Please check the examination details below before entering your candidate information

Candidate surname: Solved by Anubha | Other names: Roberts.

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

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 ▶

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Pearson

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)

Leaves can't absorb all forms of wavelength.
Leaves reflect green light.

(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)

$1700000 \times \frac{1}{15}$

Answer ..... kilocalories

$= 113333.3$ Kcal

1.13×10^5

(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)

1 Kilo calorie = 4·2 KJ

6 Kilo calorie = 6 x 4·2
= 25·2

Answer 25 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)

$$\frac{25}{154000} \times 100$$

= 0·016 %

Answer 0·016 %

(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.

(2)

PCR is used to amplify DNA sample.

This is to ensure there is sufficient sample to analyse for profiling.

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

Describe the role of Taq (DNA) polymerase.

(2)

Taq DNA Polymerase lines up the nucleotides based on complementary base pairing.

Taq DNA Polymerase forms phosphodiester bond between the nucleotides.

(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)

Linseed plants to identify the resistance gene bands.
The non-modified Broccoli plants to identify Broccoli DNA bands.
The modified Broccoli plants to identify resistance genes.

(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)

Antigen - MHC complex are transported to golgi apparatus in a vesicle. From golgi apparatus it is packed in transport vesicle to cell membrane. Vesicle fuses with cell membrane to be displayed on surface.

(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)

$1\ nm = \frac{1}{10}\ Å = \frac{3.7}{10}$

Answer 0.37 nm

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

(1)

Two objects which are 3.7 A° apart can viewed as separate objects.

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

(2)

To activate T killer cells by antigen presentation.
T killer cells further destroy the virus-infected cells. by releasing enzymes.

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

(3)

T killer cells destroy the infected cells
less new virus are produced. by infected cells.
Phagocytes engulf and destroy virus particles.

(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?

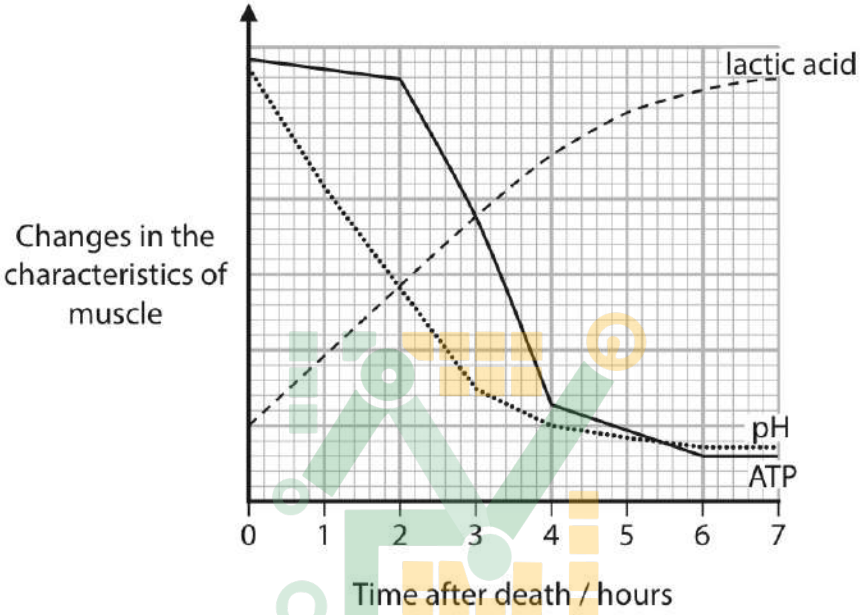
(1)

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

(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



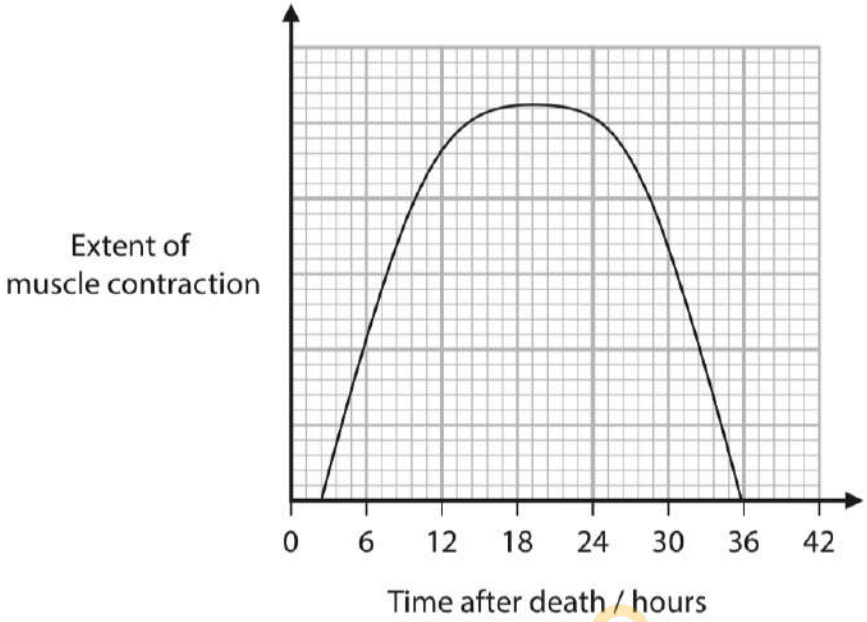
Explain the changes in each of the **three** characteristics shown in this graph.

Use your own knowledge to support your answer.

(3)

Lack of Oxygen cause anaerobic respiration and increase in lactic acid. lactic acid cause pH to decrease. ATP decreases due to less O_2 for aerobic respiration

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



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.

(3)

The extent of muscle contraction increases and decreases with time

Two values of time with same extent of contraction.

Muscle contraction is affected by other factors such as ATP at the time of death.

(Total for Question 4 = 10 marks)

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

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

(1)

A series of changes in species in a habitat over time.

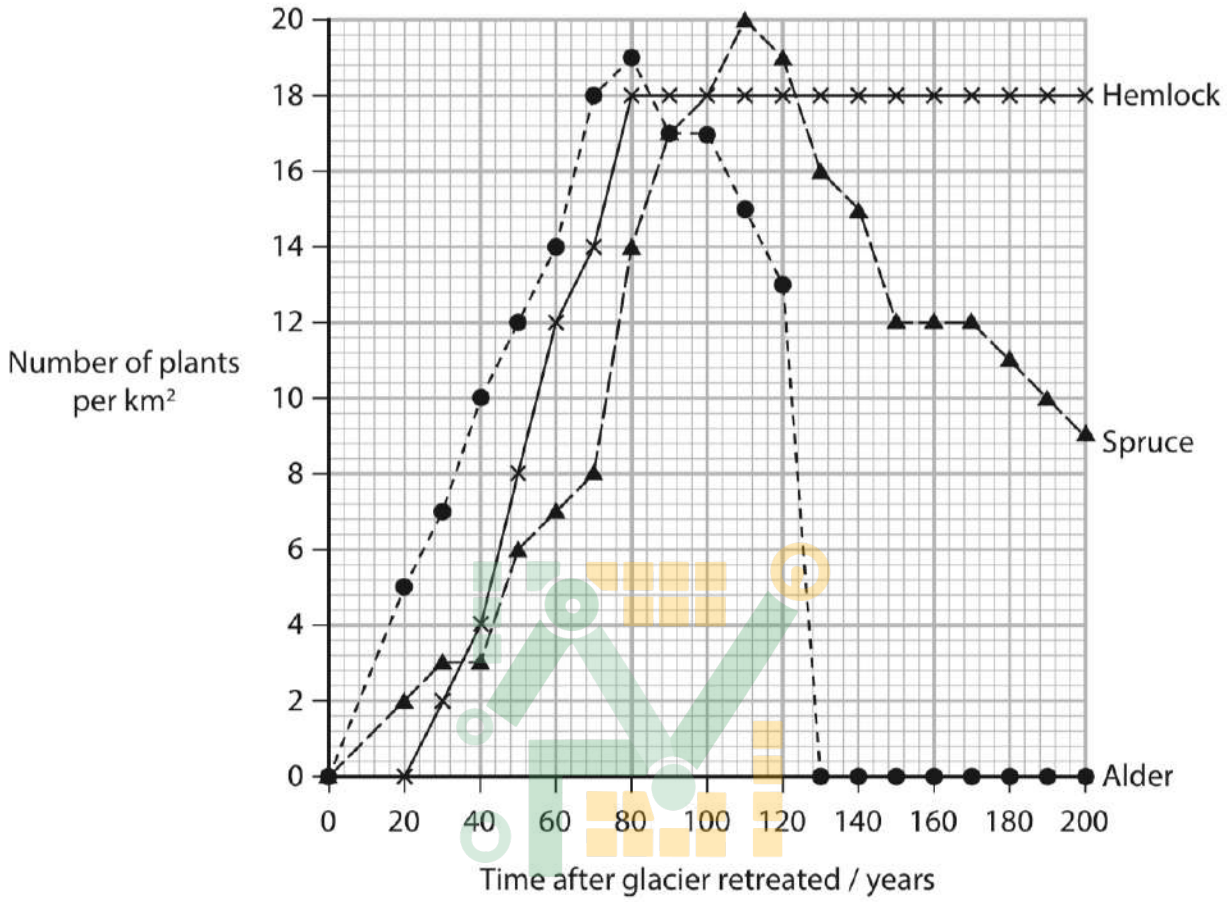
(b) Which of the following describes a habitat?

(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.



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.

(6)

Alder - First species to grow. so it is Pioneer species and death of plants Creates organic matter to create suitable conditions for other plant seeds to grow.
Alder reproduces faster than spruce and increase in number.
Starts to decrease in the presence of Spruce due to competition and lack of nutrients in soil.
Spruce - Grows to increase in number but decreases due to disease.
There number never falls to zero.
Hemlock - Starts 20 years later as soil conditions to grow are suitable and increases till 80 years and stays in equilibrium with environment.
Maximum number yet not reached.

(Total for Question 5 = 8 marks)

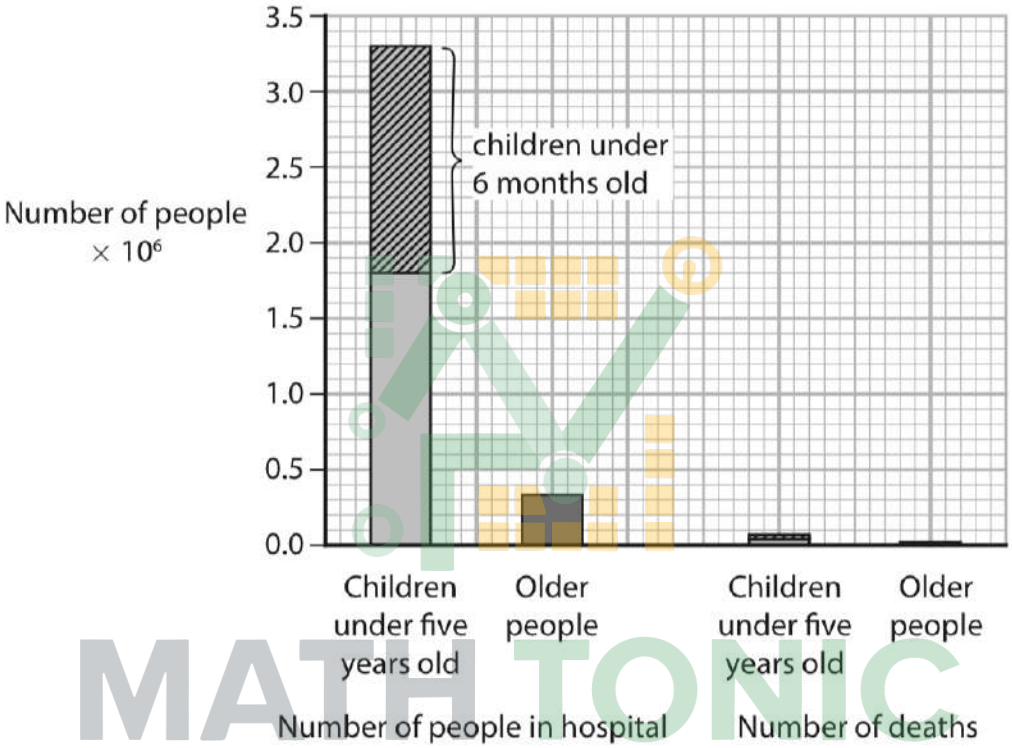
6 Respiratory syncytial virus (RSV) usually causes mild, cold-like symptoms from which most people recover.

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.



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

(1)

- ☒ **A** $\frac{5}{11}$
- ☐ **B** $\frac{6}{11}$
- ☐ **C** $\frac{5}{6}$
- ☐ **D** $\frac{6}{5}$

$$\frac{3.3 - 1.8}{3.3} = \frac{1.5}{3.3}$$

$$= \frac{5}{11}$$

(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)

Vaccine contained more than types of antigens.
Some antigens are common between two subtypes of RSV.

(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)

The vaccine has attenuated pathogen and it has antigen.
Antigen are recognised by macrophages which represent Antigen to B cells.
B cells differentiate to produce Plasma cells which secrete antibodies complementary to antigen.

Antibodies cross the placenta to the fetus.
Antibodies present in the blood of babies for short duration

(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)

One large group of pregnant females were chosen.
Vaccination for RSV was given.
After the babies were born, the babies were monitored for RSV infections.
The babies who required medical attention or not.

(Total for Question 6 = 12 marks)

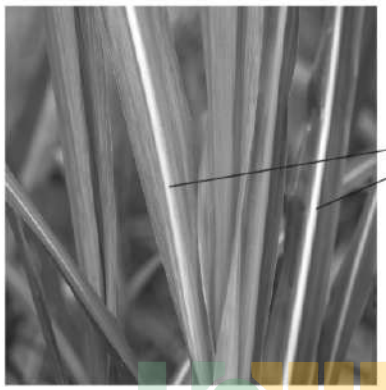
7 Leaf scald is a disease of sugarcane caused by bacteria.

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.



(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.

(4)

Albicidin is released causes Xylem vessels to produce sticky gum. Nitrate ions and water will not be transported to the leaves Photolysis will not occur. Albicidin inhibits chloroplast development. no light-dependent and independent reactions and glucose is not produced which causes cells to die due to no energy.

(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)

Prokaryotic DNA is circular and has no free phosphates. Eukaryotic DNA is linear and has free phosphate group at 5' end.

(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.

(3)

Albicidin inhibits the DNA gyrase enzyme and bacterial cells will not function properly and die. Albicidin doesn't affect human cells as they don't have DNA gyrase.

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

(2)

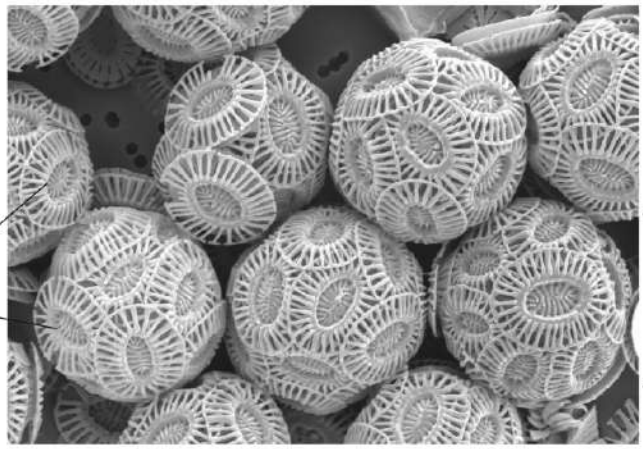
Bacteria develop resistance to antibiotic continuously. New antibiotics are used to treat infections which are resistant to other antibiotics.

(Total for Question 7 = 11 marks)

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.

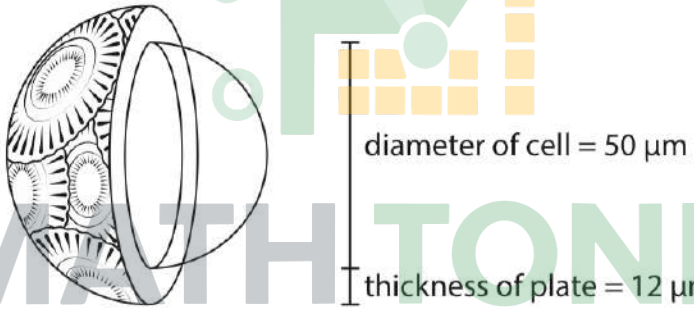
The photograph shows one species of coccolithophore, *E. huxleyi*.



(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*.



Calculate the **total** volume of this *E. huxleyi*.

Give your answer in mm^3.

Use the formula:

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

50 µm = 25 µm
(diameter) (radius)

0·025 mm

$$\frac{4}{3} \times \pi \times (0.025)^3$$

(3)

Answer 6.54×10^{-5} mm^3

(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)

1 Plate = 75 min
12 Plate = 75 x 12
= 900 min

900 / 60

Answer 15 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.

(3)

One large group of E. huxleyi cells are released.
Use a combination of different dyes to stain the cells and plates.

Observe the different plates attached not matching to cells

*(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.

(6)

E. huxleyi photosynthesize to remove CO_2 and also use CO_2 to produce plates. Marine snow can decrease the light reaching the aquatic plants. The plants don't perform photosynthesis so less CO_2 is removed from water.
Marine snow will be decomposed by other decomposers they will release CO_2 and increase CO_2 by decomposition.
Less CO_2 will diffuse from air to water.
Increased level of infrared radiations trapped by CO_2 resulting in more green house effect and more is average temperature and melting of polar ice.

(Total for Question 8 = 13 marks)

9 Light is essential for photosynthesis.

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

(3)

Light is responsible for excitation of electron
Electrons in electron carriers cause ATP to be formed.
Light is responsible for photolysis of water.
Protons produced in photolysis are used to form Reduced NADP from NADP.

(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)

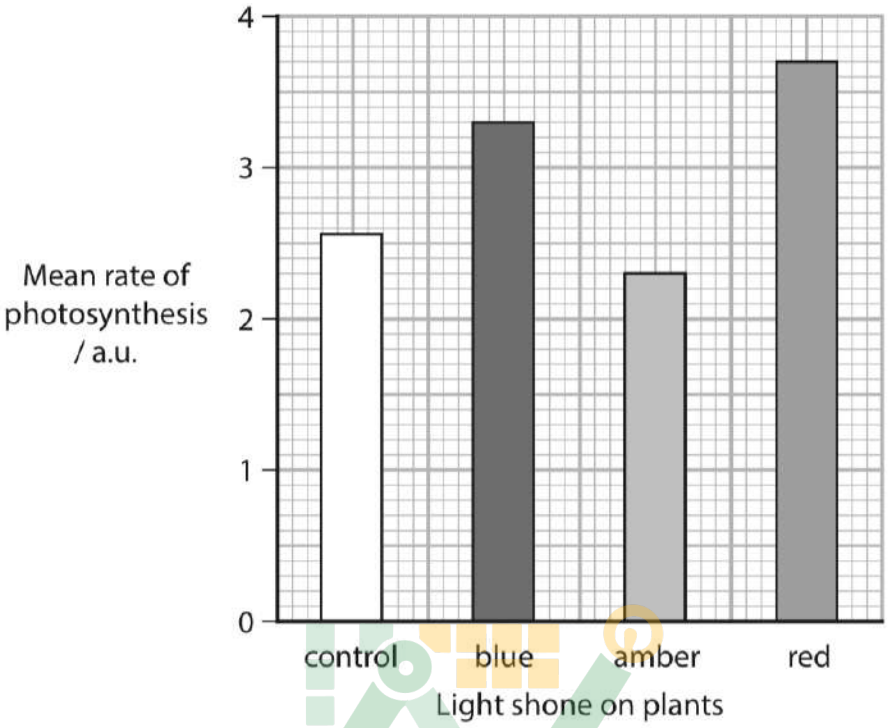
☒ **A** green

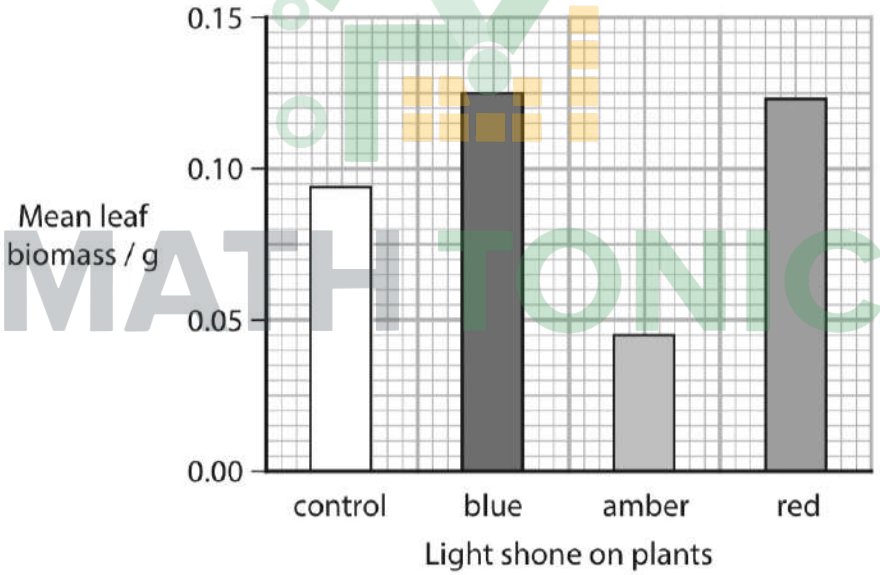
☒ **B** mixture of green, blue and red light

☒ **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.

(4)

Mean rate of photosynthesis is highest in red light and lowest in amber light
More rate of photosynthesis means more glucose is produced.
More glucose is available to make biomass or new starch, cellulose.
Control has less red or blue light so less biomass is produced.

Explain the results shown in these graphs.

(4)

Mean rate of photosynthesis is highest in red light and lowest in amber light
More rate of photosynthesis means more glucose is produced.
More glucose is available to make biomass or new starch, cellulose.
Control has less red or blue light so less biomass is produced.

(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.

(3)

All three types of pigments are present in all types of light.
Chlorophyll a is highest in all the light.
Effect of light was very little on Anthocyanins.

(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.

(3)

ATP synthase and RUBISCO gene would undergo transcription.
RUBISCO is responsible for carbon fixation when CO_2 reacts with RUBP. in Calvin cycle.
ATP synthase in the thylakoids are responsible for ATP formation from ADP + Pi in chemiosmosis.

(Total for Question 9 = 14 marks)

TOTAL FOR PAPER = 90 MARKS