



Oxford Cambridge and RSA

Friday 9 June 2023 – Afternoon

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

J257/04 Depth in Biology (Higher 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



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

Centre number

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Candidate number

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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 **24** pages.

ADVICE

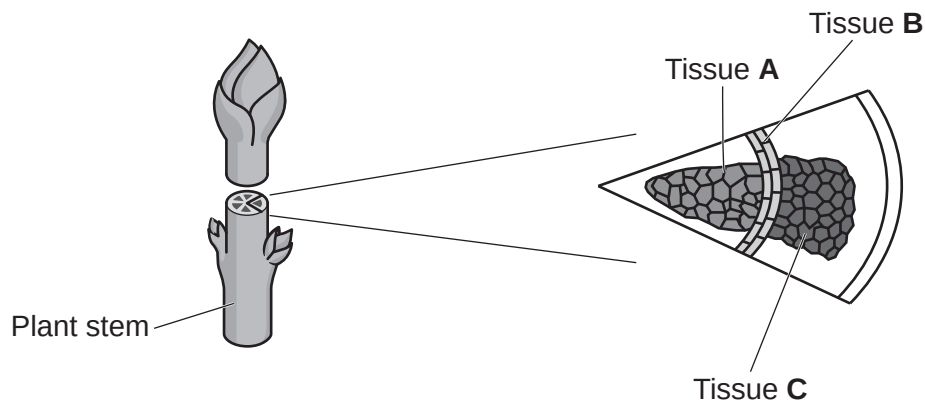
- Read each question carefully before you start your answer.

2

- 1 A scientist cuts a thin slice from a plant stem, as shown in **Fig. 1.1**.

The slice of stem contains three different tissues.

Fig. 1.1



- (a) Draw lines to connect the **description** of each tissue with its correct **name**.

One has been done for you.

Description		Name
Tissue A transports water from the plant's roots		Capillary
Tissue B is made of unspecialized cells	—	Meristem
Tissue C transports sugar from the plant's leaves		Phloem
		Xylem

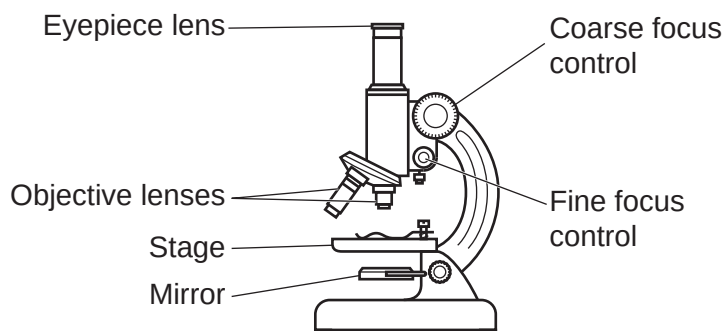
[1]

3

- (b) The scientist places the slice of stem on a microscope slide and adds a cover slip.

The scientist uses the light microscope in **Fig. 1.2** to look at the slice of stem on the slide.

Fig. 1.2



- (i) Statements **A** to **E** describe steps the scientist uses to look at the slide under the microscope.

They are **not** in the correct order.

- A** Place the slide on the stage.
- B** Look into the eyepiece lens.
- C** Use the coarse focus control to move the objective lens down towards the stage.
- D** Use the fine focus control to move the objective lens until the image is as clear as possible.
- E** Use the coarse focus control to move the objective lens upwards until the image is clear.

Write the letters in the boxes to describe the correct order of the steps.

One has been done for you.

	A			
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[3]

- (ii) Suggest **two** ways the scientist can work safely when using the microscope.

1

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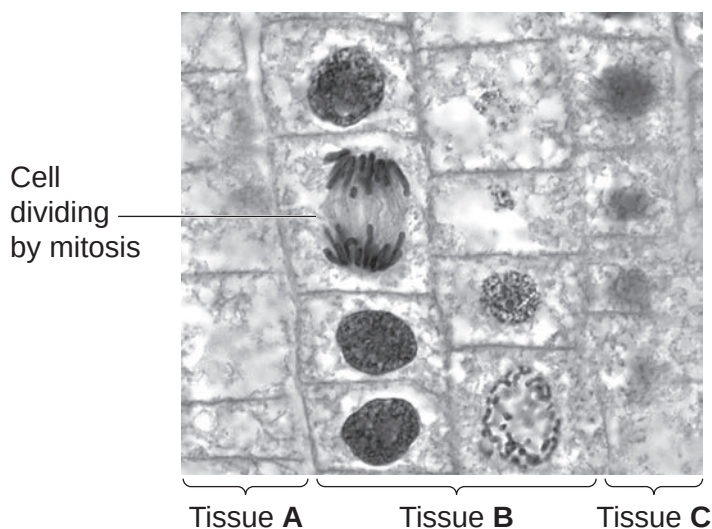
2

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[2]

- (c) **Fig. 1.3** shows part of the slice of stem. One of the cells is dividing by mitosis.

Fig. 1.3



- (i) The chromosomes in the labelled dividing cell are clearly visible and appear dark.

Describe what the scientist added to the slide to make the chromosomes clearly visible.

..... [1]

- (ii) To get the image in **Fig. 1.3** the scientist used an eyepiece lens with a magnification of $\times 10$, and an objective lens with a magnification of $\times 40$.

Describe how to calculate the total magnification.

.....
 [1]

- (d) One of the dividing cells in **Fig. 1.3** has a width of $10\text{ }\mu\text{m}$.

- (i) What is $10\text{ }\mu\text{m}$ to the nearest order of magnitude?

Put a (ring) around the correct option.

$10^0\text{ }\mu\text{m}$ $10^1\text{ }\mu\text{m}$ $10^2\text{ }\mu\text{m}$ $10^3\text{ }\mu\text{m}$ [1]

- (ii) In the dividing cell, a single chromosome has a width of $0.01\text{ }\mu\text{m}$.

How many orders of magnitude **larger** is the cell than the single chromosome?

Put a (ring) around the correct option.

3 **30** **100** **1000** [1]

5

2 Plant cells in the leaf of a tree contain chloroplasts and mitochondria.

- (a) Complete the sentences about the processes that take place in chloroplasts and mitochondria.

Use words from the list.

cellular respiration	meiosis	photosynthesis	transpiration
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In the chloroplasts, glucose is made by

The glucose is used in the mitochondria in

[1]

- (b) The process of cellular respiration takes place continuously in plant cells.

Explain why it has to take place continuously.

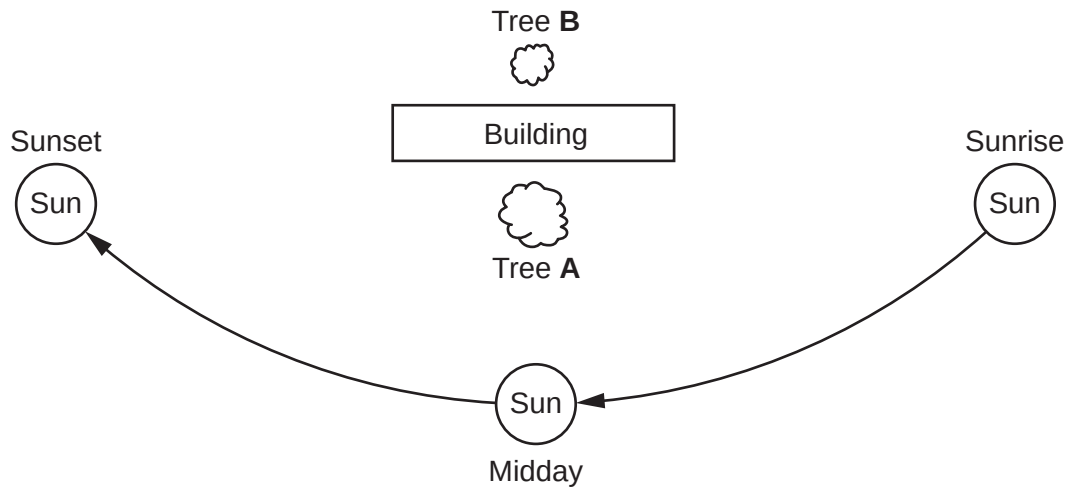
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..... [1]

(c)* There are two trees growing next to a building.

- Tree **A** is growing on the sunny side of the building.
- Tree **B** is growing on the shadier side of the building.
- Tree **A** has grown larger than tree **B**.

The map shows the positions of the trees and the building. It also shows the movement of the Sun from sunrise to sunset each day.



The two trees are the same species and were planted as seeds at the same time.

Explain why tree **A** has grown larger than tree **B**.

[6]

3 Pathogens cause communicable diseases.

- (a) Complete **Table 3.1** by explaining how the spread of each communicable disease can be reduced or stopped.

Table 3.1

Communicable disease	Infected	How the spread of the disease can be reduced or stopped
Crown gall	Plants	
Influenza	Humans	

[2]

- (b) Ash dieback and tobacco mosaic disease are communicable diseases in plants.

Complete **Table 3.2** by describing these plant diseases.

Table 3.2

Disease	Pathogen that causes the disease	Spread by
Ash dieback		
Tobacco mosaic		Contaminated seeds

[2]

8

- (c) A farmer is growing cherry trees.
The farmer notices that some of the trees have lumps on their trunks caused by crown gall disease.
- (i) The farmer counts the lumps on five trees.
Table 3.3 shows the results.

Table 3.3

Tree	Number of crown gall lumps
1	10
2	6
3	11
4	5
5	8

Calculate the mean number of lumps per tree.

Mean = ... lumps [1]

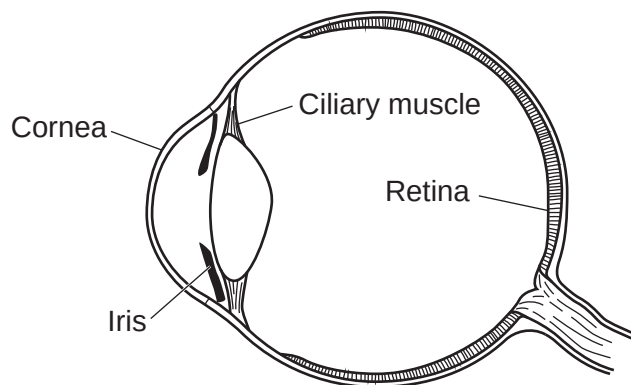
- (ii) There are 200 trees on the farm.
80 of the trees have crown gall disease.

Calculate the probability that any individual tree on the farm has crown gall disease.

Probability = ... [1]

- 4 **Fig. 4.1** is a diagram of the human eye. Some of the structures of the eye have been labelled.

Fig. 4.1



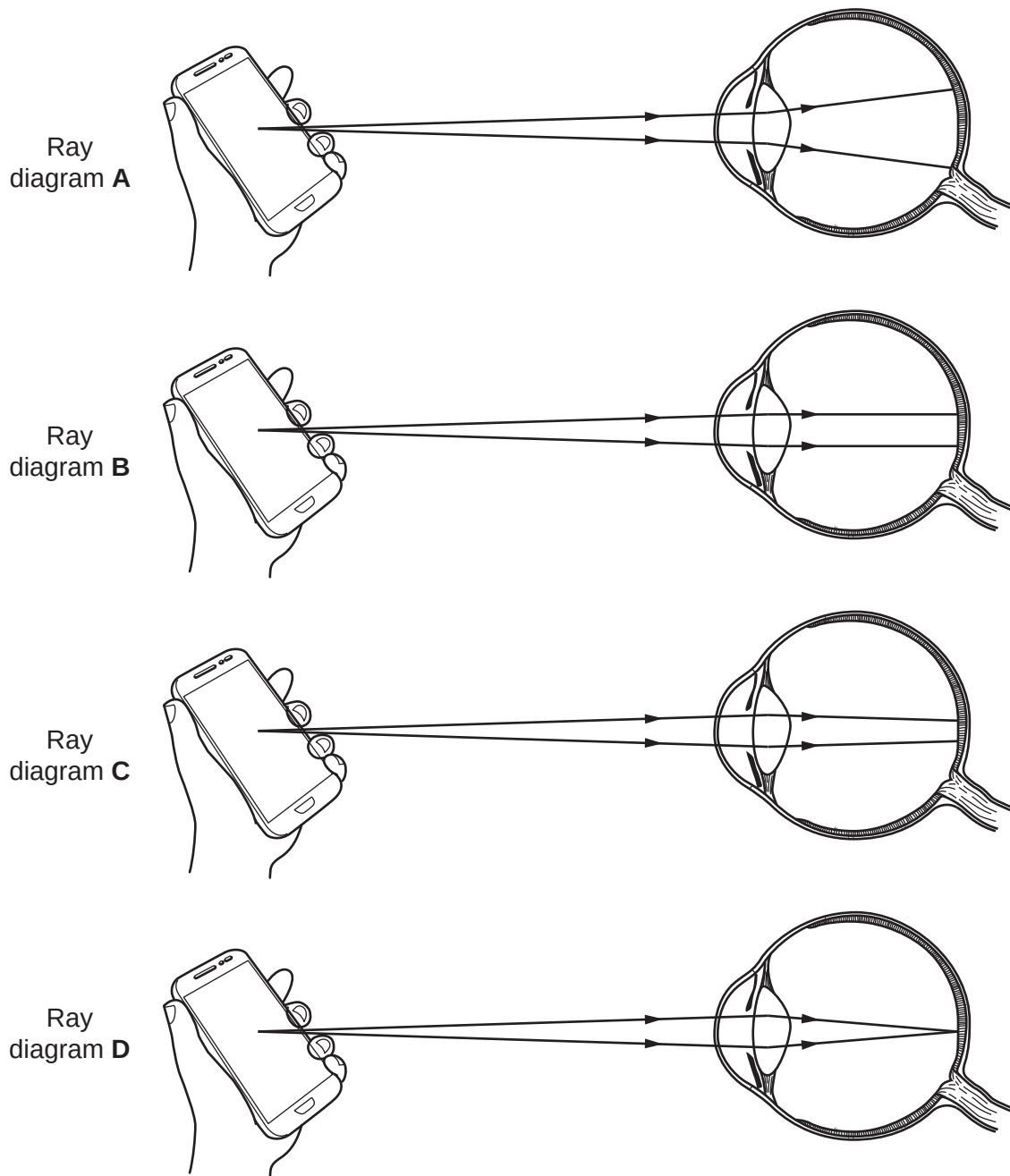
- (a) Draw lines to connect each **structure** with its correct **function**.

Structure	Function
Ciliary muscle	Changes the shape of the lens
Cornea	Changes the size of the pupil
Iris	Layer of receptor cells that detects light
Retina	Transparent tissue that helps to focus light by refraction

[2]

(b) Fig. 4.2 shows four ray diagrams.

Fig. 4.2



Which ray diagram explains how the lens of the eye focuses light so that we can see a nearby object?

Tick (✓) **one** box.

Ray diagram A

☐

Ray diagram B

☐

Ray diagram C

☐

Ray diagram D

☐

[1]

- (c) Nina has cataracts in her eyes.

Explain why Nina can only read if she uses a bright light.

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.....

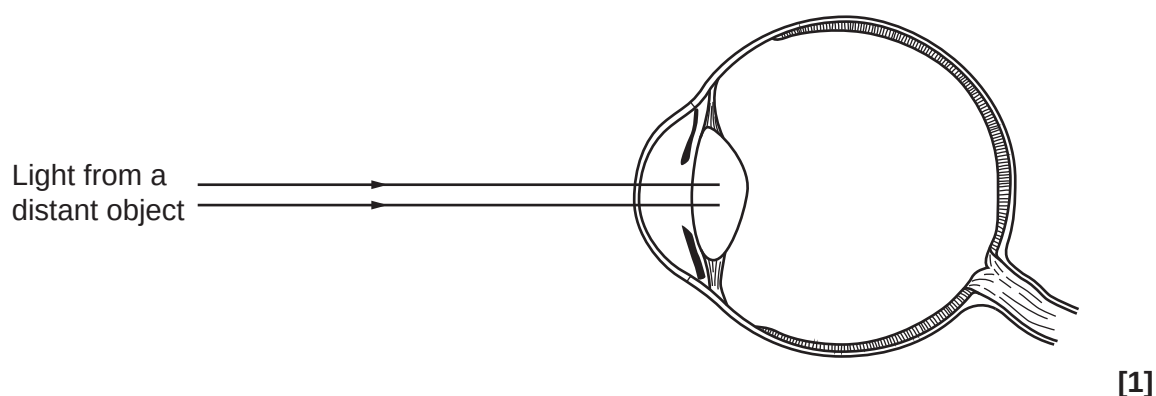
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..... [2]

- (d) Tom is shortsighted.

- (i) Complete the ray diagram in **Fig. 4.3** to show why Tom **cannot** see a distant object clearly.

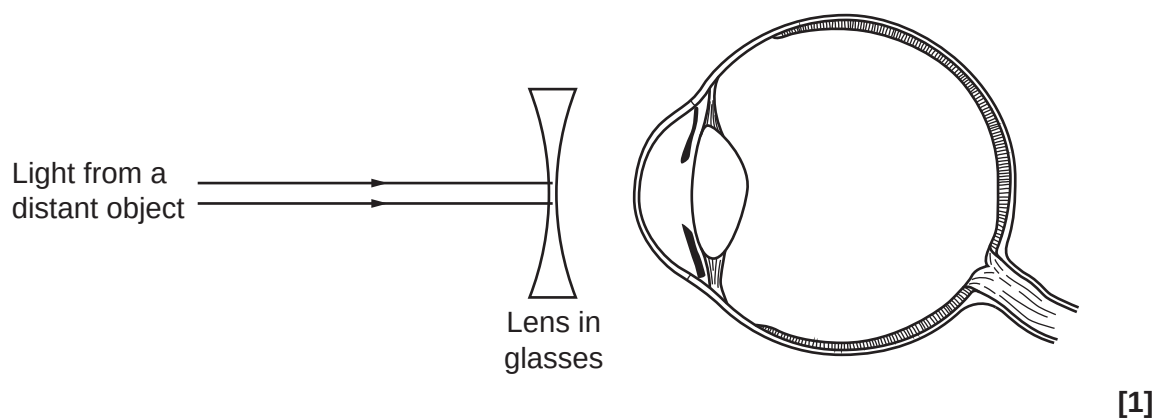
Fig. 4.3



- (ii) Tom tries on a pair of glasses.

Complete the ray diagram in **Fig. 4.4** to show how a lens in a pair of glasses allows Tom to see the distant object clearly.

Fig. 4.4



12

5 The blood transports substances around the human body.

(a) Complete the table to describe the transport of three substances around the human body.

Substance	Where it is absorbed into the blood	What it is used for in cells
Glucose	Digestive system	
.....		Aerobic cellular respiration
.....	Digestive system	As a solvent for chemical reactions, and to maintain the volume of the cytoplasm

[3]

(b) Carbon dioxide and urea are waste products made by cells.

Describe where in the body these waste products are removed from the blood.

Carbon dioxide

Urea

[1]

(c) The blood transports sugar and hormones that control the blood sugar level.

Complete the sentences to explain how hormones control blood sugar level.

Use words from the list.

ADH	auxin	FSH	glucagon	insulin
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To reduce the blood sugar level when it is too high, a hormone called

..... is released.

To increase the blood sugar level when it is too low, a hormone called

..... is released.

[2]

13

- (d) People living with diabetes cannot control their blood sugar level properly without treatment or lifestyle changes.

Doctors hope to treat type **1** diabetes by injecting embryonic stem cells into the patient's pancreas.

- (i) Explain how injecting embryonic stem cells into the pancreas could help to treat type **1** diabetes.

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..... [2]

- (ii) Discuss **one** benefit, **one** risk and **one** ethical issue with using embryonic stem cells to treat type **1** diabetes.

Benefit

.....

Risk

.....

Ethical issue

..... [3]

- (iii) People with type **2** diabetes have asked if they can also have the stem cell treatment.

Explain why **other** treatments may be better for people with type **2** diabetes.

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..... [3]

14

6 Fungi are a type of organism that live in soil. They are eukaryotic.

(a) Fungi use their genome to make proteins, like humans.

(i) Describe what the fungi's genome is **and** where it is stored.

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..... [2]

(ii) Explain how the genome is used to make proteins.

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..... [4]

15

- (b) Fungi release digestive enzymes into the soil.

Explain why these enzymes are helpful to organisms **other than** the fungi.

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..... [2]

- (c) A scientist collects soil samples from three different sites. The soil samples contain an enzyme released by fungi.

The scientist tests the enzyme from each soil sample by:

- adding the enzyme to its substrate in 10 solutions, each with a different pH
- measuring the rate of reaction.

- (i) The scientist plans to control the temperature of the solutions by leaving them in the same room.

Describe a better way to control the temperature of each solution.

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.....

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..... [2]

- (ii) The scientist makes sure that:

- the same type of enzyme is taken from each soil sample
- the same concentration of enzyme is used in each solution
- the same substrate is used in each solution.

Describe **one other** factor that could affect the rate of the enzyme reaction **and** how this factor could be controlled.

Factor

How it could be controlled

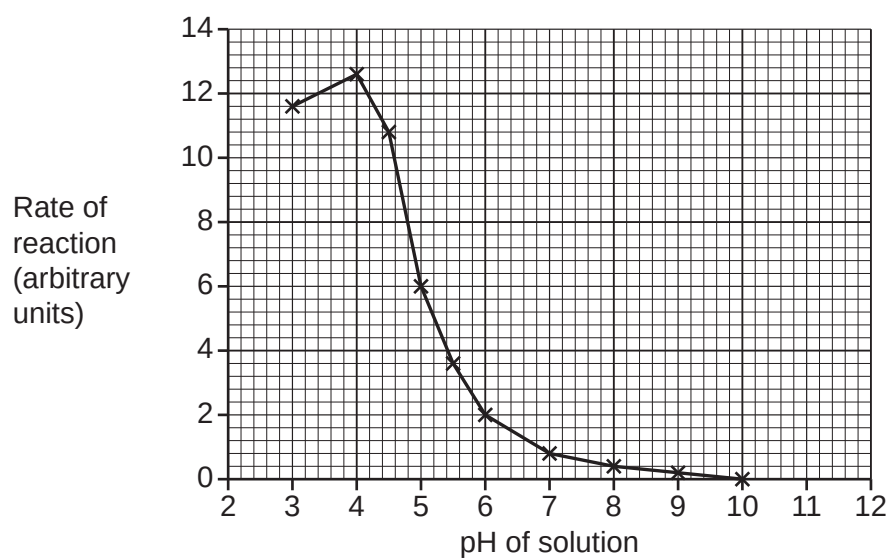
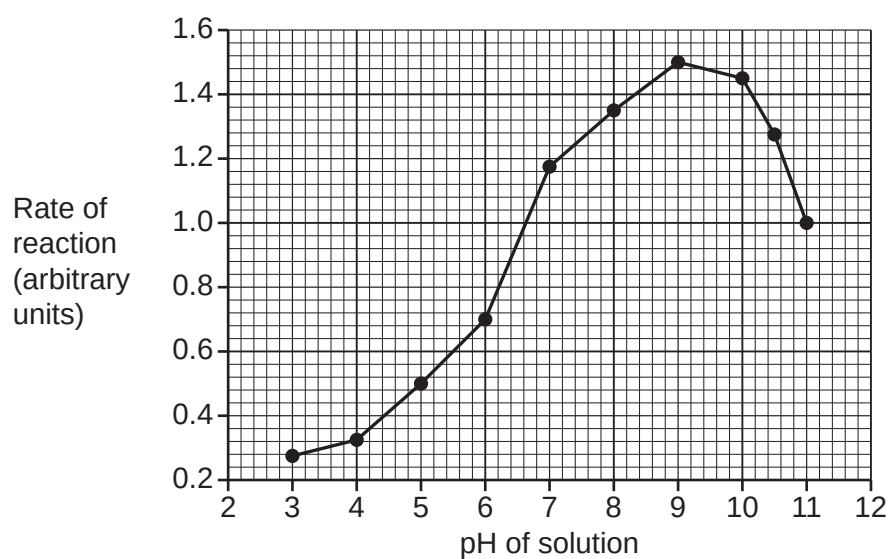
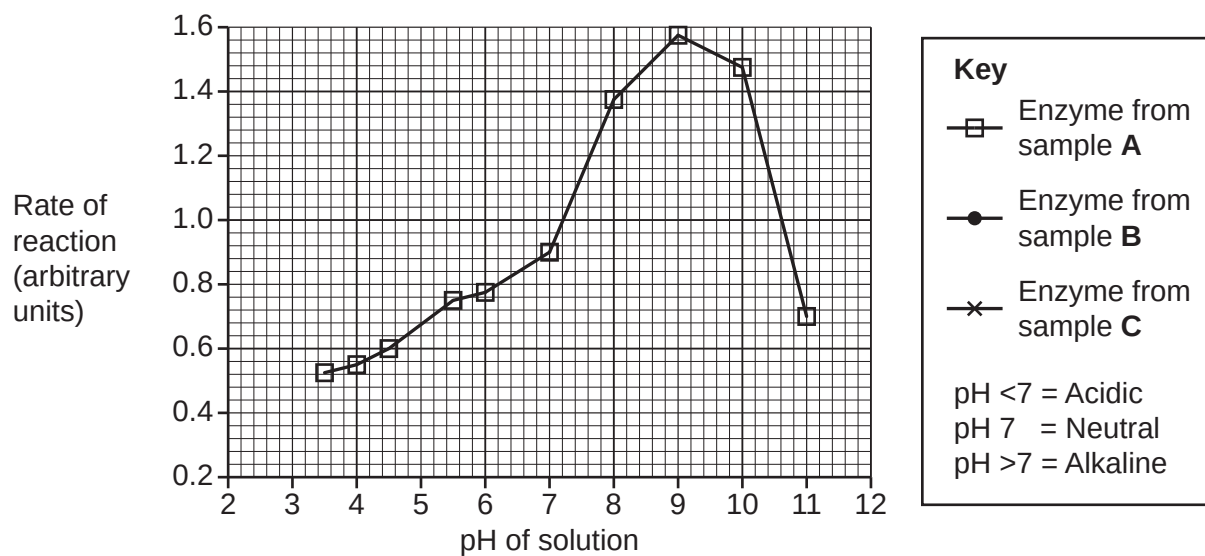
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..... [2]

16

The results of the tests are shown in the graphs.



- (d) What was the optimum pH for the enzyme from sample **A**?

Optimum pH = ... [1]

- (e) (i) What was the maximum rate of reaction for the enzyme from sample **B**?

Maximum rate of reaction = ... arbitrary units [1]

- (ii) Describe **and** explain the general trend in the results for the enzyme from sample **B**.

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..... [4]

- (f) The scientist thinks a mutation must have happened in the fungi in the soil in sample **C**.

Describe how this mutation could have caused the results for sample **C**.

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..... [3]

- (g) The scientist concludes that the enzyme works best in alkaline soil.

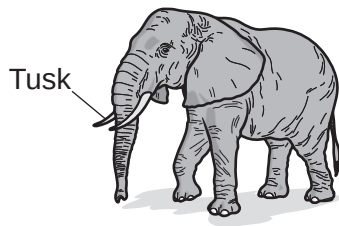
Give evidence for and against the scientist's conclusion.

For
.....

Against
.....

[2]

7 Elephants live in the wild in Mozambique, Africa.



Some elephants inherit an allele that causes them to never develop tusks. This no-tusks allele is the result of a mutation.

(a) Mutations to alleles happen quite often.

Explain why mutations often have **no** observable effects.

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..... [3]

(b) Elephants in Mozambique are hunted by humans.

The humans kill the elephants so they can sell their valuable tusks.

Scientists recorded data on the Mozambique elephant population over several generations.

	Total number of elephants	Percentage of total number of elephants with the no-tusks allele (%)
Start of study	2542	18.5
End of study	242	50.9

Calculate the percentage **decrease** in the total number of elephants from the start of the study to the end.

Give your answer to **1** decimal place.

Percentage decrease = ... % [3]

(d) Elephants have sex chromosomes just like humans.

- Female elephants have the genotype X X .
- Male elephants have the genotype X Y .

Scientists have discovered that:

- The no-tusks allele, T , is dominant.
- The allele for normal tusks, t , is recessive.
- The alleles are found on the X chromosome. This means an X chromosome can be either X^{T} or X^{t} .
- **All** elephants that have the genotype $\text{X}^{\text{T}} \text{Y}$ die before they are born.

(i) What is the phenotype of an elephant that has the genotype $\text{X}^{\text{T}} \text{X}^{\text{t}}$?

.....
 [1]

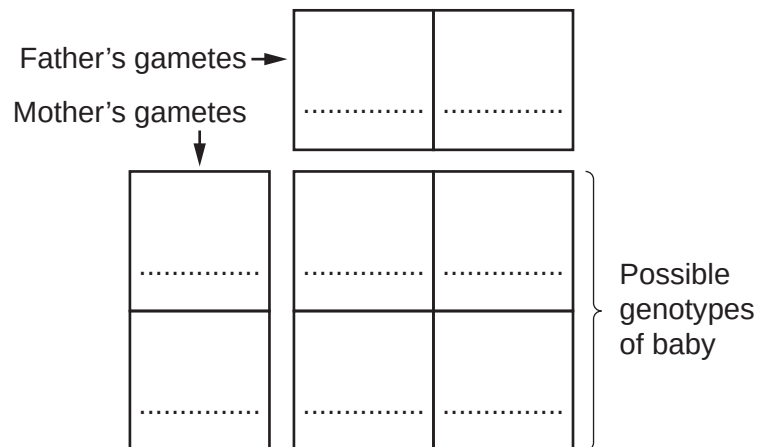
(ii) Explain why **no** female elephants are born homozygous for the no-tusks allele.

.....

 [2]

(iii) A female elephant that is heterozygous for the no-tusks allele has a baby.

Complete the Punnett square to show the possible genotypes of the baby.



[2]

21

- (iv) A scientist concludes that this female elephant is likely to have twice as many female offspring as male offspring.

Explain why the scientist is correct.

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..... [2]

- (e) Predict what is likely to happen to the population of elephants in Mozambique if the hunting continues.

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..... [3]

END OF QUESTION PAPER

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