OXFORD

INTERNATIONAL AQA EXAMINATIONS

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

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Candidate signature _____

INTERNATIONAL A-LEVEL

BIOLOGY (9610)

Unit 3 Populations and genes

Wednesday 12 June 2019 07:00 GMT Time allowed: 1 hour 30 minutes

Materials

For this paper you must have:
- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- All working must be shown.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 75.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
TOTAL	

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Answer **all** questions in the spaces provided.

0 1 Limpets are aquatic organisms. Limpets attach themselves to rocks. The shells of limpets vary in colour from white to dark brown.

A scientist investigates a population of limpets. The scientist gives each limpet a shell-colour score between 0 and 10 where:

- 0 represents a completely white limpet
- 10 represents a completely dark brown limpet.

Figure 1 shows limpets with different shell colours.

Figure 1

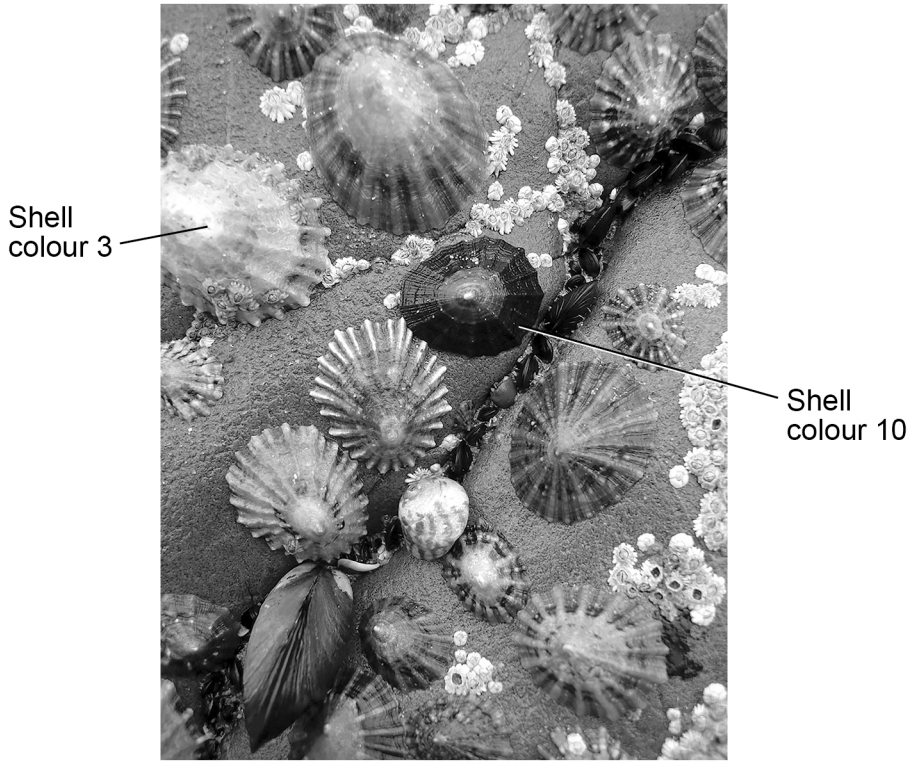
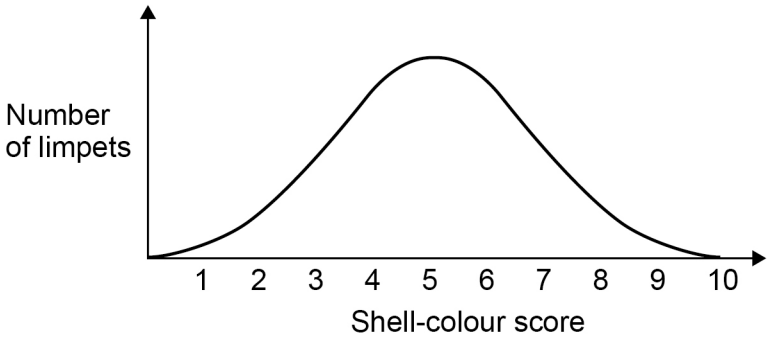


Figure 2 shows the shell-colour distribution of the population of limpets.

Figure 2



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The scientist collects a sample of limpet larvae from the population.

He moves the larvae a short distance to a new area.

The larvae attach to rocks in the new area.

The rocks in the new area are much darker but have some white patches.

Birds are predators of limpets.

0 1 . 1 Explain how the number of limpets with different shell colours will have changed after one year.

Include a sketch graph on **Figure 3**.

[3 marks]

Figure 3

0 1 . 2 A student concludes that the population of limpets on the darker rocks could eventually evolve into two separate species. The student describes this as allopatric speciation.

Explain why the student is **not** correct.

[2 marks]

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0 1 . 3 Another student investigates a population of limpets using a mark-release-recapture technique.

The student uses bright red nail polish to mark the shells of the limpets in a sample.

Only a small area of each limpet's shell is marked.

Suggest **one** reason why.

[1 mark]

6

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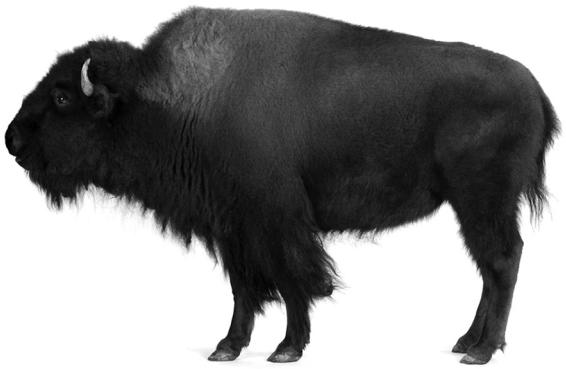
0 2 Human activity has affected the gene pool of the European bison.

Figure 4 shows a European bison.

Figure 4



0 2 . 1 Define the term 'gene pool'.

[2 marks]

Question 2 continues on the next page

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0 2 . 2 European bison were hunted for food and for their skins. By 1921, there were no wild European bison.

There were only 54 European bison alive in captivity.

European bison bred in captivity have been reintroduced into the wild. Bison numbers are increasing after their reintroduction but there is still a risk of extinction.

Explain why the European bison is still at risk of extinction.

Use ideas about the gene pool in your answer.

[3 marks]

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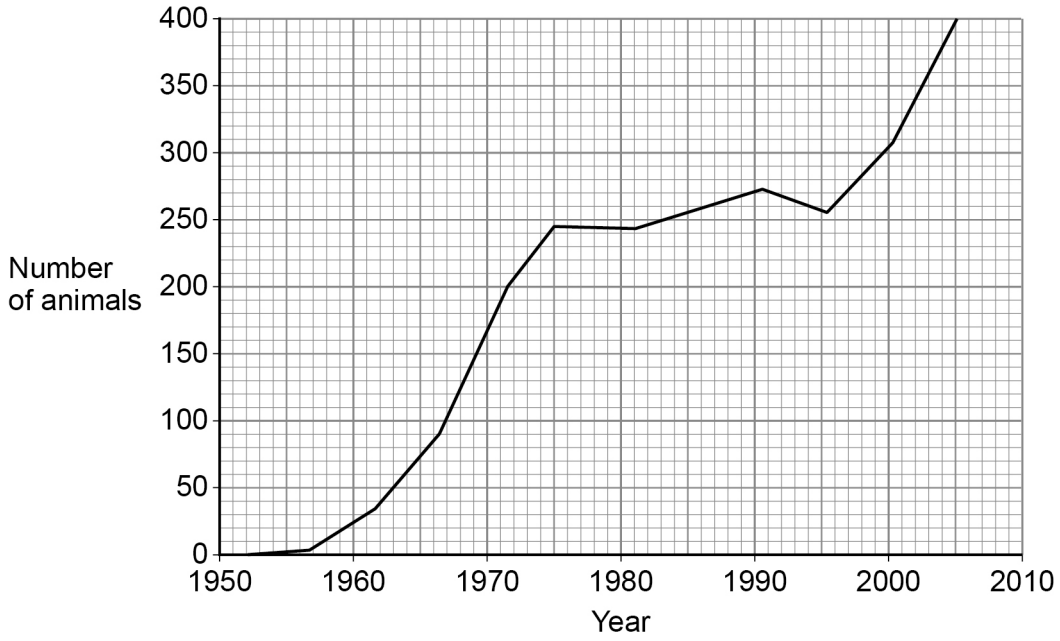
Figure 5 shows the number of wild European bison from the time they were reintroduced into the wild to 2005.

Figure 5



0 2 . 3 Calculate the percentage change in the number of bison from 1975 to 2005.

Give your answer to the nearest whole number.

[2 marks]

Percentage change = _____ %

7

Turn over for the next question

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0 3 ATP is synthesised during aerobic respiration.

0 3 . 1 A scientist estimates that aerobic respiration uses 40% of the available energy in one mole of glucose to produce 38 moles of ATP.

Synthesis of one mole of ATP needs 30 kJ of energy.

Use the scientist's estimate to calculate the total energy in one mole of glucose.

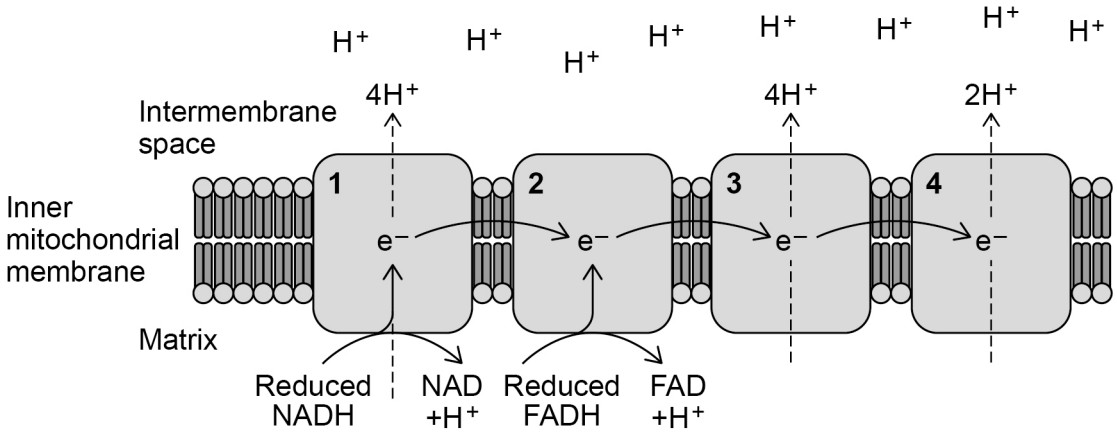
[2 marks]

Total energy = _____ kJ

Figure 6 shows part of the electron transfer chain.

The chain includes carrier molecules called complexes.
These are labelled 1, 2, 3 and 4.

Figure 6



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0 3 . 2 Antimycin A is a respiratory inhibitor blocking the flow of electrons from complex 3 to complex 4.

Table 1 shows if each complex in the electron transfer chain is oxidised or reduced.

Which row, **W**, **X**, **Y** or **Z**, in **Table 1** shows the effect of antimycin A?

Tick (✓) **one** box.

[1 mark]

Table 1

	Complex 1	**Complex 2**	**Complex 3**	**Complex 4**	Tick (✓) **one** box
W	Oxidised	Oxidised	Reduced	Reduced	
X	Oxidised	Oxidised	Oxidised	Reduced	
Y	Reduced	Reduced	Oxidised	Oxidised	
Z	Reduced	Reduced	Reduced	Oxidised	

A scientist uses isolated mitochondria to investigate the effect of antimycin A on the rate of aerobic respiration.

This is the method the scientist uses:

Step 1 – isolate mitochondria from cells
Step 2 – add pyruvate to the mitochondria
Step 3 – put on disposable gloves and a face mask
Step 4 – add antimycin A to the mitochondria
Step 5 – measure oxygen uptake of the isolated mitochondria.

0 3 . 3 Explain why the scientist adds pyruvate rather than glucose to the isolated mitochondria in step 2.

[2 marks]

Do not write outside the box

0 3 . 4 Suggest why the scientist wore gloves and a face mask in step 3.

[2 marks]

0 3 . 5 Explain why antimycin A reduces the oxygen uptake of the isolated mitochondria.

[2 marks]

9

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Turn over for the next question

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0 4 A scientist investigates feeding relationships and energy transfers in the Atlantic Ocean.

Figure 7 shows one Atlantic Ocean food chain.

Figure 7

Plankton → Shrimp → Cod → Human

0 4 . 1 The scientist uses sampling techniques to collect data on population size.

Give **two** ways that the scientist could ensure that the data are representative of the population.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

0 4 . 2 The scientist makes the statement:

'The number of humans in this food chain is less than the number of cod.'

If **H** = number of humans and **C** = number of cod, how can this statement be shown mathematically?

[1 mark]

Tick (✓) **one** box.

H α **C** ☐

H < **C** ☐

H ~ **C** ☐

H > **C** ☐

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Table 2 shows the relative amount of energy available at each trophic level of the Atlantic Ocean food chain.

Table 2

Trophic level	Relative amount of energy available / kJ m^{-2} $year^{-1}$
Plankton	87 000
Shrimp	14 000
Cod	1 600
Human	67

0 4 . 3 Calculate the percentage efficiency of energy transfer from cod to human.

Give your answer to three significant figures.

[2 marks]

Percentage efficiency = _____ %

0 4 . 4 Suggest **one** reason why humans should eat shrimp rather than cod.

Use **only** information from **Figure 7** and **Table 2**.

[1 mark]

_____

_____

_____

_____

6

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0 5 Hair colour in dogs has several phenotypes. A gene for hair colour has three possible alleles. One of these alleles is dominant to the other two alleles.

0 5 . 1 Define the terms 'phenotype' and 'dominant'.

[2 marks]

Phenotype _____

_____

Dominant _____

_____

The three alleles for hair colour are arranged in a dominance hierarchy:

$\mathbf{a^y}$ – light brown
$\mathbf{a^t}$ – dark brown
a – black

Each allele is dominant to the alleles below it and recessive to the alleles above it.

0 5 . 2 Give **all** the possible genotypes of a dog with dark brown hair.

[1 mark]

_____

_____

0 5 . 3 A dog breeder crosses a light brown male with a dark brown female.

One of the offspring is black.

Give the genotype of each parent.

[1 mark]

Genotype of male parent _____

Genotype of female parent _____

Do not write outside the box

0 5 . 4 The light brown male and dark brown female in Question **05.3** are mated several times.

There are 16 offspring produced in total.

Use a genetic diagram to predict the number of offspring of each phenotype.

[2 marks]

Number of light brown offspring _____

Number of dark brown offspring _____

Number of black offspring _____

0 5 . 5 Suggest why the actual number of each phenotype may differ from the numbers you predicted in your answer to Question **05.4**.

[1 mark]

_____

_____

_____

0 5 . 6 Give **one** reason why a cross between a dark brown male and a dark brown female cannot produce light brown offspring.

[1 mark]

_____

_____

_____

8

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0 6 Lapwings are ground-nesting birds.

Figure 8 shows a lapwing.

Figure 8

The population of lapwings has decreased in the UK since 1940.

Some conservationists manage fields using farm animals. The farm animals graze the fields to produce suitable habitats for lapwings during the lapwing breeding season.

0 6 . 1 The conservationists keep the farm animals out of the fields during the lapwing breeding season.

Suggest **one** reason why.

[1 mark]

0 6 . 2 Other birds are predators of lapwing eggs and young.

Management for lapwing conservation also includes removing trees and high hedges from the edges of fields.

Suggest **one** reason why.

[1 mark]

Animals grazing can reduce the mean height of grass and can produce 'tussocks'.

Tussocks are small areas of tall grass, higher than the surrounding grass.

Figure 9 shows a field with some tussocks.

Figure 9

Tussocks provide cover for the nests of ground-nesting birds.

The frequency of tussocks can be described using this scale:

N – none
R – rare
O – occasional
F – frequent
A – abundant

Table 3 shows the effect of grazing for different species of animal on the mean grass height and on tussock frequency.

Table 3

Species of animal	Mean height of grass after grazing / cm	Tussock frequency
Cattle	5–8	Frequent
Sheep	4–6	Rare
Horse	2–3	Abundant

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A scientist investigates the effect of grass height and tussock frequency on the use of fields by lapwings.

The results are shown in **Figures 10** and **11**.

Figure 10

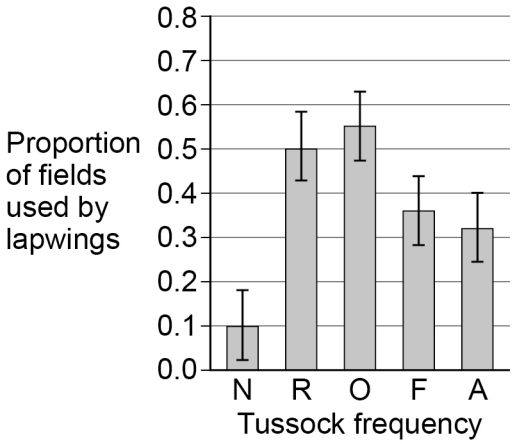
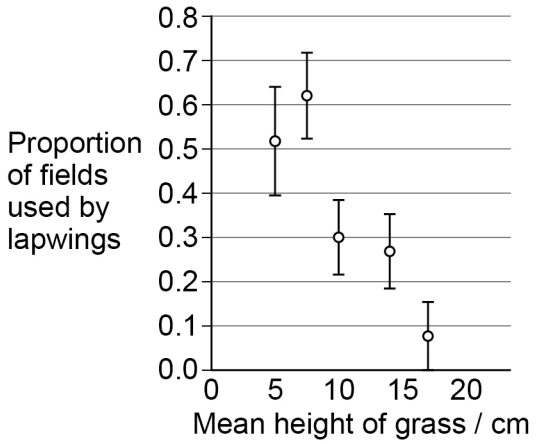


Figure 11



Key

= $\bar{x}$ ± SD

0 6 . 3 The scientist concludes that using sheep to graze fields is the most effective management technique for increasing the lapwing population.

Evaluate this conclusion.

Use information from **Table 3** (on page 17), **Figure 10** and **Figure 11**.

[4 marks]

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0 6 . 4 Management of land for lapwing conservation can prevent succession.

Suggest why some conservationists are against the various land management techniques used to increase the lapwing population.

[2 marks]

8

Turn over for the next question

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0 7 A student uses a suspension of green algae and a red indicator to investigate the effect of light intensity on the rate of photosynthesis.

The green algae are cells containing the pigment chlorophyll.

The red indicator changes colour when the pH of a solution changes.

The pH of a solution decreases when carbon dioxide is added and increases when carbon dioxide is removed.

This is the method the student uses:

- add 5 cm^3 of the suspension of green algae to a bottle
- add red indicator solution to the bottle
- put the bottle 0.25 m away from a lamp
- leave the bottle for 20 minutes
- measure the absorbance of the suspension
- repeat at different distances from the lamp.

The student keeps the temperature constant during the investigation.

0 7 . 1 Describe how the student could keep the temperature constant.

[1 mark]

0 7 . 2 Explain why changes in temperature affect the rate of photosynthesis.

[2 marks]

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Table 4 shows the student's results.

Table 4

Distance from lamp (D) / m	Relative light intensity ($1/D^2$)	Absorbance
0.25	16.0	0.81
0.35	8.2	0.74
0.50	4.0	0.56
0.75		0.39
1.25		0.25

0 7 . 3 Calculate the relative light intensity at each distance from the lamp to complete **Table 4**.

Use the formula $\mathbf{1/D^2}$ where **D** = distance from the lamp in metres.

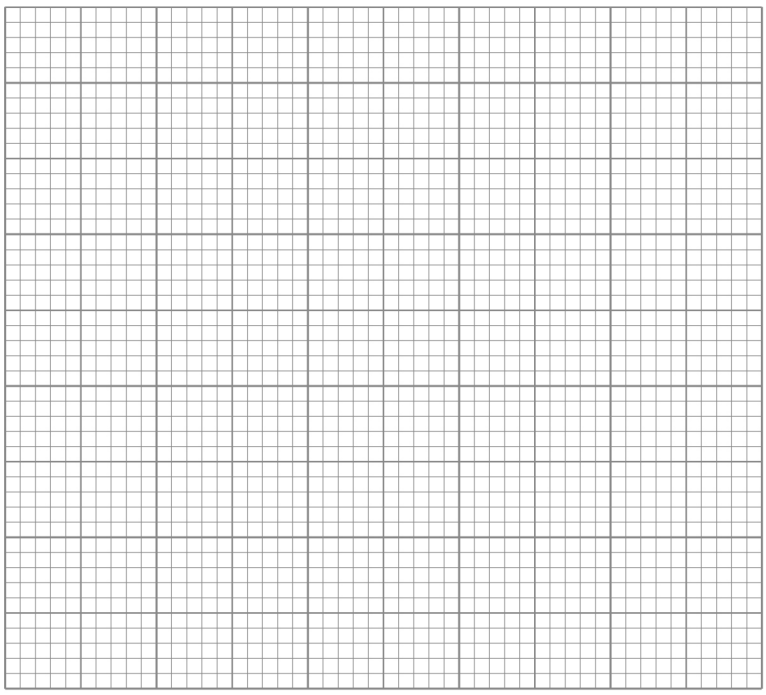
Give your answers to **one** decimal place.

[2 marks]

0 7 . 4 Plot a graph to show the effect of relative light intensity on the absorbance.

Draw a line of best fit.

[3 marks]



Question 7 continues on the next page

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0 7 . 5 The student puts the bottle 0.15 m away from the lamp.

Use your graph to predict the absorbance at a distance of 0.15 m

[1 mark]

Absorbance = _____

Another student uses green algae and the red indicator to investigate the effect of the wavelength of light on photosynthesis.

The indicator is red when the concentration of carbon dioxide in a solution is the same as the concentration of carbon dioxide in the atmosphere (0.04%).

Table 5 shows the colour of the indicator at different pH values.

Table 5

pH	Colour of liquid in bottle at start	Colour of liquid in bottle after 30 minutes
7.6	Red	Yellow
8.0	Red	Orange
8.4	Red	Red
8.8	Red	Red-purple
9.2	Red	Purple

This is the method the student uses:

- add green algae to five small bottles
- add red indicator solution to each bottle
- cover four of the bottles with clear plastic filters: colourless, red, green or blue
- cover one of the bottles with black paper
- put the five bottles an equal distance away from a light source
- record the colour of the indicator after 30 minutes.

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Table 6 shows the student's results.

Table 6

Bottle number	Covering on bottle	Colour of light entering the bottle	Wavelengths of light entering the bottle / nm	Colour of solution in bottle after 30 minutes
1	Colourless	All	400–680	Purple
2	Red	Red	600–680	
3	Green	Green	520–590	Orange
4	Blue	Blue	425–500	Red-purple
5	Black paper	None	None	Yellow

0 7 . 6 Explain the colour changes in bottles 1 and 5 after 30 minutes.

[4 marks]

Bottle 1

Bottle 5

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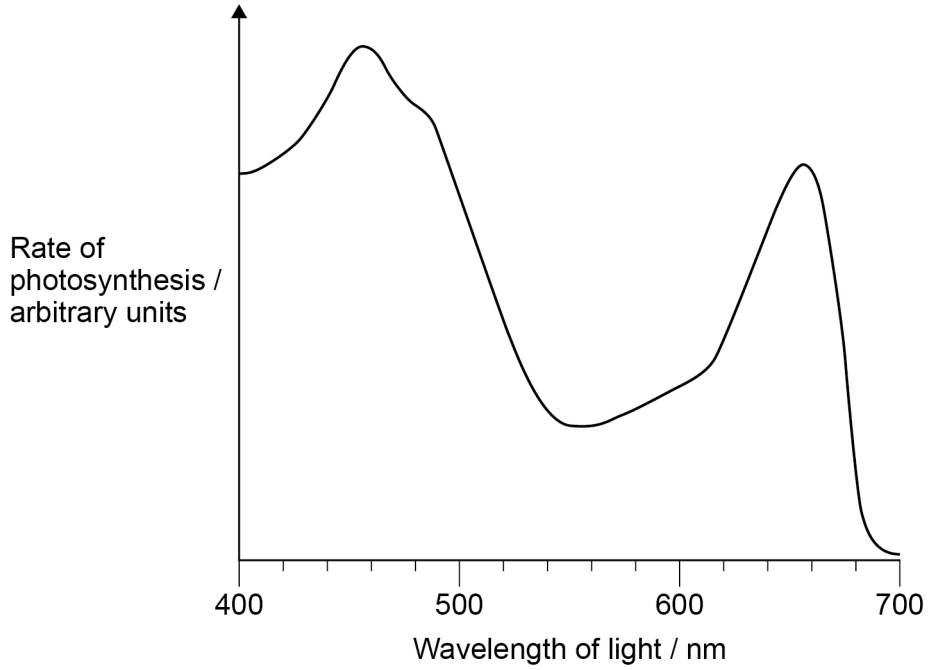
Figure 12 shows the rate of photosynthesis at different wavelengths of light.

Figure 12



0 7 . 7 Predict the colour of the solution in bottle 2 after 30 minutes.

Explain your prediction. Use data from **Table 6** (on page 23) and **Figure 12**.

[2 marks]

0 7 . 8 Explain the rate of photosynthesis at 550 nm
Use data from **Table 6** (on page 23), **Figure 12** and your own knowledge.

[2 marks]

17

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0 8 In some countries, cattle are farmed to produce meat for humans to eat.

0 8 . 1 Horn flies are blood-sucking insects.

Horn flies bite cattle and cause pain and irritation, preventing cattle from feeding and resting.

Horn flies can also spread pathogens when biting.

Cattle farmers can buy pesticides to control horn flies. The farmers can spray pesticides onto the cattle, or add the pesticides to the food the cattle eat.

Suggest advantages and disadvantages of using pesticides to control horn flies.

[5 marks]

Question 8 continues on the next page

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0 8 . 2 A farmer collects animal urine and faeces, then spreads this waste on his fields.

Grass grows in the fields and a cow eats the grass.

Explain how an atom of nitrogen in the animal waste could become part of a protein molecule in a cow.

Use your knowledge of the nitrogen cycle.

[6 marks]

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0 8 . 3 A scientist working at a nature reserve near a cattle farm sees that the colour of the water in a pond changes from colourless to green.

The scientist thinks that this change in the colour of the water is linked to farming practices at the cattle farm.

Explain how farming practices could cause the change in the colour of the water.

[3 marks]

14

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