Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

5810558866

BIOLOGY **9700/42**

Paper 4 A Level Structured Questions **May/June 2017**

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Section A
Answer **all** questions.

Section B
Answer **one** question.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **22** printed pages and **2** lined pages.

CAMBRIDGE International Examinations

Section A

Answer **all** the questions.

1 **(a)** Fig. 1.1 represents the link reaction.

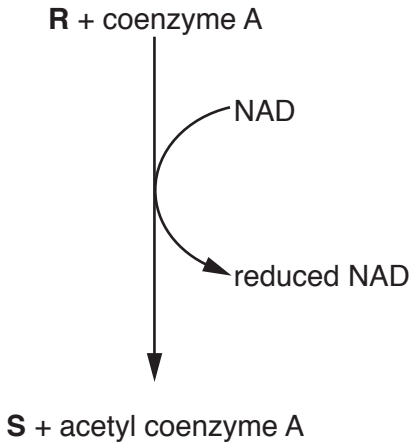

Fig. 1.1

With reference to Fig. 1.1:

(i) name substances **R** and **S**

R .....

S ..... [2]

(ii) explain what happens to the reduced NAD.

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..... [2]

(b) The pH of the blood of an athlete decreases during a race and returns to its normal level after the race. The decrease in the pH of the blood is caused by the presence of waste products that have been excreted by cells during respiration.

Name the waste products that are excreted **and** describe what occurs to these products to help return the pH of the blood back to a normal level.

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..... [5]

[Total: 9]

2 Chloroplasts belong to a group of organelles called plastids. Although different types of plastid have different structures and functions, one type of plastid can change into another type of plastid in response to environmental or developmental signals.

- Example 1: plants grown in the dark have plastids called etioplasts which lack chlorophyll. If these plants are exposed to light, the etioplasts quickly change into chloroplasts.

- Example 2: chloroplasts in surface tissues of tomato fruits change into plastids called chromoplasts as the fruits ripen. Thylakoid membranes break down and chlorophyll synthesis stops. Chromoplasts synthesise and accumulate red lycopene and orange β-carotene pigments.

(a) For each of these examples, explain the effect on the rate of photosynthesis of one type of plastid changing into another type of plastid.

Example 1 .....

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Example 2 .....

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(b) Outline the method you would use to separate and identify the pigments in an extract of tomato chromoplasts.

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(c) Cyanobacteria are prokaryotic organisms. Plastids are thought to have evolved from cyanobacteria that became incorporated into larger cells. Experiments show that free-living cyanobacteria can adapt to environmental signals in the same way as plastids.

Fig. 2.1 shows the absorption spectra of cyanobacteria grown under two different lighting conditions. One group was grown under fluorescent light and the other group was grown under red light.

The range of light wavelengths absorbed by each group of cyanobacteria was then measured under identical lighting conditions.

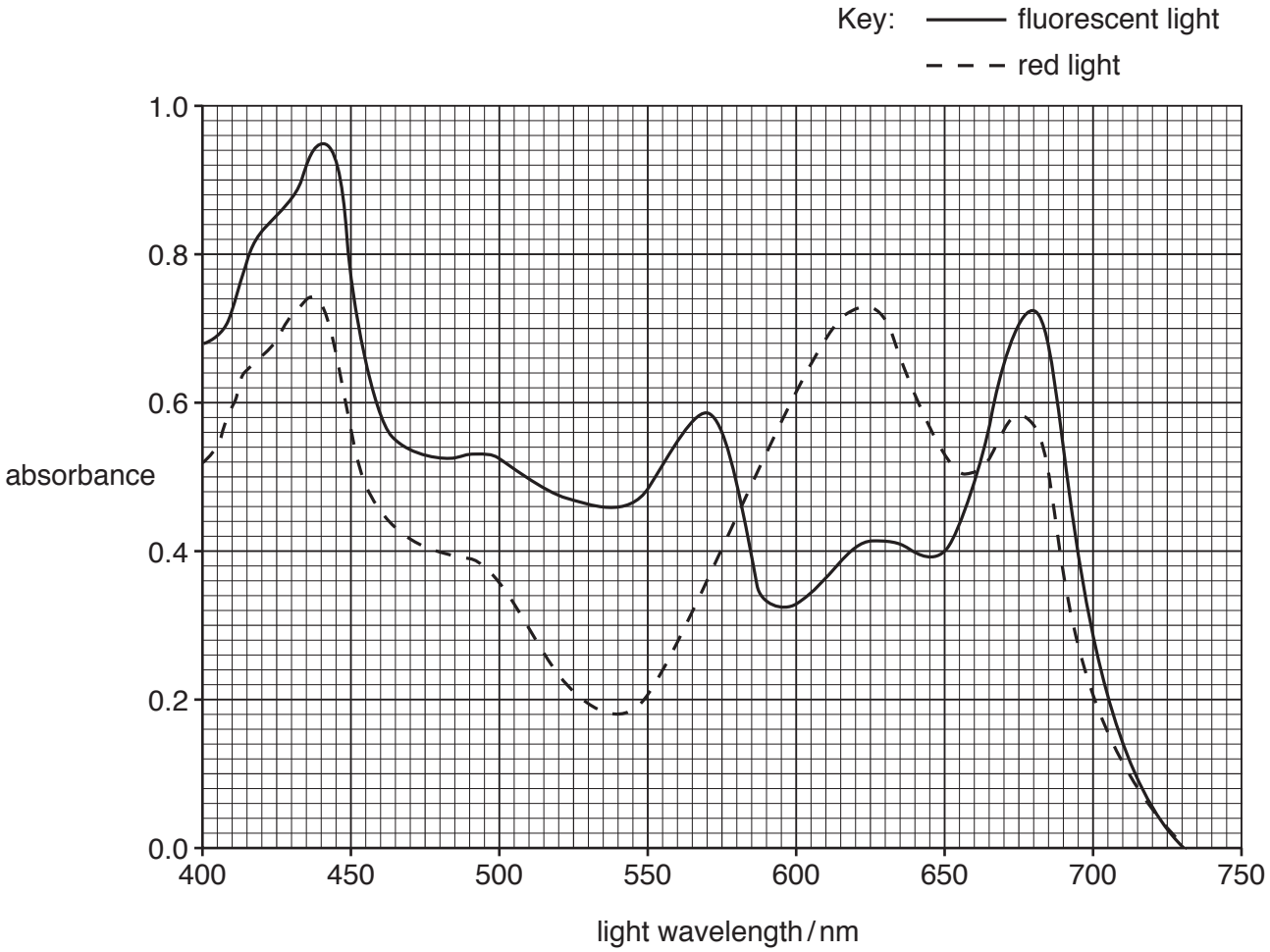

Fig. 2.1

With reference to Fig. 2.1 and the information given on pages 4 and 5, explain the effect of different lighting conditions on the absorption spectra of the two groups of cyanobacteria.

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[Total: 9]

3 Fig. 3.1 shows a diagram of two sarcomeres of relaxed striated muscle.

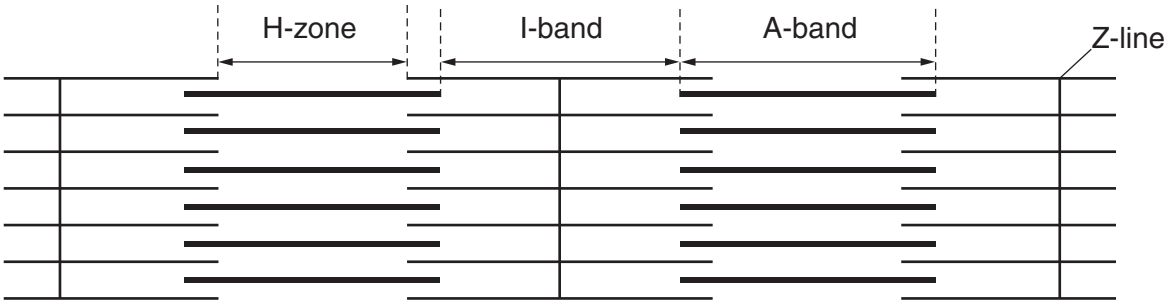

Fig. 3.1

(a) When the striated muscle contracts, state what happens to the length of:

(i) the I-band ..... [1]

(ii) the A-band. ..... [1]

(b) Describe how the response of the sarcoplasmic reticulum to the arrival of an action potential leads to the contraction of striated muscle.

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(c) Glycogen storage disease type V (GSDV) is a metabolic disorder where stored glycogen cannot be broken down to release glucose, resulting in the production of only small quantities of ATP. People with GSDV are unable to exercise normally, as the lack of ATP affects the functioning of striated muscle.

With reference to the sliding filament model of muscular contraction, suggest why a **lack** of ATP affects the functioning of striated muscle.

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[Total: 9]

4 Weeds reduce crop yields by competing with crop plants for space, light, water and minerals. The modes of action of three different types of herbicide are summarised in Table 4.1.

Table 4.1

type of herbicide	mode of action	year of first widespread use
photosystem II inhibitor	prevents photophosphorylation	1960
ALS inhibitor	prevents synthesis of the amino acids isoleucine, leucine and valine	1980
glyphosate	prevents synthesis of the amino acids phenylalanine, tryptophan and tyrosine	1990

Fig. 4.1 shows the cumulative number of species of weeds that have become resistant to these three types of herbicide since 1960.

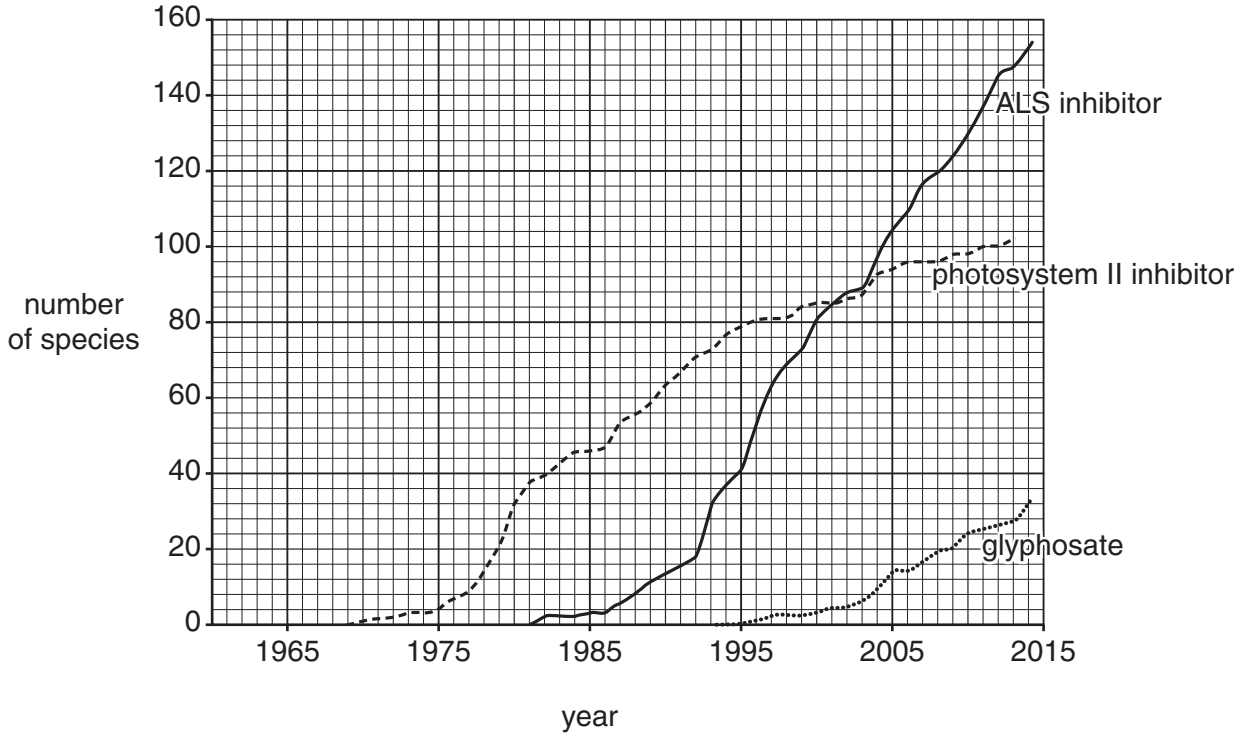

Fig. 4.1

(a) (i) Describe how the number of weed species resistant to herbicides has changed since 1960.

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(ii) Explain how a weed species becomes resistant to a herbicide.

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(b) ALS inhibitor herbicides work by binding to an enzyme present in chloroplasts called acetolactate synthetase (ALS). ALS is a globular protein consisting of four identical polypeptides each composed of 668 amino acids.

The primary structure of the ALS polypeptide of each weed species resistant to ALS inhibitor herbicides has been sequenced. Amino acid substitutions at positions as far apart as position 122 and position 574 can result in resistance.

(i) The gene that codes for the ALS polypeptide does not contain any non-coding sections (introns). The first amino acid in the final polypeptide is methionine.

State the number of base pairs in the gene that codes for an ALS polypeptide.

..... [1]

(ii) Explain why resistance to ALS inhibitor herbicide can result from substitutions of amino acids that are **far apart** in the primary sequence.

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(c) Genetic modification is one method used to develop herbicide resistance in crop plants. Other methods include:

method 1: crossing a crop plant with a herbicide-resistant wild plant belonging to the same genus and then applying the herbicide

method 2: causing mutations in the crop plants and then applying the herbicide.

State **two** benefits of using method 1 **and two** benefits of using method 2 to develop herbicide resistance in crop plants.

method 1 .....

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method 2 .....

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..... [4]

[Total: 14]

5 Cancer is a disease in which normal controls over cell division are lost and malignant tumours form. An early diagnosis of many types of cancer can result in successful treatment.

The BRCA2 protein is involved in suppressing the development of tumours. The gene that codes for this protein is on chromosome 13.

Several different dominant alleles of this gene, *BRCA2*, code for faulty versions of the protein. The presence of any one of these faulty alleles leads to an increased chance of developing several types of cancer, including breast cancer. Not everyone with one of these alleles develops cancer. This is because environmental factors, including lifestyle, are also involved.

Fig. 5.1 is a pedigree (family tree) showing the occurrence of cancers in four generations of a family. The presence of a faulty *BRCA2* allele was confirmed in person 15. The other individuals with cancer were not tested for the presence of the allele. Individuals 24–30 are all under twelve years old.

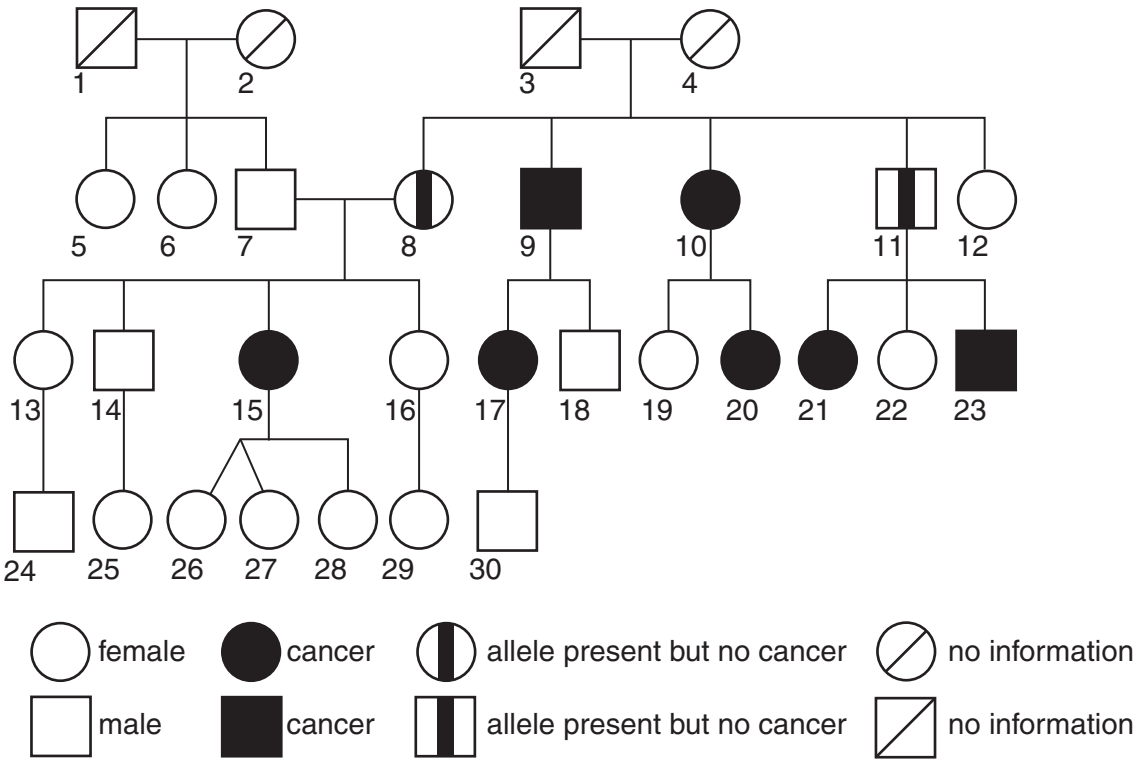

Fig. 5.1

(a) Discuss the extent to which Fig. 5.1 provides evidence that a faulty *BRCA2* allele increases the risk of a person developing cancer.

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(b) People whose families are suspected of having a faulty *BRCA2* allele may choose to be tested for its presence in their own genome.

A company based in the USA sells a microarray containing DNA probes for 20 different alleles that are associated with an increased risk of cancer, including the faulty *BRCA2* alleles. This microarray can be used in a medical facility or research laboratory to test blood samples for the presence of these alleles.

(i) Explain the meaning of the term *genome*.

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..... [1]

(ii) Suggest a type of cell from a blood sample that is suitable for testing for the presence of this allele **and** explain your choice.

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(iii) Outline how a microarray enables the detection of particular alleles.

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(iv) Suggest **one** advantage and **one** disadvantage of screening for faulty alleles of *BRCA2* before any symptoms occur.

advantage .....

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disadvantage .....

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..... [2]

[Total: 12]

6 **(a)** Fig. 6.1 is a diagram of a Bowman's (renal) capsule of a nephron from a mammalian kidney.

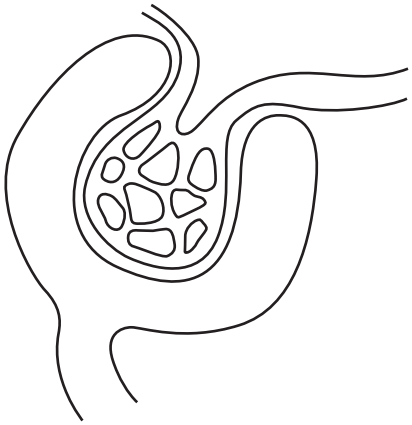

Fig. 6.1

On Fig. 6.1, use label lines and letters to label:

E – the efferent arteriole

G – the glomerulus

P – the region of podocyte cells.

[3]

(b) Describe how the structure of the epithelial cells of the proximal convoluted tubule is adapted to carry out selective reabsorption.

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(c) Complete the following sentences about osmoregulation.

In mammals, the water potential of the blood is constantly monitored by

..... in the hypothalamus of the brain.

When the water potential of the blood decreases, the production of a hormone

called ..... in the cells of the

hypothalamus increases.

This hormone is released into the blood via the .....

This causes the kidneys to retain more water until the water potential of the blood

returns to the set point.

This is an example of a ..... mechanism.

[4]

[Total: 12]

7 **(a)** Cats with either black fur or white fur are common in Europe, whereas cats with brown fur are less common.

A gene, coding for an enzyme involved in pigment production, has two alleles.

- The dominant allele, **B**, results in black fur.
- The recessive allele, **b**, results in brown fur.

A second gene can affect fur colour.

- The dominant allele, **A**, prevents pigment production, resulting in a cat with white fur.
- The recessive allele, **a**, has no effect on fur colour.

The two genes are on different pairs of autosomes.

Use a genetic diagram to show how a cross between two cats, heterozygous at both loci, can produce offspring with three different colours: white, black and brown.

State the expected ratio of the different coloured offspring.

[6]

(b) Suggest how the presence of allele **A** prevents pigment production.

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..... [3]

[Total: 9]

8 An investigation was carried out in a temperate woodland that contained a number of areas with two different types of ground cover vegetation.

- On higher ground where the soil was drier, the dominant ground cover plant was bracken, *Pteridium aquilinum*.
- On lower ground where the soil was wetter, the dominant ground cover plant was bramble, *Rubus fruticosus*.

(a) Describe how the abundance of the two plant species at higher and lower ground sites could be measured.

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(b) Soil from under bracken and under brambles was collected and placed in two funnels. A bright light was placed over each funnel so that small invertebrate animals moved down the funnels and were collected in two collecting vessels.

The main groups of invertebrates present were identified and counted. Some of the results are shown in Table 8.1.

Table 8.1

invertebrate group	number present in soil under bracken	number present in soil under brambles
pseudoscorpion	49	21
wireworm	22	12
gamasid mite	18	7
springtail	10	1
total	99	41

(i) It was not possible to identify the invertebrates as far as genus or species level, and only the wireworm group could be classified as far as the taxonomic level **above** genus.

Name the taxonomic level represented by the wireworm group.

..... [1]

(ii) State the null hypothesis for a statistical test comparing the data from the two types of site.

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..... [1]

(iii) Simpson's Index of Diversity for invertebrates from the soil under bracken was calculated as 0.663 using the formula:

$$D = 1 - \left(\sum\left(\frac{n}{N}\right)^2\right)$$

n = number of individuals of each species present in the sample
N = the total number of all individuals of all species.

Calculate Simpson's Index of Diversity for the invertebrates from the soil under brambles. Complete Table 8.2 and use the space provided to show your working. Show all working to **three** decimal places. Write your final answer on the dotted line.

Table 8.2

animal taxon	**number present in soil under brambles**	$\frac{n}{N}$	$\left(\frac{n}{N}\right)^2$
pseudoscorpion	21		
wireworm	12		
gamasid mite	7		
springtail	1		
total	41		

Simpson's Index of Diversity = ... [3]

(iv) Describe what Table 8.1 and the calculated figures for Simpson's Index of Diversity show about the effect of bracken and bramble vegetation cover on the diversity and abundance of soil invertebrates in the woodland.

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..... [2]

[Total: 11]

[Turn over

Section B

Answer **one** question.

9 **(a)** Explain the mechanism by which guard cells open stomata. [9]

(b) State the changes in the external environment that lead to stomatal opening and closure. Explain why these stomatal responses are necessary. [6]

[Total: 15]

10 **(a)** Compare the endocrine and nervous systems in control and co-ordination in mammals. [8]

(b) Outline the role of a chemoreceptor cell in the human taste bud in detecting stimuli **and** in stimulating the transmission of nerve impulses in sensory neurones. [7]

[Total: 15]

[Turn over