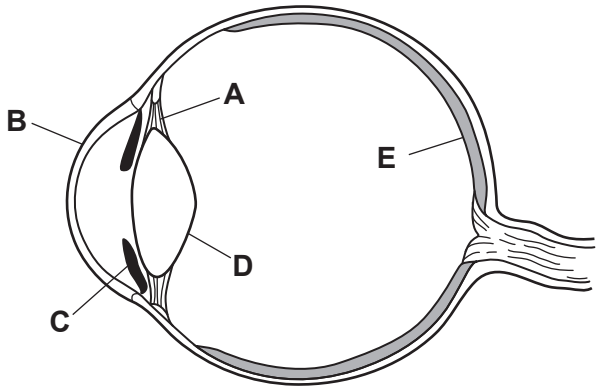

Fig. 7.1

Which structure in the eye changes the size of the pupil?

Tick (✓) **one** box.

A	Ciliary muscles	☐
B	Cornea	☐
C	Iris	☐
D	Lens	☐
E	Retina	☐

[1]

(b) The pupil changing size is a reflex action that happens in response to light. It uses a reflex arc in the nervous system.

The pupil reflex arc includes a sensory neuron that connects the eye to the spinal cord.

State **two other** types of neurons that must be part of the pupil reflex arc.

1 .....

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

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(c) Ali plans to investigate the effect of light brightness on the diameter of the pupil of a person's eye.

The method Ali plans to use is shown in **Fig. 7.2**.

1. Shine a bright light into the person's eye.
2. Hold a ruler up to their eye and measure the diameter of the pupil.
3. Repeat with light at a different brightness.

Fig. 7.2

Ali's teacher says that Ali's method is not safe and could damage the person's eye.

(i) Identify the structure in the person's eye that could be damaged by step **1**, and suggest why the damage would affect the person's vision.

Structure that could be damaged .....

Why this would affect the person's vision .....

.....

.....

[2]

(ii) Identify the structure in the person's eye that could be damaged by step **2**, and suggest why the damage would affect the person's vision.

Structure that could be damaged .....

Why this would affect the person's vision .....

.....

.....

[2]

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(d) A scientist uses a safer method to collect the data as shown in the graph in **Fig. 7.3**.

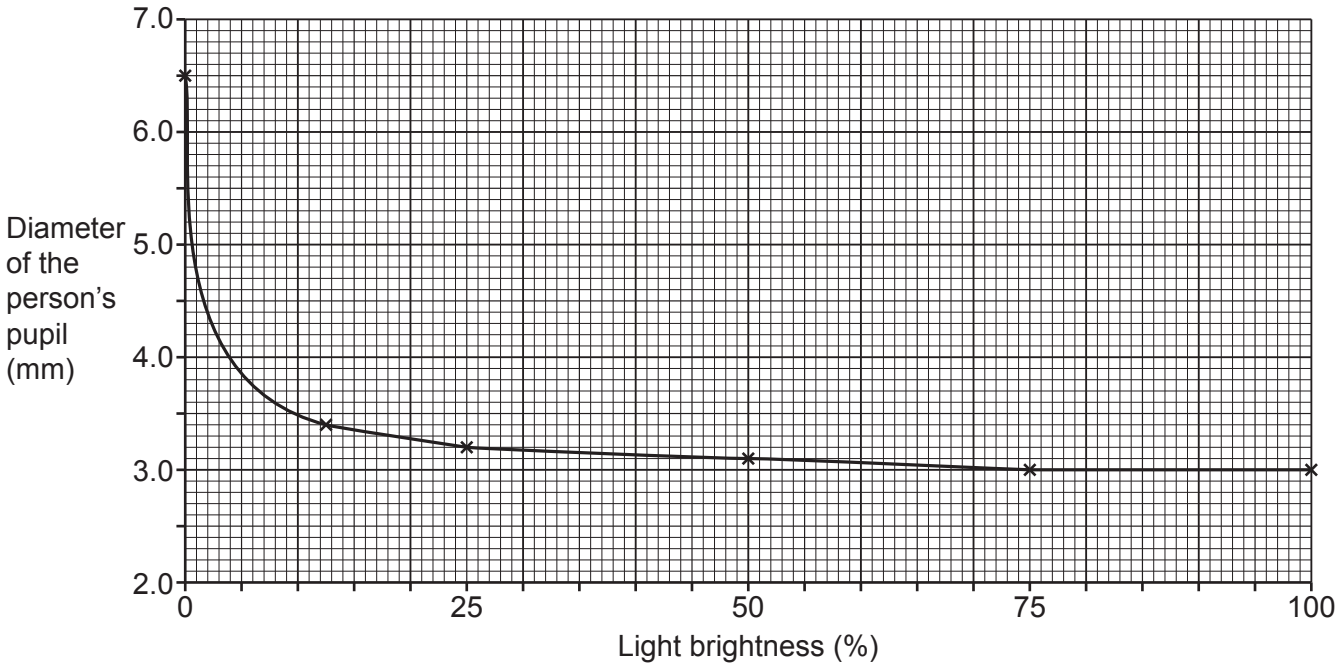

Fig. 7.3

Use **Fig. 7.3** to answer the following questions.

(i) What was the diameter of the person's pupil in complete darkness?

Diameter = ... mm **[1]**

(ii) What would you conclude is the smallest possible diameter of the person's pupil?

Explain your answer.

Smallest possible diameter = ... mm

Explanation .....

.....

[2]

(iii) Calculate the rate at which the pupil diameter changed between 25% and 50% light brightness.

Rate = ... mm / % **[2]**

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(e)* Describe a method that can be used to collect the data shown in **Fig. 7.3**.
Assume that 100% light brightness is a normally lit room.

In your answer you should describe:

- how you would safely change the light brightness and measure the results
- things you would do or control to make sure the measurements are as accurate as possible.

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..... **[6]**

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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