Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number | Candidate Number

Time 1 hour 45 minutes

Paper reference **9BI0/02**

Biology B

Advanced

PAPER 2: Advanced Physiology, Evolution and Ecology

You must have:
Calculator, HB pencil, ruler

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 your working in any calculation questions and include units in your answer where appropriate.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- You may use a scientific calculator.

Information

- The total mark for this paper is 90.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- In question(s) 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.
- Good luck with your examination.

Turn over

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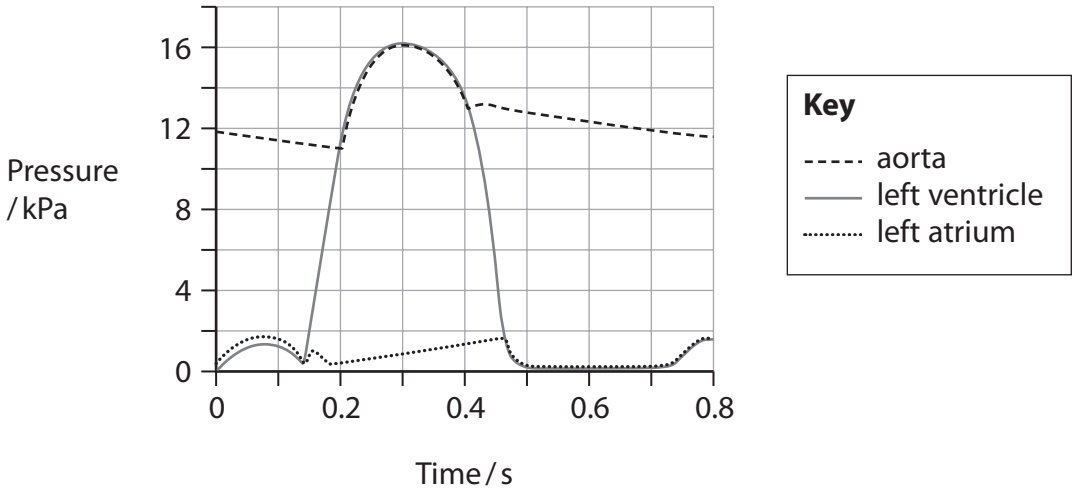
Answer ALL questions.

Write your answers in the spaces provided.

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 (a) The graph shows the pressure changes in the left side of the heart during one contraction.



(i) At what time does the atrioventricular (bicuspid) valve close?

(1)

☒ **A** 0.14 s

☒ **B** 0.20 s

☒ **C** 0.45 s

☒ **D** 0.40 s

(ii) Which is the sequence of structures that an impulse passes through during one heart contraction?

(1)

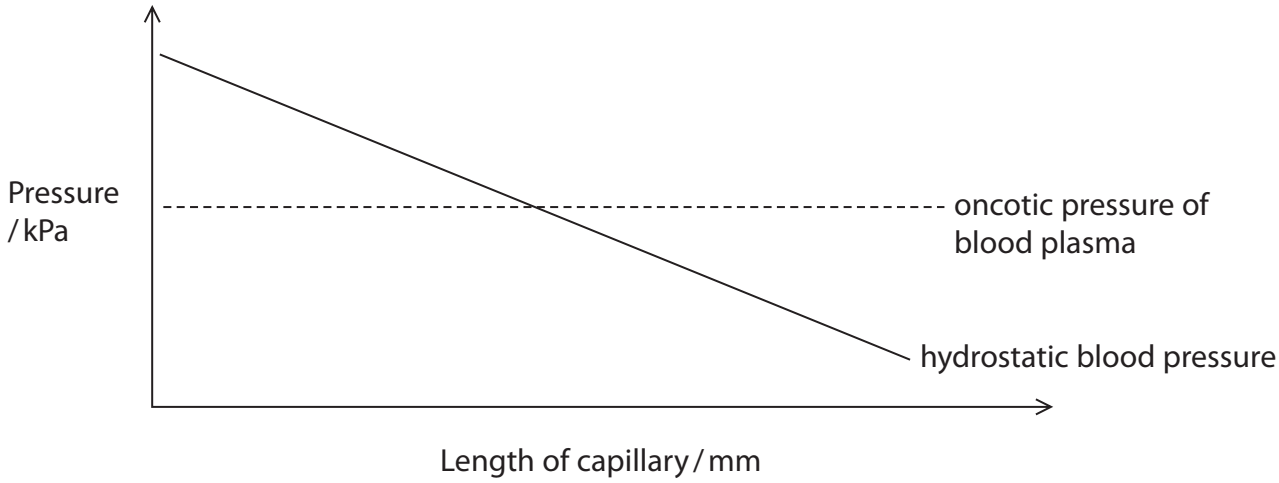
☒ **A** atrioventricular node, bundle of His, sinoatrial node

☒ **B** atrioventricular node, sinoatrial node, bundle of His

☒ **C** sinoatrial node, bundle of His, atrioventricular node

☒ **D** sinoatrial node, atrioventricular node, bundle of His

(b) The graph shows the hydrostatic pressure and oncotic pressure of the blood along a capillary.



(i) Explain how tissue fluid is formed by the capillary. Use the information in the graph to help your answer.

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(ii) Kwashiorkor is a condition caused by a lack of dietary protein. One symptom is accumulation of tissue fluid.

Explain why children suffering from kwashiorkor often suffer from an excess of tissue fluid. Use the graph to support your answer.

(2)

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(Total for Question 1 = 7 marks)

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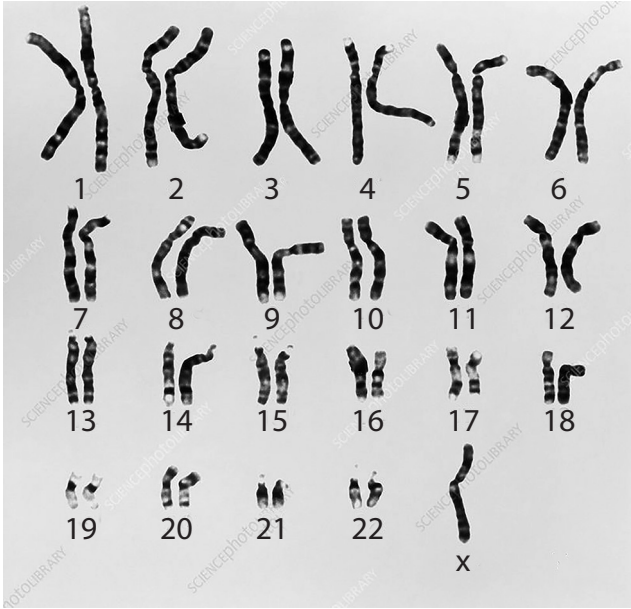
2 (a) The diagram shows a human karyotype.



(Source: © DEPT. OF CLINICAL CYTOGENETICS, ADDENBROOKES HOSPITAL/SCIENCE PHOTO LIBRARY)

(i) Which of the following identifies the human with this karyotype?

(1)

☒ **A** female with Down's syndrome

☒ **B** female with Turner's syndrome

☒ **C** male with Down's syndrome

☒ **D** male with Turner's syndrome

(ii) Which of the following would cause the karyotype in the diagram?

(1)

☒ **A** non-disjunction producing a monosomy

☒ **B** non-disjunction producing a polysomy

☒ **C** translocation producing a monosomy

☒ **D** translocation producing a polysomy

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(b) (i) The table shows the chromosome number and chromatid number of some of the cells formed during oogenesis in humans.

Cell type	Chromosome number	Chromatid number
ovum	23	23
primary oocyte	46	92
secondary oocyte	23	46

Which of the cells are haploid?

(1)

☒ **A** ovum and primary oocyte

☒ **B** ovum and secondary oocyte

☒ **C** primary oocyte and secondary oocyte

☒ **D** ovum alone

(ii) Explain how meiosis produces new combinations of alleles in gametes.

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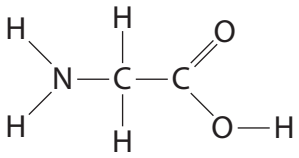
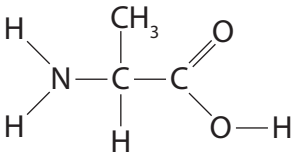
3 The diagram shows two amino acids found in the primary sequence of collagen.



glycine



alanine

(a) (i) Which is the R-group for alanine?

(1)

☒ **A** CH_3

☒ **B** COOH

☒ **C** H

☒ **D** NH_2

(ii) Draw the products of a condensation reaction between glycine and alanine.

(2)

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(iii) Describe the structure of collagen.

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(b) Ehlers-Danlos syndrome is a human condition caused by a mutation in a collagen gene.

This causes changes to the elasticity and strength of arteries.

Mice were genetically modified to have this mutation.

The elastic constant and force required to break arteries from genetically modified mice and unmodified mice were measured.

The elastic constant is calculated by using the formula:

$$\text{elastic constant} = \frac{\text{force applied}}{\text{increase in length of artery}}$$

The results are shown in the table.

Artery	Elastic constant / N mm^{-1}	Force required to break artery / N
unmodified mice	0.26	2.0
genetically modified mice	0.12	1.6

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(i) Calculate the force required to produce an increase in length of 0.5 cm for an artery taken from an unmodified mouse.

(1)

Answer.....

(ii) People with Ehlers-Danlos syndrome are at risk of developing aneurysms.

An aneurysm is an area of artery wall that weakens and can burst.

Explain why people with Ehlers-Danlos syndrome have a high risk of aneurysms.

(3)

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(Total for Question 3 = 10 marks)

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4 The photograph shows an insect fossilised in amber resin.

(Source: Bjoern Wylezich. 123rf.com/PAL)

Scientists have classified another fossilised insect found in amber resin as a new species of mosquito, *Priscoculex burmanicus*.

This mosquito is anatomically very similar to modern species of mosquito.

(a) (i) Which of these processes produces new species without geographically separating populations?

(1)

☒ **A** allopatric speciation

☒ **B** genetic speciation

☒ **C** stabilising speciation

☒ **D** sympatric speciation

(ii) *Priscoculex burmanicus* became extinct about 100 million years ago.

State why it was difficult for scientists to decide if this insect belonged to a different species from modern mosquitoes.

(1)

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(iii) State how scientists would have reached agreement on classifying this mosquito.

(1)

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(iv) Complete the classification table for *Priscoculex burmanicus*.

(2)

Taxon	Name
Domain	Eukarya
Kingdom	Animalia
	Arthropoda
	Diptera
Order	Culicidae
Family	Anophelinae
Genus	
Species	

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(b) Mosquito populations are often controlled using pesticides that inhibit the enzyme acetylcholinesterase.

Long-term use of pesticides often leads to the development of resistance in these mosquitoes.

The ace-1 gene codes for the enzyme acetylcholinesterase.

The ace-1^r allele is a recessive form of this gene that gives resistance to pesticides.

The changes in the numbers of resistant and non-resistant mosquitoes in an area of farmland where pesticides were used in 2007 was investigated.

The use of the pesticides was stopped in 2016.

The table shows the results of this investigation.

Mosquito type	**Number of mosquitoes**		
	2005	**2015**	**2018**
resistant	125	5250	4120
non-resistant	8755	1250	3950

(i) Calculate the number of heterozygous mosquitoes in 2015.

Use the Hardy-Weinberg equation

$$p^2 + 2pq + q^2 = 1$$

(3)

Answer.....

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(ii) Explain why the changes in the numbers of the resistant and non-resistant mosquitoes, from 2005 to 2018, are related to the function of the ace-1 gene.

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(Total for Question 4 = 12 marks)

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5 (a) (i) Which bonds join the nucleotides in a single strand of DNA?

(1)

☒ **A** peptide

☒ **B** disulfide

☒ **C** glycosidic

☒ **D** phosphodiester

(ii) Describe how the process of DNA replication produces two identical DNA molecules.

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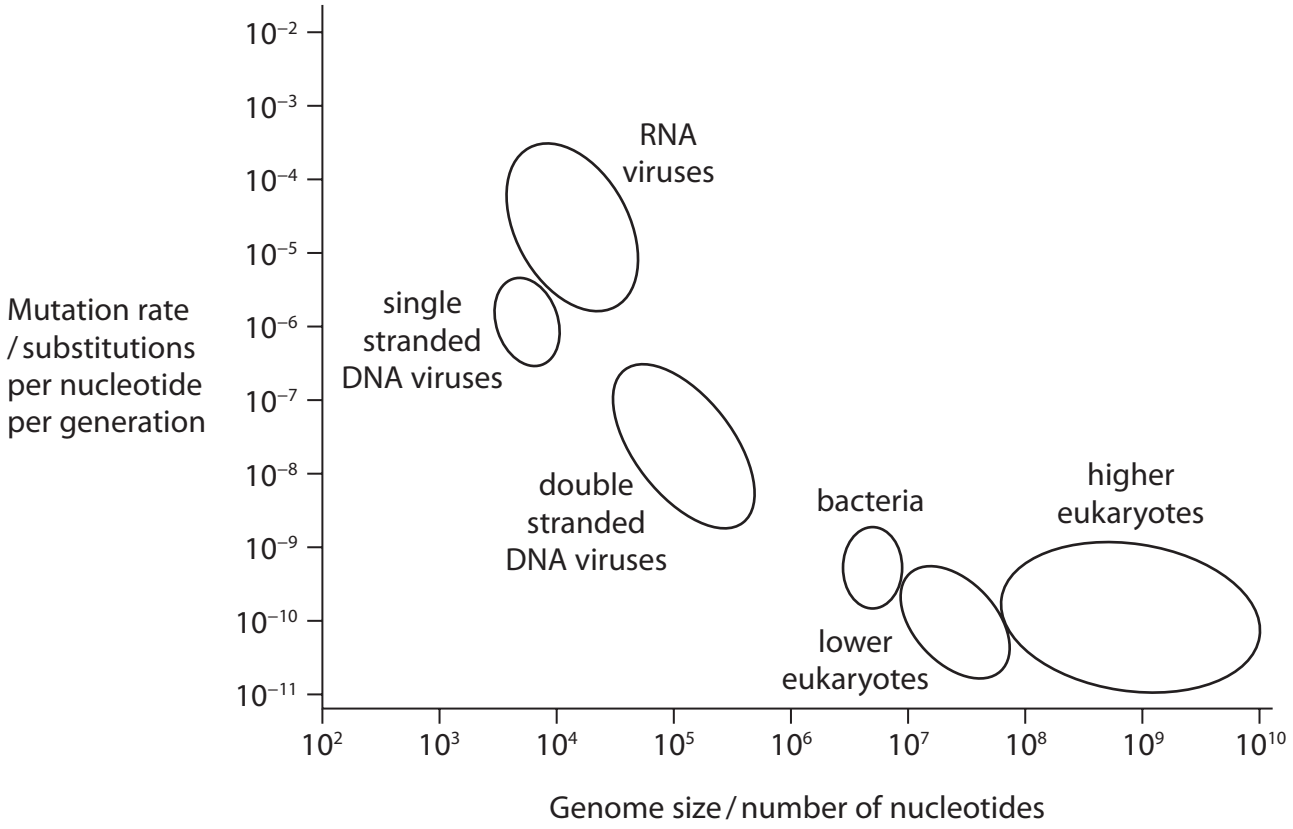
(b) The graph shows the relationship between genome size and mutation rates of organisms.



(i) Analyse the graph to determine the approximate mutation rate for tobacco mosaic virus (TMV).

(2)

Answer.....

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(ii) Comment on the relationship between genome size and mutation rate of the organisms shown in the graph.

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(Total for Question 5 = 10 marks)

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6 Acetylcholine is a neurotransmitter released by neurones in the autonomic nervous system.

(a) (i) Which of the following substances bind to acetylcholine receptors?

(1)

1. cobra venom
2. nicotine
3. lidocaine

☒ **A** 1 and 2

☒ **B** 1 and 3

☒ **C** 1, 2 and 3

☒ **D** 2 and 3

(ii) Which row is correct for acetylcholine?

(1)

	Type of neurone that releases acetylcholine	Effect of acetylcholine
☒ **A**	parasympathetic neurone	increases heart rate
☒ **B**	parasympathetic neurone	decreases heart rate
☒ **C**	sympathetic neurone	increases heart rate
☒ **D**	sympathetic neurone	decreases heart rate

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(iii) Describe the events that lead to the release of acetylcholine at a synapse.

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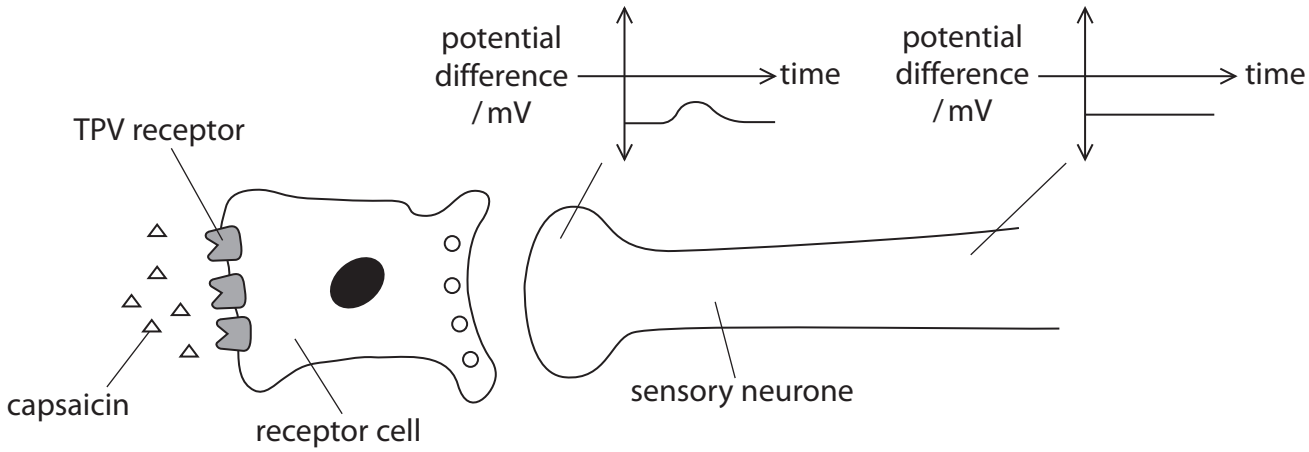
(b) Capsaicin is a substance found in chilli plants that makes them taste 'hot.'

Capsaicin binds to temperature receptor proteins called TPV receptors. This stimulates impulses along sensory neurones that send impulses to the brain.

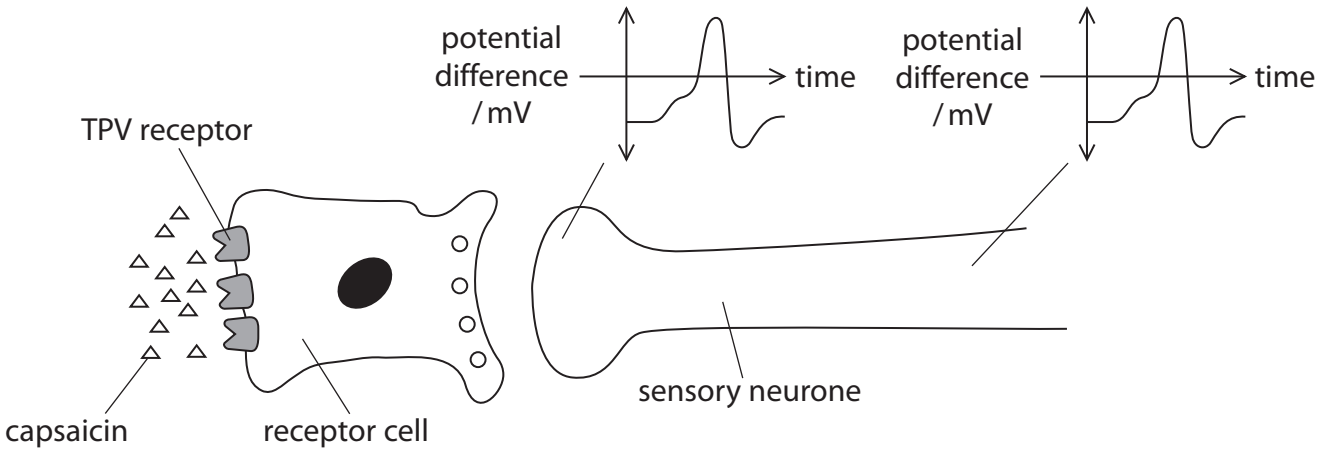
The effect of capsaicin on the depolarisation of the membrane of a sensory neurone was investigated. The potential difference across the membrane was measured at two places on the sensory neurone after adding capsaicin.

The results for a high concentration and a low concentration of capsaicin are shown in the diagram.

Low concentration of capsaicin



High concentration of capsaicin



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(i) Explain the effect of capsaicin on the depolarisation of the sensory neurone.

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*(ii) Capsaicin affects sweat production. It has been suggested that capsaicin could be used to lower the temperature of people with fevers.

The effect of three different doses of capsaicin on sweat production was investigated.

Five students took one 10 mg tablet of capsaicin each day, for one week.

The mass of sweat produced from a 10 cm^2 area of skin was measured one hour after taking each tablet of capsaicin.

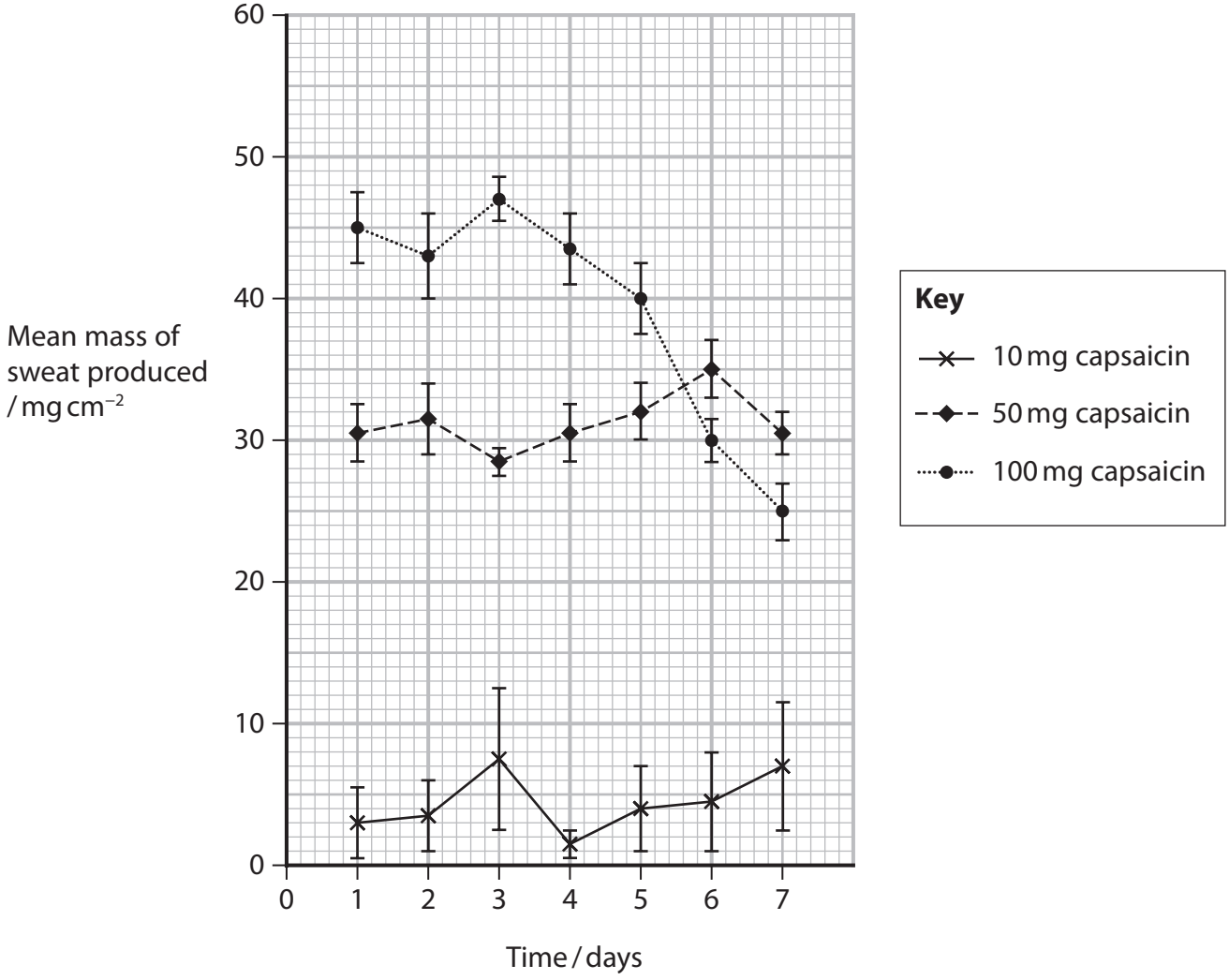
The mean mass of sweat per square centimetre of skin for the group of students was calculated for each day.

This was repeated with different groups of students taking 50 mg of capsaicin and taking 100 mg of capsaicin.

Most of the students who were given 100 mg of capsaicin reported a burning sensation and redness of the skin.

The results are shown in the graph.

Error bars represent standard deviations.



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Analyse the data to discuss the use of capsaicin to lower the temperature of people with fevers.

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(Total for Question 6 = 14 marks)

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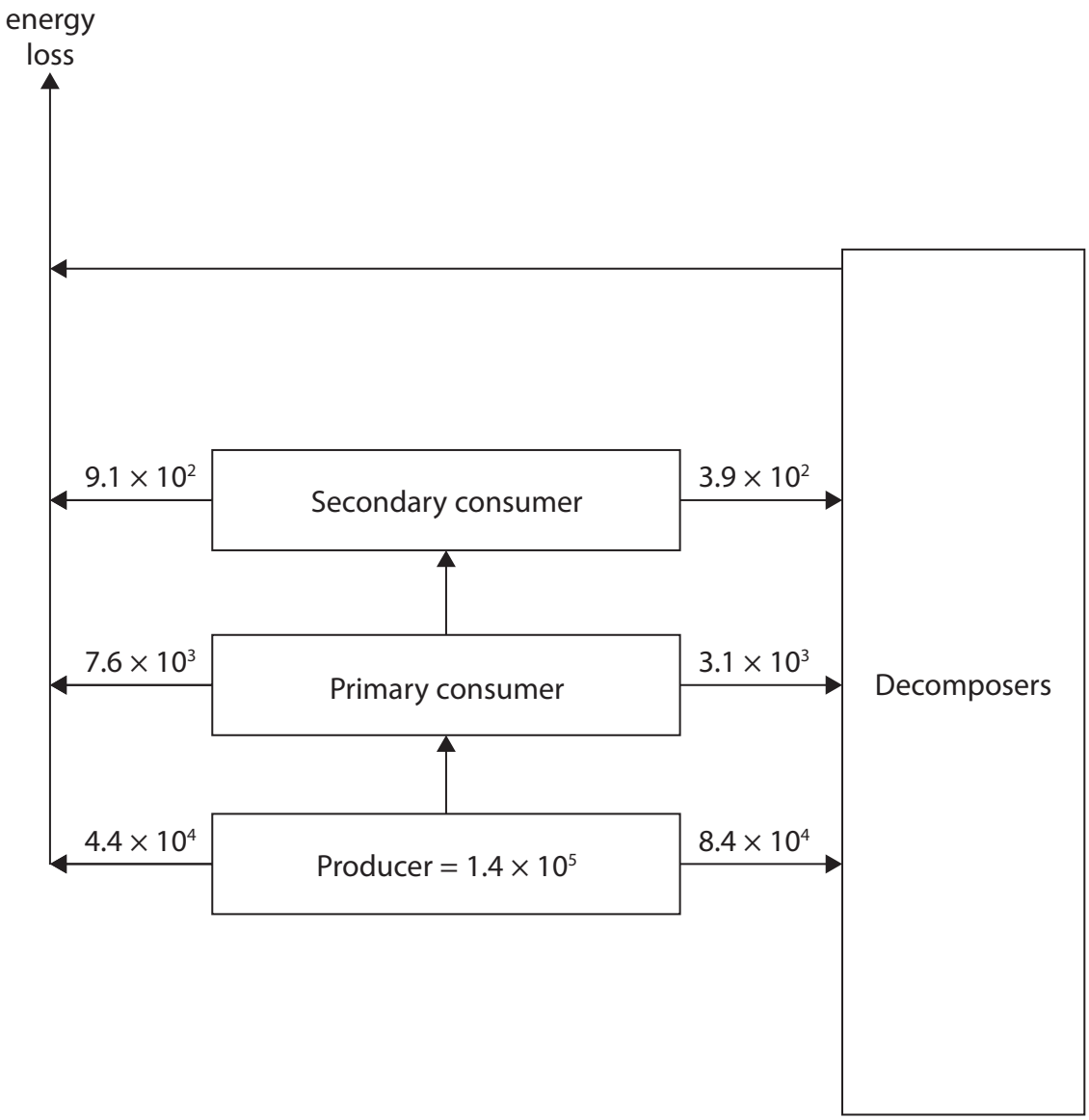
7 (a) (i) The diagram shows the transfer of energy through a grassland food chain.

All values are given in $kJ\,m^{-2}\,yr^{-1}$.



Calculate the percentage efficiency of the energy transfer from the producer to the primary consumer.

(2)

Answer.....

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(ii) Explain the differences in the efficiency of energy transfer between the trophic levels in a food chain.

(3)

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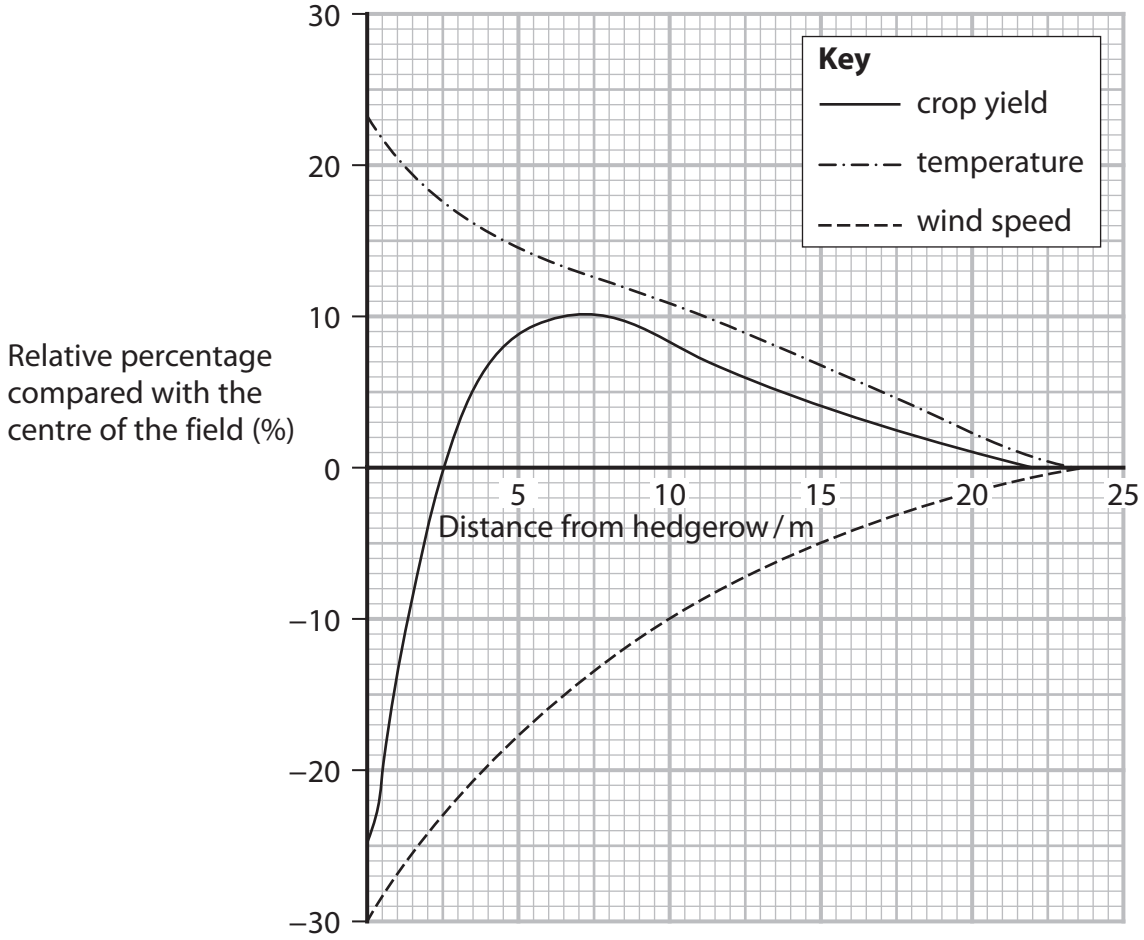
*(b) For many years, hedgerows have been removed to increase field sizes to grow crop plants.

Hedgerows provide a habitat for many species of plants and animals.

Some animals that live in hedgerows eat pests of crops and some pollinate crop plants.

The crop yield, temperature and wind speed were measured across the field starting at the hedge. These factors and the crop yield are shown as a relative percentage compared with the centre of the field in the graph.



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Analyse the information to comment on the value of conserving hedges around fields used for growing crops.

(6)

(Total for Question 7 = 11 marks)

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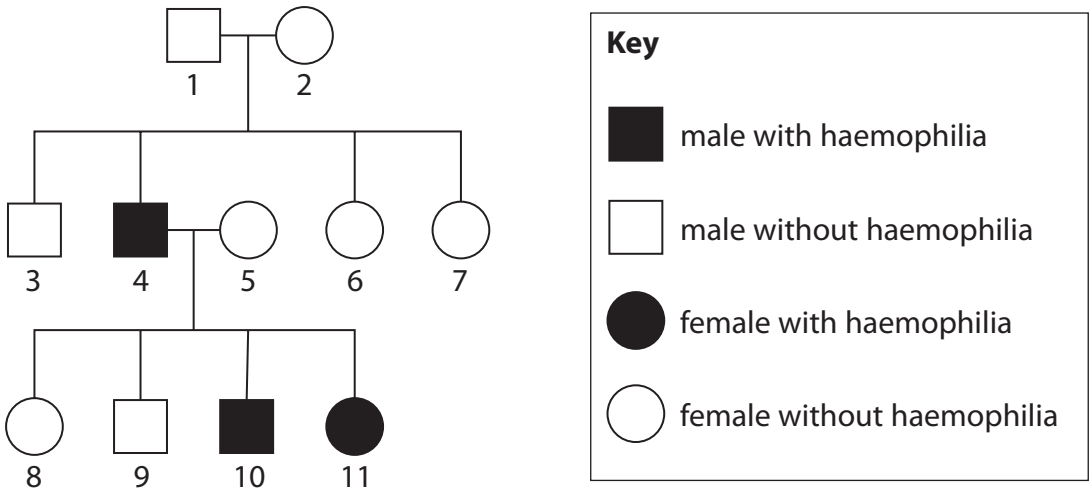
8 (a) Haemophilia is a sex linked, genetic condition that prevents blood clotting.

X^H is the allele for blood clotting

X^h is the allele for haemophilia

The pedigree diagram shows a family that has individuals who have haemophilia.



(i) What are the genotypes of individuals 1 and 2?

(1)

☒ **A** X^HY and X^HX^H

☒ **B** X^hY and X^HX^h

☒ **C** X^hY and X^HX^H

☒ **D** X^HY and X^HX^h

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(ii) Use a genetic diagram to determine the probability that the next child of individuals 4 and 5 will be a boy without haemophilia.

(3)

Answer.....

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(b) Kidney dialysis machines are used to remove urea from the blood of patients who are suffering from kidney disease.

Anti-clotting drugs are given to patients to reduce the risk of blood clot formation whilst undergoing kidney dialysis.

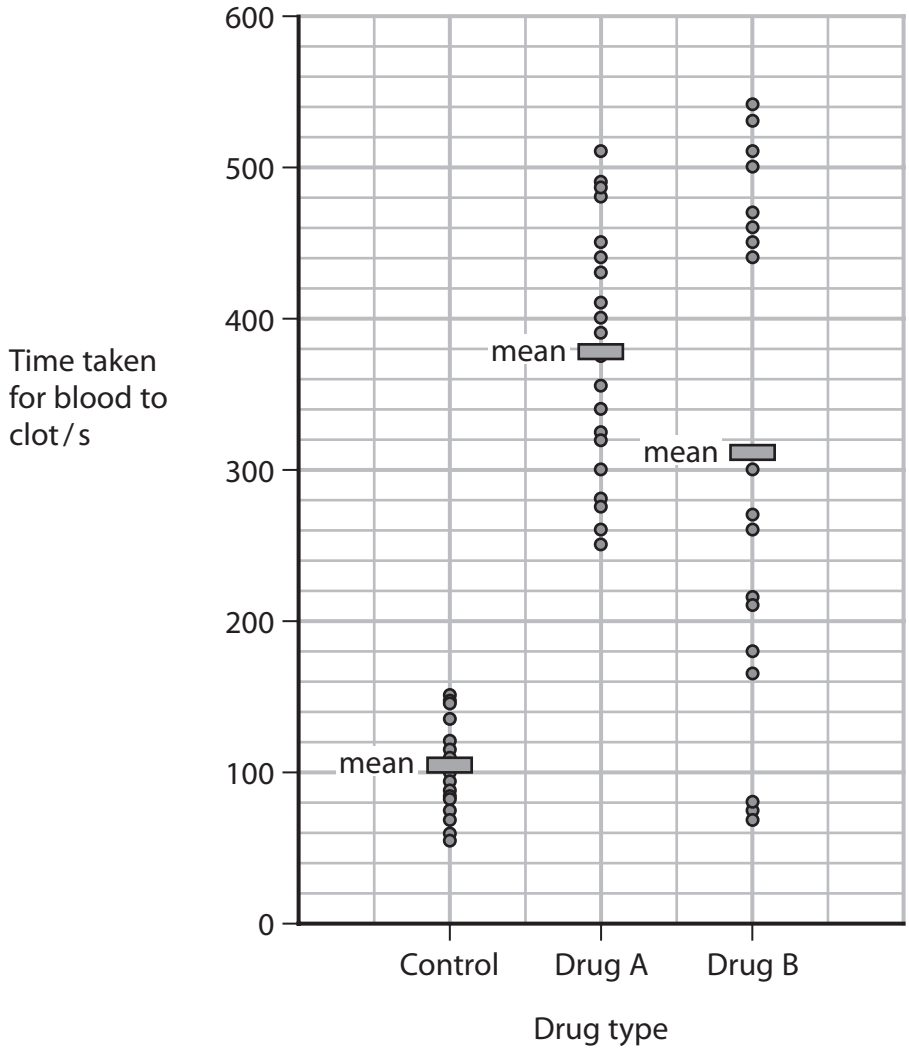
The potential use of two anti-clotting drugs, Drug A and Drug B, was investigated.

Blood samples were taken from 20 healthy adults and placed into test tubes.

The times taken for the blood samples to clot after addition of 2 mg dm^{-3} of Drug A were recorded.

This was repeated with Drug B and again with a control.

The results are shown in the graph.



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It takes 40 minutes for Drug A to become inactive in a person and 110 minutes for Drug B to become inactive.

Analyse the data to discuss the use of Drug A and Drug B to prevent the formation of blood clots.

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9 Auxins and cytokinins are plant growth regulators that control apical dominance and cell elongation.

(a) Explain how auxins and cytokinins control the growth of lateral buds.

(3)

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(b) Auxin is an uncharged molecule when it diffuses through the cell surface membrane.
When inside the cytoplasm, auxin develops a negative charge.
Auxin leaves cells by facilitated diffusion.

Explain how the structure of the cell membrane affects the transport of auxin.

(2)

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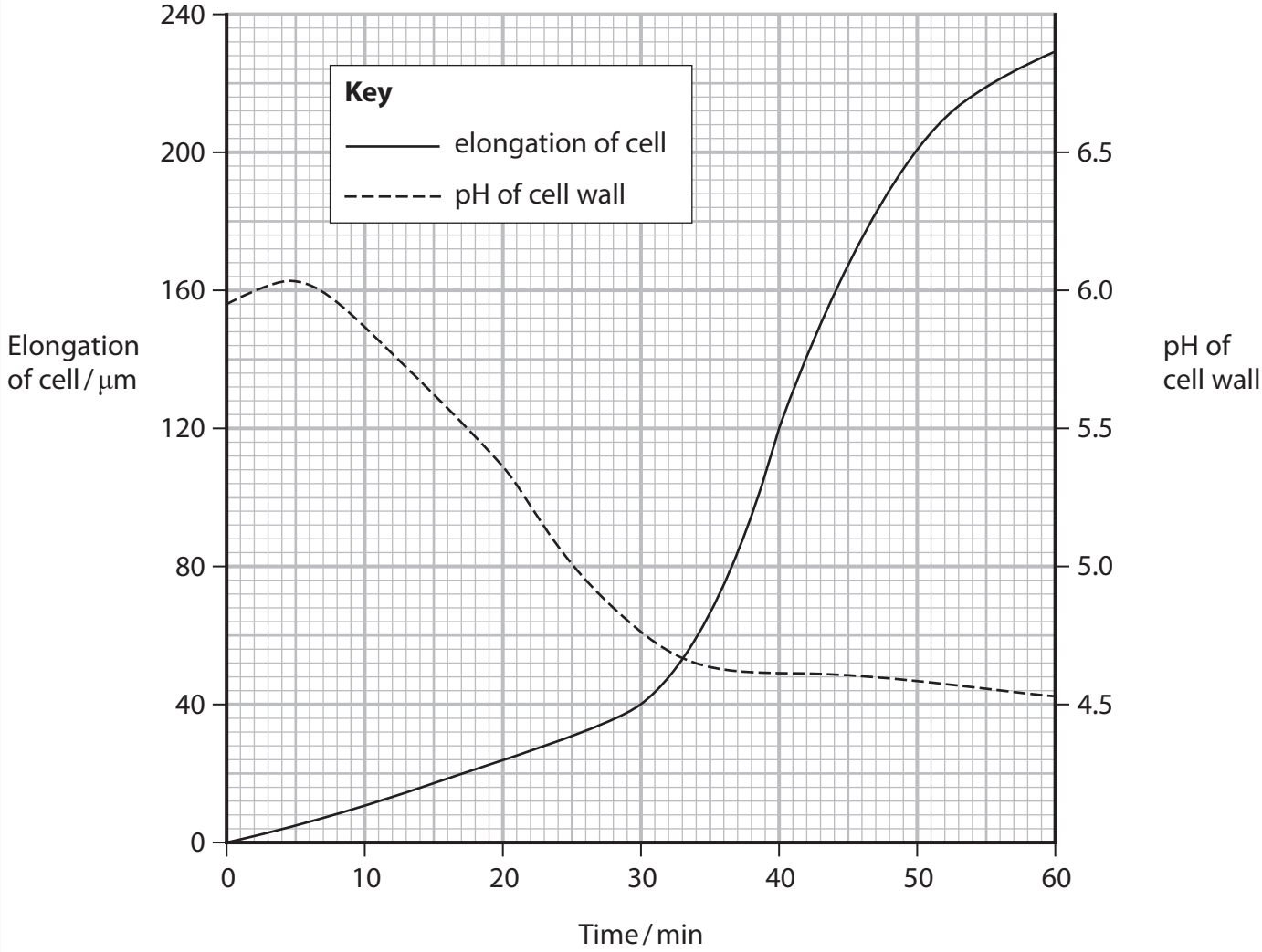
(c) When auxin enters a cell, it causes hydrogen ions to be pumped out of the cell into the cell wall.

The effect of auxin on the pH of the cell wall and cell elongation was investigated. Auxin was added to plant cells. The pH of the cell wall and cell elongation were measured over a period of 60 minutes.

The results are shown in the graph.



(i) Calculate the maximum rate of elongation of the cell.

(2)

Answer.....

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(ii) Expansin is a protein located in cell walls.

Expansin disrupts hydrogen bonds and ionic bonds of molecules in the cell wall.

Deduce a mechanism by which auxin and expansin cause cells to elongate.

(3)

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(Total for Question 9 = 10 marks)

TOTAL FOR PAPER = 90 MARKS

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