Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel Level 3 GCE

Wednesday 7 June 2023

Afternoon (Time: 2 hours)

Paper reference **9BN0/01**

Biology A (Salters Nuffield)

Advanced

PAPER 1: The Natural Environment and Species Survival

You must have:
Scientific 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 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

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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 *Homo sapiens* is the only living species of the genus *Homo*. Over 100 000 years ago, *Homo neanderthalensis,* a species closely related to modern humans, lived with other *Homo* species in the same habitat.

(a) Which of the following is the correct definition of the term habitat?

(1)

☐ **A** a group of organisms of different species living in the same area

☐ **B** a group of organisms of the same species living in the same area

☐ **C** a place where an organism lives

☐ **D** the role of an organism

(b) A fossil bone discovered in China is thought to be from a new species, *Homo longi*.

(i) Samples of DNA from this bone and bones from other *Homo* species can be amplified using PCR.

Describe how these amplified samples of DNA can be prepared for analysis using gel electrophoresis.

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(ii) Explain how the results of this analysis would show whether *Homo longi* is closely related to other *Homo* species.

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(Total for Question 1 = 6 marks)

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2 Human activities are affecting many habitats.

These activities can change the biodiversity of communities and populations within a habitat.

(a) Which of the following describes biodiversity within a habitat?

(1)

☒ **A** the number of different alleles and the number of the same species

☒ **B** the number of different species and the number of different alleles

☒ **C** the number of different species and the number of the same alleles

☒ **D** the number of the same alleles and the number of the same species

(b) Brown Moss is a site of special scientific interest. It is an area containing shallow ponds, inhabited by birds and rare plants.

The biodiversity of plants growing in two ponds, A and B, at Brown Moss was studied. The table includes data collected from the two ponds.

Species	Number (n) in pond A	n (n–1) for pond A	Number (n) in pond B	n (n–1) for pond B
Azolla filiculoides	5	20	0	0
Lemna minuta	29	812	0	0
Lemna trisulca	50	2 450	0	0
Alisma plantago-aquatica	2	2	0	0
Alopecurus aequalis	11	110	0	0
Carex pseudocyperus	2	2	0	0
Equisetum fluviatile	0	0	71	4 970
Juncus effusus	0	0	60	3 540
Menyanthes trifoliata	16	240	0	0
Polygonum amphibium	0	0	25	600
Ranunculus circinatus	13		0	0
Sparganium erectum	3	6	0	0
Typha latifolia	5	20	0	0
Total			156	9 110

(i) Complete the table for pond A giving the value for n (n–1) for *Ranunculus circinatus* and give the totals.

(1)

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(ii) Calculate the index of diversity for pond B using the formula

$$D = \frac{N(N-1)}{\sum n(n-1)}$$

(2)

Answer .....

(iii) Pond B is close to a farm and some houses.

Chemicals and waste from the farm and houses have increased the levels of pollutants in pond B.

The biodiversity index for pond A is 4.81.

Comment on the effect of pollutants on the biodiversity of pond B.

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(Total for Question 2 = 7 marks)

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3 The genetic information for a cell is stored in the DNA.

(a) Describe the structure of a DNA mononucleotide.

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(b) Molecules of DNA are copied by semi-conservative replication.

(i) Which of the following is the result of semi-conservative replication?

(1)

☒ **A** both DNA molecules are a mixture of original DNA and RNA

☒ **B** both daughter DNA molecules contain one original DNA strand and one new DNA strand

☒ **C** one daughter DNA molecule has two original parent strands, the other daughter DNA molecule has two new strands

☒ **D** each strand of both daughter DNA molecules is a mixture of original and new DNA

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(ii) Describe how DNA is replicated.

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(Total for Question 3 = 7 marks)

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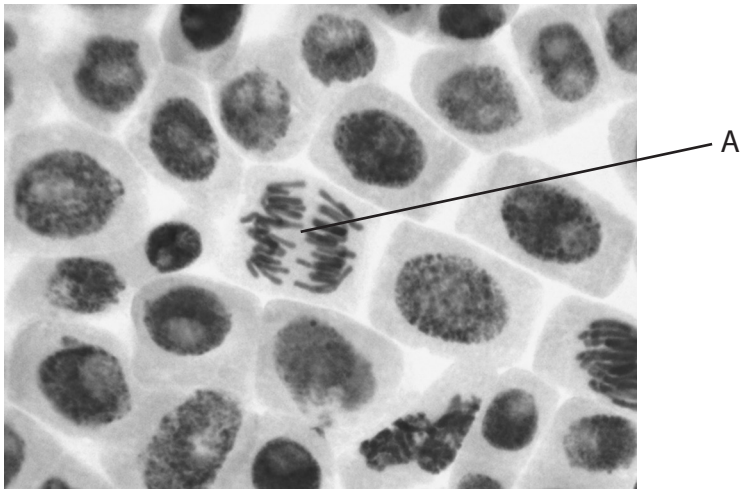
4 Cell division can be observed using a microscope. The photograph shows cells from a root tip dividing.



(Source: © Dimarion/Shutterstock)

(a) (i) Which of the following is the stage of mitosis shown in the cell labelled A?

(1)

☒ **A** anaphase

☒ **B** cytokinesis

☒ **C** metaphase

☒ **D** telophase

(ii) Describe how other plant tissues can be prepared to find out if the cells are undergoing mitosis.

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(b) Describe what happens inside a cell during prophase of mitosis.

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(Total for Question 4 = 8 marks)

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5 Many plants are known to have medicinal properties and are used in traditional medicines. These plants are often endangered.

A drug to treat breast cancer has been extracted from *Taxus brevifolia*, the Pacific yew tree.

(a) Seeds from endangered plants are placed in seed banks to conserve the species.

(i) Describe how the seeds are preserved for long periods of time in a seed bank.

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(ii) Seed banks obtain seeds collected from a number of plants of each species.

Explain the advantages of this for the conservation of a plant species.

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(b) The active ingredients in medicinal plants are identified and purified to make new drugs.

These drugs are tested extensively before use.

(i) Which of the following methods are used before the three-phased testing of clinical trials?

(1)

☒ **A** testing on animals and humans

☒ **B** testing on animals, isolated cells and tissues

☒ **C** computer modelling and testing on humans

☒ **D** computer modelling and testing isolated cells with a placebo

(ii) Describe the stages of a three-phased clinical trial.

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(c) The gut has barriers to prevent pathogens entering the body.

Explain the role of conditions in the gut in preventing infection by microorganisms.

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(Total for Question 5 = 11 marks)

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6 Shrews, moles and hedgehogs are members of the same taxonomic group of mammals that eat insects.

(a) Members of this group of mammals occupy a variety of niches.

Which of the following describes a niche?

(1)

☒ **A** the environment of an organism

☒ **B** the habitat of an organism

☒ **C** the population of an organism

☒ **D** the role of an organism in its environment

(b) Shrews are very small mammals that maintain a body temperature of 40 °C.

They require a good supply of oxygen as they lose heat rapidly.

(i) Explain how the structure of their lungs enables shrews to get oxygen into the body rapidly.

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(ii) Some species of shrew have evolved to feed on insects found in cold water streams. They are semi-aquatic, spending part of their lives diving in water and part of the time living on land.

These shrews have large concentrations of the protein myoglobin in their muscles.

Myoglobin stores oxygen, which can be released for aerobic respiration during a dive.

The myoglobin in these shrews has a different, tertiary structure than in other species of shrew. This allows larger quantities of myoglobin to be stored in their muscles.

Describe how these species of semi-aquatic shrew may have evolved.

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(iii) Explain why a change in the base sequence of the gene coding for myoglobin could change its tertiary structure.

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(Total for Question 6 = 12 marks)

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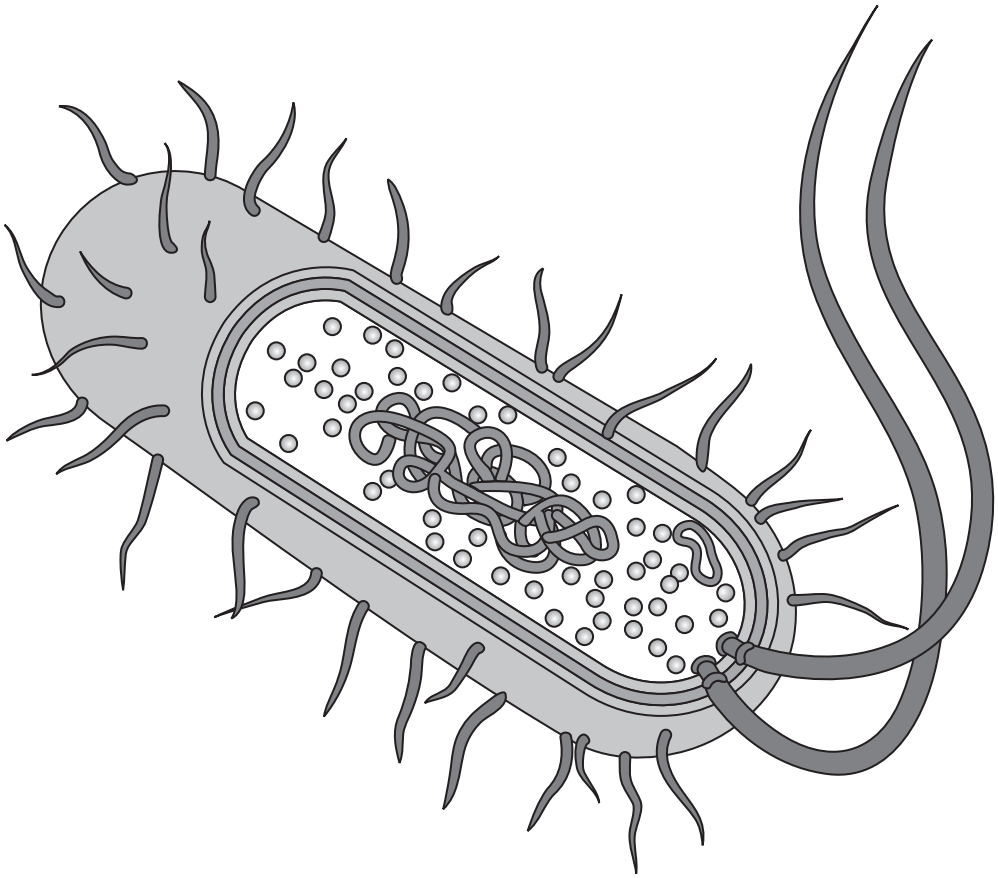
7 The diagram shows the structure of a bacterium. Some bacteria are pathogenic to humans and can cause inflammation and fever.



(a) Which of the following are found **only** in bacterial cells?

(1)

☒ **A** cellulose cell wall, plasmid, 70S ribosome

☒ **B** flagellum, plasma membrane, mitochondria

☒ **C** plasma membrane, cellulose cell wall, plasmid

☒ **D** plasmid, 70S ribosome, circular DNA

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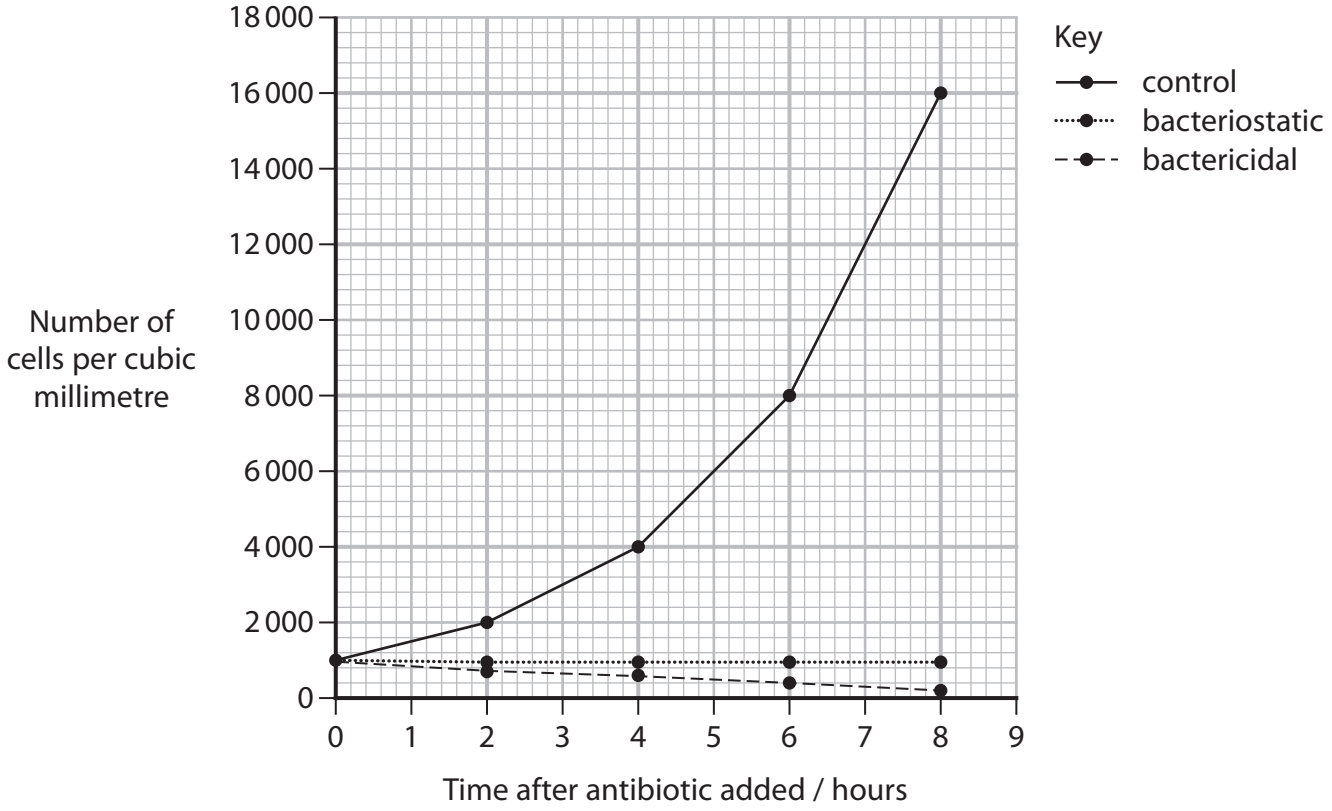
(b) Some bacteria are pathogenic. Bacteriostatic and bactericidal antibiotics are drugs used to treat diseases caused by bacteria.

The graph shows the effects of two types of antibiotic on the growth of bacteria. The control line shows the growth of bacteria with no antibiotic present.



(i) State what is meant by the term **bactericidal** antibiotic.

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(ii) Calculate the mean rate of increase in the number of bacteria in the control from 6 to 8 hours.

Give your answer in **standard form**.

(2)

Answer .....

(iii) Symptoms of bacterial infection include fever and inflammation.

Explain the role of the inflammatory response in protecting the body from bacterial infection.

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*(c) Antibiotics can be used to prevent death from bacterial infections.

They act in a number of ways, but all affect a target site in the bacteria.

Many bacteria are developing resistance to antibiotics.

Antibiotic resistance is likely to cause 300 million premature deaths by 2050.

The table gives examples of some antibiotics and the development of resistance.

Mechanism of resistance	**Example of antibiotic**	**How bacteria develop resistance to antibiotic**	**Example of resistant bacteria**
Destruction of the antibiotic	penicillin	Produces enzymes that destroy the drug	*Staphylococcus*
Decrease in antibiotic uptake	vancomycin	Changes in the permeability of the cell membrane prevent the drug entering the bacterial cell	*Pseudomonas*
Activation of a transport mechanism	tetracycline	Pumps develop in the cell membrane to remove toxic substances from the cell	*Escherichia coli*
Modification of target site	linezolid	Mutations in the bacterial DNA causes a change in the target site so the antibiotic can no longer bind to it	*Escherichia coli*

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Discuss the mechanisms bacteria have developed to become resistant to antibiotics and the codes of practice used to overcome this resistance.

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(Total for Question 7 = 14 marks)

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8 The species of seagrass, *Posidonia oceanica,* is endemic to the Mediterranean Sea.

The photograph shows part of an underwater seagrass meadow.

(Source: © Alberto Romeo)

(a) Which of the following describes an endemic species?

(1)

☒ **A** found in many geographical areas

☒ **B** found in only one geographical area

☒ **C** a hybrid between two species

☒ **D** threatened with extinction

(b) Seagrass is a very slow growing species that lives for a long time.

Seagrass absorbs large amounts of carbon dioxide. It stores 15 times more carbon dioxide per year than a similar area of rainforest.

Rainforests store approximately 5 tonnes of carbon per hectare per year.

In the sea near Spain, seagrass covers an area of 1.2 million hectares

Which of the following describes the mass of carbon stored by this area of seagrass each year?

(1)

☒ **A** 7.5×10^6 tonnes year^{-1}

☒ **B** 75 tonnes per year

☒ **C** 9.0×10^6 tonnes year^{-1}

☒ **D** 9.0×10^7 tonnes year^{-1}

(c) Seagrass cannot survive if the water becomes warmer or more acidic.

Seagrass in the Mediterranean Sea has declined by 34% in the last 50 years.

(i) Explain why the increase in greenhouse gases is leading to a decrease in the growth of seagrass.

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(ii) Discuss the possible effects of a reduction in seagrass on animals living in the Mediterranean Sea.

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(iii) Seagrass is long-living and more resistant to breakdown by microorganisms than plants living in the rainforest.

Explain why maintaining a healthy population of seagrass reduces the release of carbon dioxide into the atmosphere.

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(Total for Question 8 = 12 marks)

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9 It is difficult to tell the sex of young chickens. This can be overcome by breeding programmes that allow the sex of the chicken to determine the visible features.

In birds the sex chromosomes are Z and W. Males are ZZ and females are ZW.

Head colour in chickens is a sex-linked characteristic carried only on the Z chromosome.

The dominant allele gives bar-headed chickens and the recessive allele gives black-headed chickens.

(Source: © Dimarion/Shutterstock)

Bar-headed chicken

(Source: © Muskoka Stock Photos/Shutterstock)

Black-headed chicken

(a) (i) Which of the following is the genotype of a black-headed female chicken?

(1)

☒ **A** Z^BZ^b

☒ **B** Z^bZ^b

☒ **C** Z^bW

☒ **D** Z^BW^b

(ii) A bar-headed female chicken was crossed with a black-headed male chicken.

Draw a genetic diagram to show the genotypes and phenotypes of the offspring produced by this cross.

(3)

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(iii) Male chickens produced by this cross were crossed with a bar-headed female chicken.

Deduce why this cross will produce both bar-headed and black-headed females.

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(b) Gene expression leads to the synthesis of proteins that give rise to the phenotype.

Describe how one gene can give rise to more than one protein.

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(Total for Question 9 = 10 marks)

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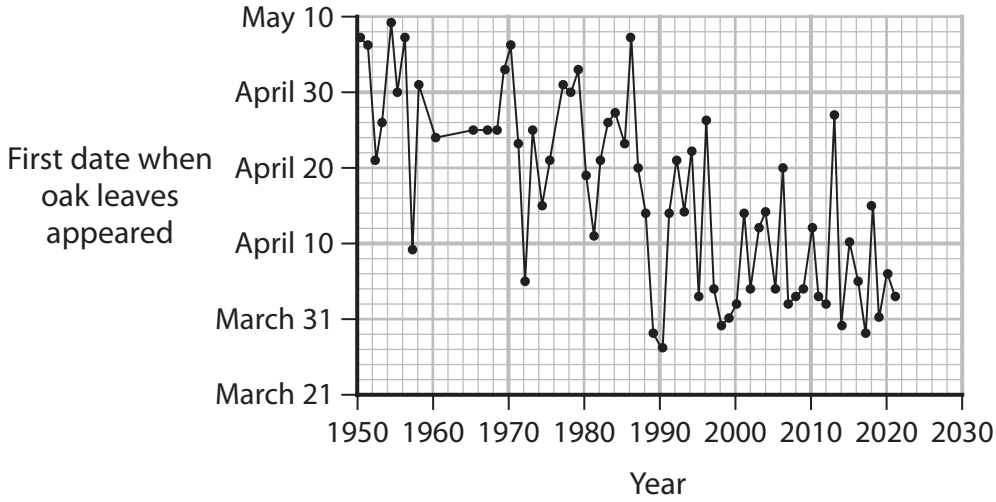
10 The average spring temperature in the UK has increased by 0.5 °C from 1995 to 2014. This is due to climate change.

This has affected plants and the insects that feed on them.

(a) Many butterfly species depend on oak trees.
The larvae feed on the young leaves in spring.

The graph shows the date when oak leaves first appeared on one tree between the years 1950 and 2021.



Draw a trend line to predict when oak leaves will first appear in the year 2030.

(2)

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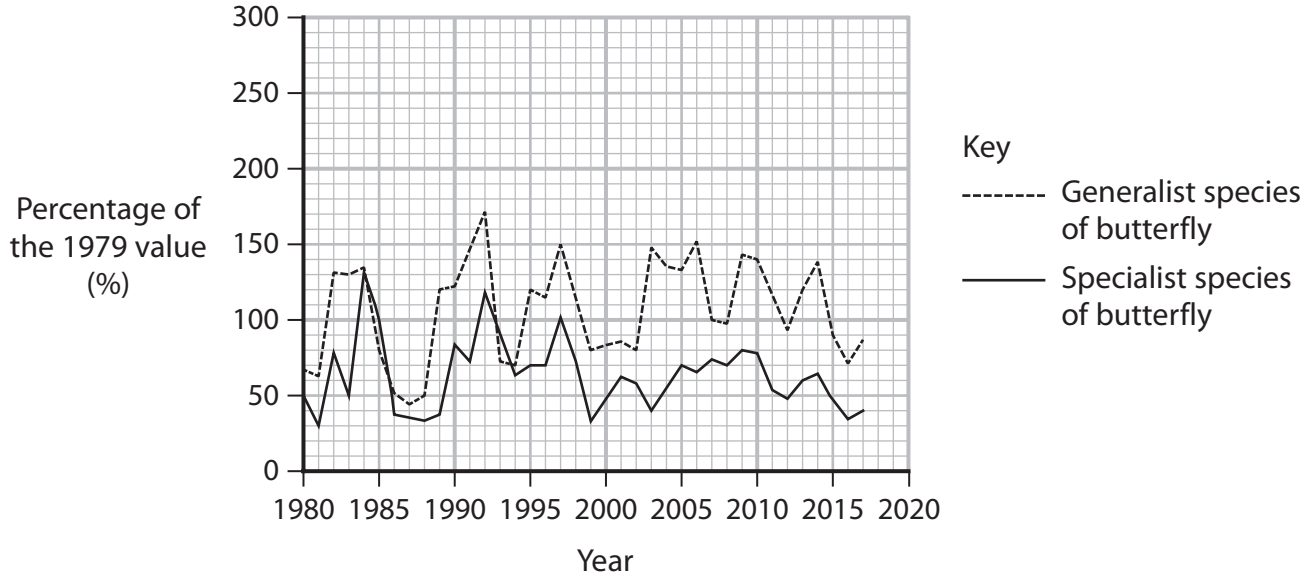
(b) Specialist butterfly species feed on only one plant species. Generalist butterfly species feed on a range of plant species.

The graph shows the changes in the population sizes of the two types of butterfly from 1980 to 2017.



Explain why specialist butterfly species may find it more difficult to adapt to the changes in spring temperatures.

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(c) The effect of the rise in spring temperature on the life cycle of butterflies was studied.

These insects have a typical life cycle of four stages:

egg, larva, pupa and adult.

The photograph shows a butterfly larva (caterpillar) feeding on a leaf.

(Source: © dossyl/Shutterstock)

(i) Explain why an increase in environmental temperature may lead to a shorter life cycle.

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*(ii) Devise a laboratory investigation to study the effect of temperature on the duration of the larval stage in a specialist butterfly species.

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(Total for Question 10 = 13 marks)

TOTAL FOR PAPER = 100 MARKS

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