Candidate surname | Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Monday 21 October 2024

Afternoon (Time: 1 hour 45 minutes) | **Paper reference** **WBI14/01**

Biology
International Advanced Level
UNIT 4: Energy, Environment, Microbiology and Immunity

You must have:
Scientific calculator, ruler, HB pencil

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.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

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 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 ▶

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 Very little of the light energy falling on a field of plants is absorbed by the plants and transferred to higher trophic levels.

(a) Suggest **two** reasons why very little of the light energy is absorbed by plants.

(2)

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(b) In an American study, the light energy falling on one square metre of a field in one year was recorded as 1 700 000 kilocalories.

(i) Only one fifteenth of this light energy was converted into plant biomass.

Calculate the number of kilocalories of light energy converted into plant biomass.

Give your answer in standard form.

(1)

Answer .... kilocalories

(ii) Only 6 kilocalories became animal biomass.

Calculate the number of kilojoules (kJ) of energy that became biomass.

1 kilocalorie = 4.2 kJ.

Give your answer to **two** significant figures.

(1)

Answer .... kJ

(iii) In another field 154 000 kilocalories of energy was converted into plant biomass.

Only 25 kilocalories of this energy was passed onto the highest trophic level in a food chain.

Calculate the percentage of energy that was passed onto the highest trophic level.

(1)

Answer .... %

(Total for Question 1 = 5 marks)

2 Broccoli is a vegetable plant that is grown as a crop in many parts of the world.

Broccoli is susceptible to a disease called clubroot.

Genetic engineering can be used to produce clubroot-resistant varieties of broccoli.

Genetic engineering involves inserting resistance genes into the cells of the broccoli plants.

The resistance genes were obtained from linseed plants.

Scientists can use DNA profiling to identify the broccoli plants that have been successfully genetically engineered.

(a) Samples of DNA were extracted from the plants and subjected to a polymerase chain reaction (PCR) before analysis.

(i) Explain why PCR was used on the DNA samples.

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(ii) Taq (DNA) polymerase is used in PCR.

Describe the role of Taq (DNA) polymerase.

(2)

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(b) After PCR, gel electrophoresis was used to separate the DNA fragments.

  (i) Which type of enzyme is used to produce DNA fragments?

(1)

    ⊠ **A** integrase

    ⊠ **B** restriction enzyme

    ⊠ **C** reverse transcriptase

    ⊠ **D** RUBISCO

  (ii) The results of the gel electrophoresis were used to identify the plants that contained the resistance genes.

Deduce the types of plants that would have supplied the DNA samples for this analysis.

Give reasons for your answer.

Use the information in the question to support your answer.

(3)

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(Total for Question 2 = 8 marks)

3 A person's immune response to viral infections involves T killer cells.

Cells infected with viruses present viral antigens to the T killer cells.

(a) Peptide fragments bind to MHC molecules to form an antigen-MHC complex. This takes place in the rough endoplasmic reticulum (rER).

The complex is then transported to the surface of the infected cell.

Describe how the antigen-MHC complex is transported from the rER onto the outside of the surface membrane of the infected cell.

(2)

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(b) An electron microscope with a resolution of 3.7 Å can be used to study antigen-MHC complexes.

$1 \, \mu m = 1 \times 10^4 \, Å$

(i) Calculate the resolution of this electron microscope in nanometres.

(1)

Answer .... nm

(ii) State what is meant by a resolution of 3.7 Å

(1)

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(c) Explain why antigens need to be presented to T killer cells in a person's immune response to viral infections.

(2)

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(d) Explain how the action of T killer cells results in a person recovering from a viral infection.

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(Total for Question 3 = 9 marks)

4 The time of death of a mammal can be determined by a number of different methods.

(a) Insects can be used to determine the time of death of a mammal.

(i) Which is the term used to describe the use of insects in determining the time and place of death of a mammal?

(1)

☒ **A** chromatography

☒ **B** dendrochronology

☒ **C** forensic entomology

☒ **D** heterozygosity

(ii) Which of the following factors provides information about the time of death of a mammal?

1. species of insect

2. size of larvae, e.g. maggots

3. stages in development of insects

(1)

☒ **A** 1 only

☒ **B** 1 and 3 only

☒ **C** 2 and 3 only

☒ **D** 1, 2 and 3

(b) The body temperature of a human corpse can be used to determine the time of death.

(i) Which is the most accurate method of measuring the body temperature of a human corpse to determine time of death?

(1)

☒ **A** placing a temperature-sensitive strip on the forehead

☒ **B** pushing a temperature probe into the liver

☒ **C** putting a thermometer under the tongue

☒ **D** putting a temperature probe under the armpit

(ii) Time of death can be estimated by determining the fall in body temperature.

Which row of the table shows how more clothing and higher ambient temperature would affect the estimated time of death?

(1)

		Effect on estimated time since death of:	
		more clothing	**higher ambient temperature**
☒	**A**	increase	increase
☒	**B**	increase	decrease
☒	**C**	decrease	increase
☒	**D**	decrease	decrease

P 7 8 3 8 7 A 0 9 3 6

(c) The extent of muscle contraction (*rigor mortis*) can be used to estimate the time of death.

(i) The graph shows the changes in three characteristics of muscle with time after the death of a mammal:

- ATP

- lactic acid

- pH
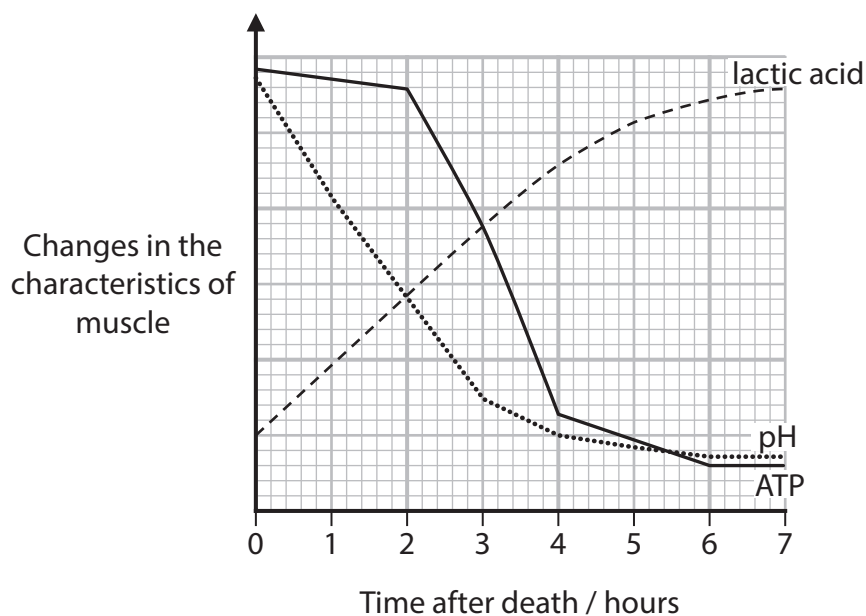
Explain the changes in each of the **three** characteristics shown in this graph.

Use your own knowledge to support your answer.

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P 7 8 3 8 7 A 0 1 0 3 6

(ii) The graph shows the changes in the extent of muscle contraction with time after death.

Extent of
muscle contraction

Time after death / hours
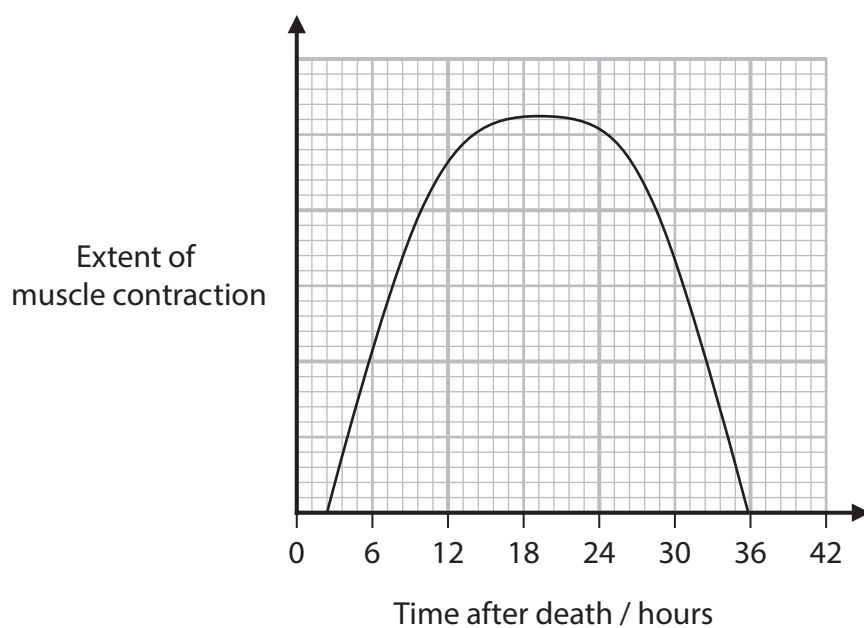
Explain why using the extent of muscle contraction by itself may give an incorrect time of death.

Use the information in the graph to support your answer.

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(Total for Question 4 = 10 marks)

P 7 8 3 8 7 A 0 1 1 3 6

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5 Succession can result in the formation of different types of habitat.

(a) State the meaning of the term **succession**.

(1)

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(b) Which of the following describes a habitat?

(1)

☒ **A** a group of interacting organisms

☒ **B** a place that meets the environmental conditions an organism needs to survive

☒ **C** the number of one species found in a particular place

☒ **D** the niche of an organism

*(c) Succession takes place as a glacier retreats. As the ice melts, bare rock is exposed.

The graph shows the changes in the numbers of three different types of plant, alder, spruce and hemlock, with time after a glacier has retreated.

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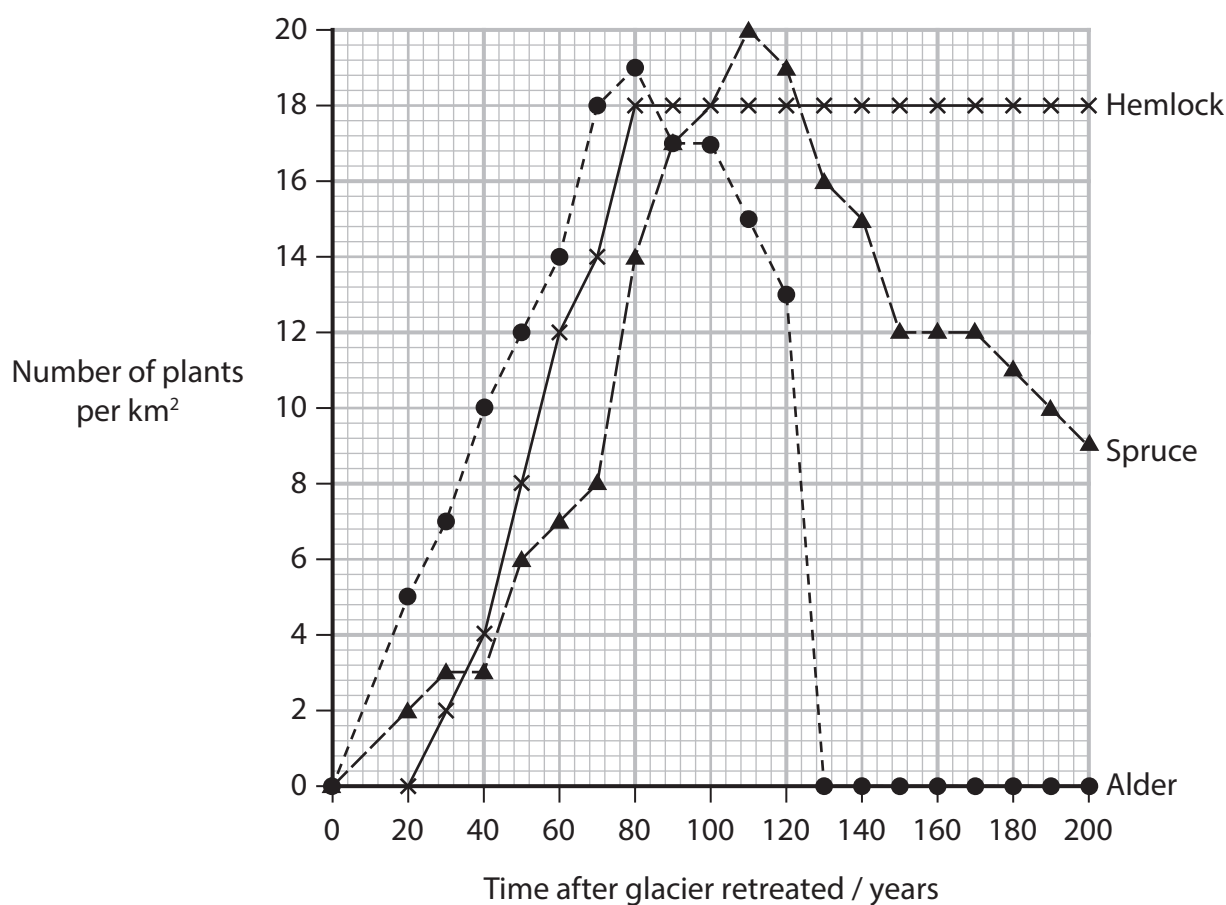
Explain the changes in the numbers of the three types of plant with time after the glacier has retreated.

Use the information in the question and your own knowledge to support your answer.

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(Total for Question 5 = 8 marks)

6 Respiratory syncytial virus (RSV) usually causes mild, cold-like symptoms from which most people recover.

Infection with RSV can be serious in young children and older people.

Currently, there are no approved vaccines against RSV, although there are some in clinical trials.

(a) The graph shows the number of people who had to go to hospital in one country in one year.

The graph also shows the number of deaths in children under five years old and in older people in the same country in that year.

Number of people in hospital   Number of deaths
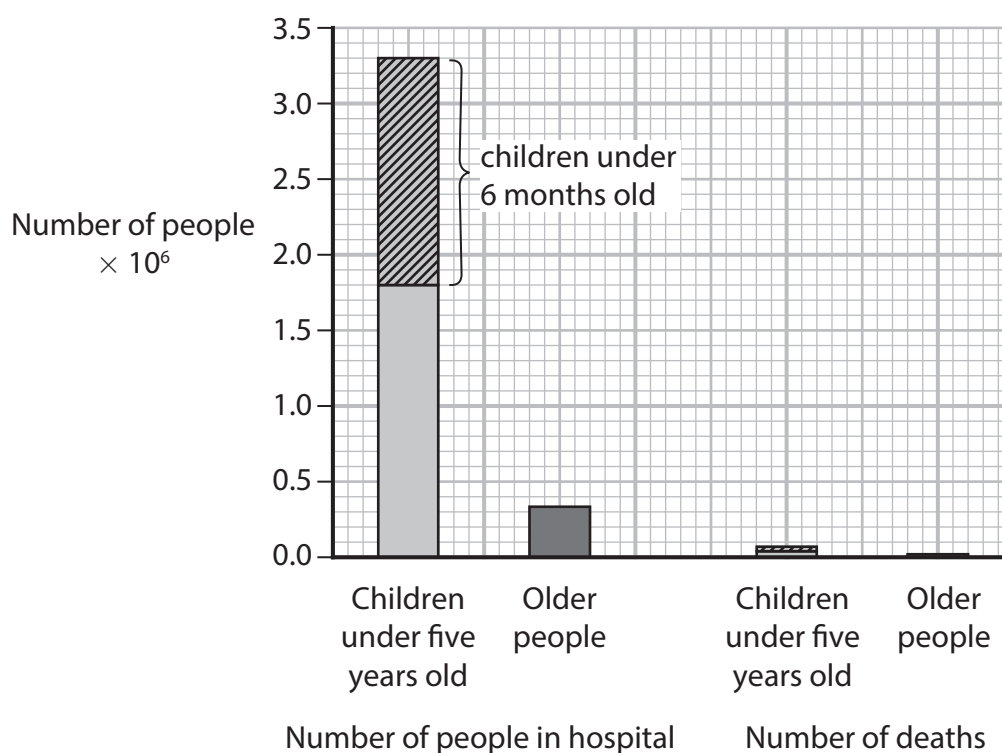
(i) Which is the proportion of the children under five in hospital who are under 6 months old?

(1)

☒ **A** $\dfrac{5}{11}$

☒ **B** $\dfrac{6}{11}$

☒ **C** $\dfrac{5}{6}$

☒ **D** $\dfrac{6}{5}$

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P 7 8 3 8 7 A 0 1 6 3 6

(ii) Which would be a more appropriate scale to use on the y-axis so that the range of values for the number of deaths can be seen clearly?

(1)

☒ **A** linear

☒ **B** logarithmic

☒ **C** standard deviation

☒ **D** standard form

(b) In one trial, people received a new vaccine against RSV.

The results showed that this vaccine protected against two subtypes of RSV.

Give **two** reasons why one vaccine can protect against two subtypes of RSV.

(2)

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(c) In another trial, pregnant women were given a vaccine against RSV.

This vaccine did not cross from the mother into the developing fetus.

(i) As a result of passive immunity, the babies of these pregnant women were born with high levels of antibodies against RSV.

Explain how passive immunity developed in these babies before they were born.

(5)

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(ii) The scientists running this trial claimed that the vaccine was 85 % successful at protecting babies against RSV infections that required medical attention.

Describe how the data could have been collected to support this claim.

(3)

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(Total for Question 6 = 12 marks)

P 7 8 3 8 7 A 0 1 9 3 6

7 Leaf scald is a disease of sugarcane caused by bacteria.

These bacteria are found in the **xylem** and release chemicals, one of which is called albicidin.

Some of these chemicals stimulate the xylem vessels to produce a sticky gum.

Albicidin inhibits chloroplast development.

The photograph shows the appearance of part of a sugarcane leaf infected with these bacteria.
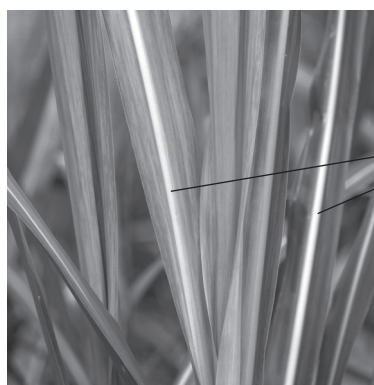
white streaks on leaf

(Source: © Nigel Cattlin / Alamy Stock Photo)

(a) Explain how infection with these bacteria results in the death of the leaf cells and eventually the whole plant.

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(b) Albicidin is an inhibitor of the enzyme DNA gyrase.

This enzyme is present in prokaryotic cells.

It binds to DNA and causes the DNA to supercoil, a process needed for cells to function properly.

(i) Describe **two** differences in the structure of DNA found in prokaryotic cells and the structure of DNA found in human cells.

(2)

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(ii) Albicidin is being developed as an antibiotic to human pathogens.

Suggest why albicidin can be used as an antibiotic.

Use the information in the question to support your answer.

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(iii) Explain the importance of developing new antibiotics, such as albicidin.

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(Total for Question 7 = 11 marks)

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QUESTION 8 BEGINS ON THE NEXT PAGE.

8 Phytoplankton are single-celled eukaryotic organisms that can photosynthesise. They live in the oceans.

A coccolithophore is a phytoplankton enclosed by plates of calcium carbonate.

The photograph shows one species of coccolithophore, *E. huxleyi*.

plates of calcium carbonate

coccolithophore
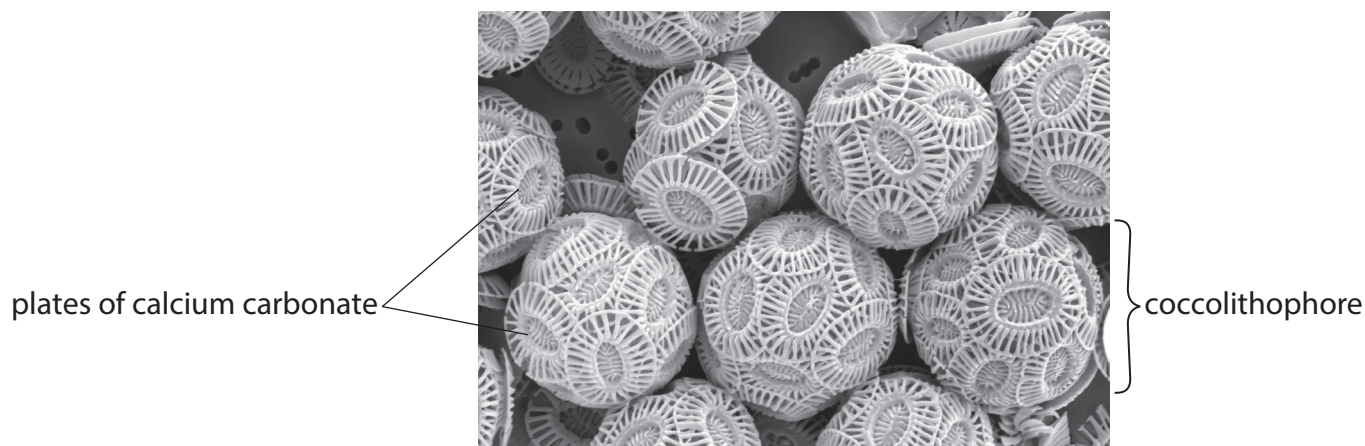
(Source: © The Natural History Museum / Alamy Stock Photo)

(a) In one drop of seawater there are between 1 000 and 10 000 *E. huxleyi*.

The diagram shows the dimensions of one *E. huxleyi*.

diameter of cell = 50 μm

thickness of plate = 12 μm
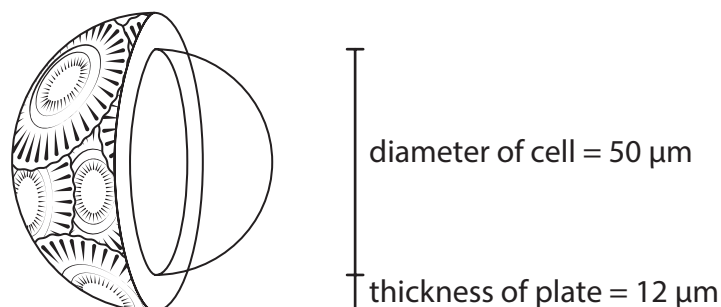
Calculate the **total** volume of this *E. huxleyi*.

Give your answer in mm³.

Use the formula:

$$V = \frac{4}{3}\pi r^3$$

(3)

Answer .... mm³

(b) Scientists think that *E. huxleyi* may have an impact on global warming and climate change.

E. huxleyi are continually producing the plates of calcium carbonate using the carbon dioxide they have taken in from the water.

(i) One *E. huxleyi* can contain 12 plates.

It takes 75 minutes to produce one plate.

Calculate the number of **hours** it takes one *E. huxleyi* to produce 12 plates.

Assume only one plate at a time is made.

(1)

Answer .... hours

(ii) Some of the plates produced by *E. huxleyi* are shed into the ocean water.

Scientists have discovered that plates shed into the water can attach to other *E. huxleyi*.

Describe how scientists could show that plates shed into the water can attach to **other** *E. huxleyi* cells.

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*(iii) The plates can carry viruses that infect the *E. huxleyi*.

Infected *E. huxleyi* produce a glue that sticks many cells and plates together to form a 'marine snow'.

The marine snow is very dense and sinks to the bottom of the oceans.

Explain the possible impact that infected *E. huxleyi* could have on global warming and the effects of climate change.

Use the information in the question and your own knowledge to support your answer.

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(Total for Question 8 = 13 marks)

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QUESTION 9 BEGINS ON THE NEXT PAGE.

9 Light is essential for photosynthesis.

(a) Explain the role of light in the light-dependent reactions in photosynthesis.

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(b) The photograph shows thale cress, a small flowering plant found in Europe, Asia and Africa.

(Source: © blickwinkel / Alamy Stock Photo)

The effect of wavelength of light on thale cress was investigated.

Three groups of plants were treated with a different wavelength of light.

One group of plants was treated with blue light, one group with amber light and one group with red light.

The following were measured:

• rate of photosynthesis

• leaf biomass

• pigment content of the leaves
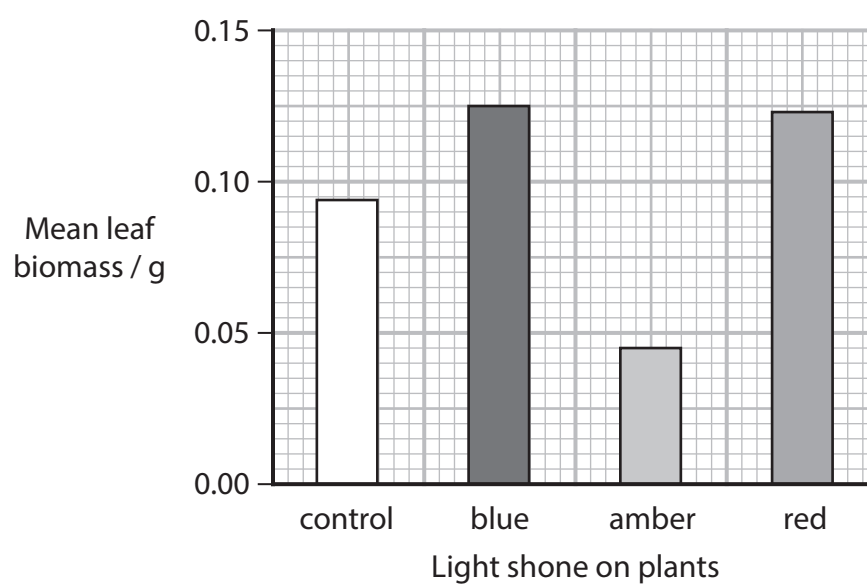
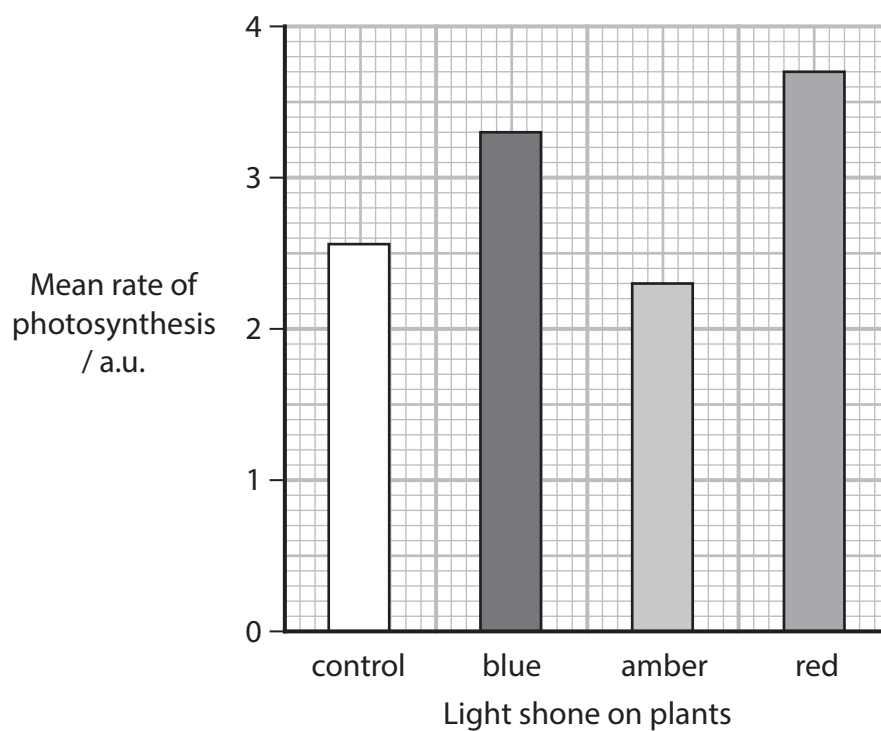• changes in transcription of genes in the leaves.

Another group of these plants had a control light shone on them.

(i) Which would have been the most appropriate light to use as a positive control?

(1)

☒ **A** green

☒ **B** mixture of green, blue and red light

☒ **C** ultraviolet

☒ **D** sunlight

(ii) The graphs show the results for the mean rate of photosynthesis and mean leaf biomass.

Explain the results shown in these graphs.

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(iii) The table shows the results for the pigment content of the leaves.

Pigment	Mass of pigment / µg per g of leaf biomass			
	Control light	Blue light	Amber light	Red light
Chlorophyll a	382	412	315	441
Chlorophyll b	148	148	125	133
Anthocyanins	78	79	71	72

Describe **three** conclusions that can be made from these results.

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P 7 8 3 8 7 A 0 3 2 3 6

(iv) Plants treated with blue light had an increase in photosynthesis caused by an increase in the transcription of some genes in the leaves.

Suggest **two** genes whose transcription could be increased in the presence of blue light.

Give a reason for suggesting each of these genes.

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(Total for Question 9 = 14 marks)

TOTAL FOR PAPER = 90 MARKS

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