OXFORD
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INTERNATIONAL A-LEVEL
BIOLOGY (9610)

Unit 3 Populations and Genes

Monday 22 May 2023 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.
- 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).
- All working must be shown.
- 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	
TOTAL	

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

0 1 Peatland is a wetland habitat.

Figure 1 shows peatland.

Figure 1

Human activity has affected much of the peatland in the UK.

Table 1 shows the percentage of peatland in different conditions in the UK.

Table 1

Condition of peatland	**Percentage of total UK peatland**
Used for agriculture	15
Natural	25
Woodland	15
Semi-natural	40
Other	5

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0 1 . 1 **Figure 2** shows a pie chart.

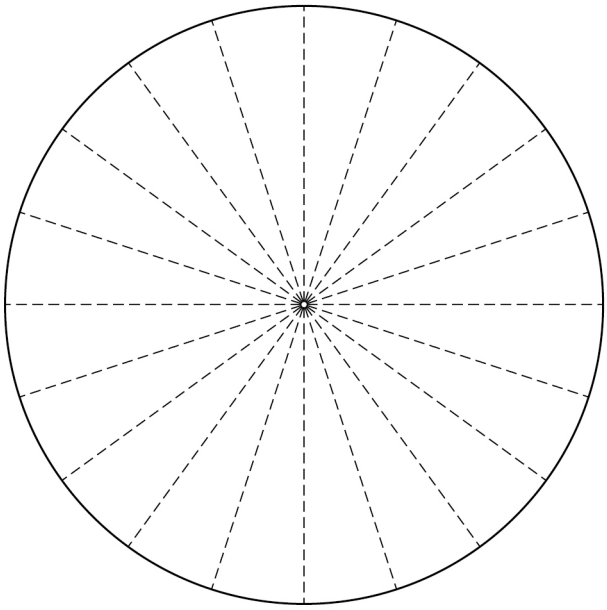
Complete **Figure 2** to show the percentage of peatland in each condition.

Use data from **Table 1**.

Label the pie chart.

[2 marks]

Figure 2



Question 1 continues on the next page

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0 1 . 2 Peatland has waterlogged soil. This means there are no air spaces in the soil.

Waterlogged conditions prevent plant material from decomposing completely.

Draining the soil removes water.

Explain how draining the soil increases carbon release.

[3 marks]

0 1 . 3 The vegetation growing on peatland is mostly mosses and other small plants. Peatland is an important store of carbon.

Peatland conservation reduces the release of stored carbon. Peatland can be conserved by preventing trees from growing.

Suggest how preventing tree growth conserves peatland.

[2 marks]

7

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0 2 A student investigates the effect of carbon dioxide concentration on the rate of photosynthesis in spinach leaves.

The student changes the carbon dioxide concentration using sodium hydrogencarbonate solution.

The student:

1. cuts 50 discs out of spinach leaves
2. removes gases from the leaf discs
3. puts 10 discs into a beaker of water
4. puts the beaker next to a lamp
5. measures the time it takes for 50% of the leaf discs to float to the surface
6. repeats steps 1 to 5 four more times with water
7. repeats steps 1 to 6 using different concentrations of sodium hydrogencarbonate solution instead of water.

0 2 . 1 Suggest why the student removes gases from the leaf discs (step 2).

[1 mark]

_____

_____

_____

Question 2 continues on the next page

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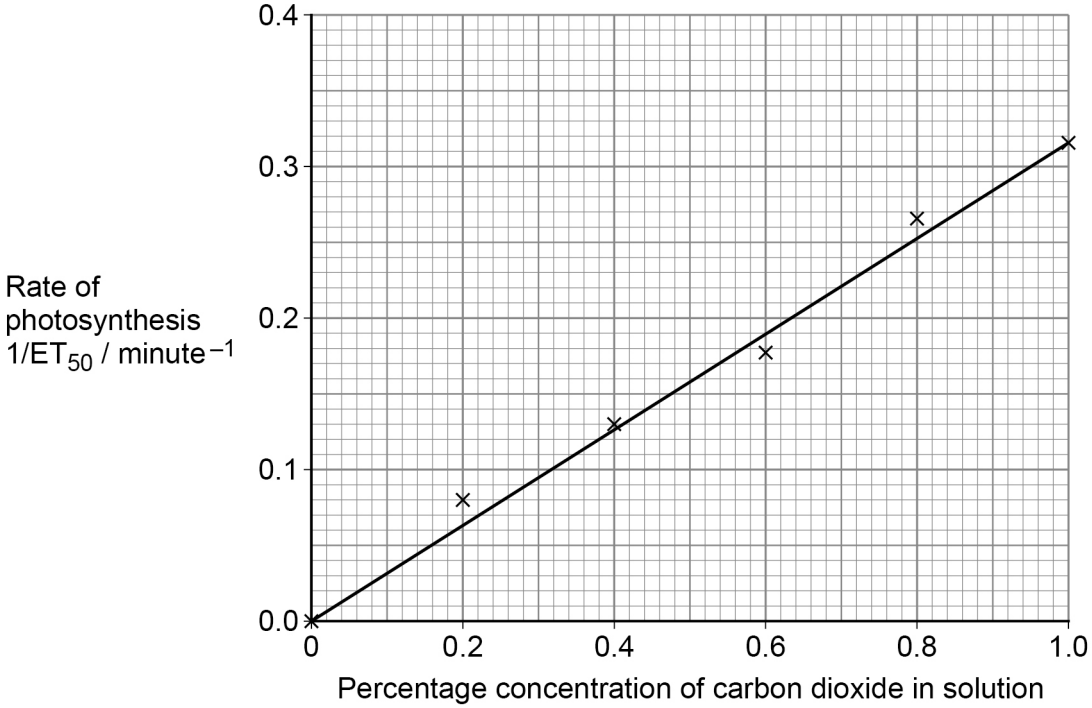
0 2 . 2 The ET_{50} is the effective time for 50% of the leaf discs to float.

The student calculates $1/ET_{50}$ for different concentrations of carbon dioxide.

$1/ET_{50}$ is used as a measure of the rate of photosynthesis.

Figure 3 shows the student's results.

Figure 3



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The student concludes that there is a direct relationship between carbon dioxide concentration and the rate of photosynthesis in spinach leaves.

Evaluate the student's conclusion.

[4 marks]

0 2 . 3 The student puts the beaker next to a lamp (step 4).

Explain what would happen if the student put the beaker of leaf discs in the dark.

[3 marks]

8

Turn over for the next question

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0 3 The transfer of energy through the trophic levels in food chains is not efficient.

Farmers use different methods to make energy transfer more efficient and increase productivity.

0 3 . 1 Productivity in plants can be determined by calculating the net primary production (NPP).

Give the definition of NPP and the equation to calculate NPP.

[2 marks]

Definition _____

_____

Equation NPP = _____

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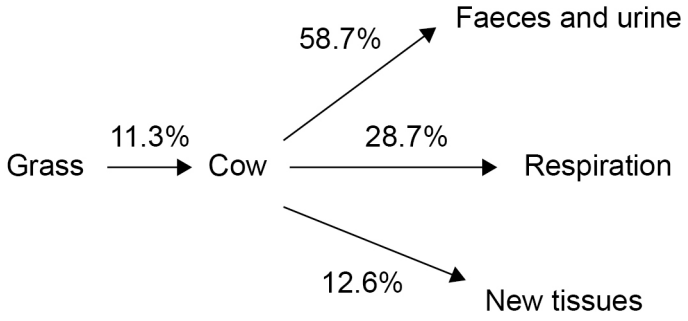
The NPP of a plant is available to the next organism in a food chain.

Figure 4 shows the percentage of energy transferred from grass to a cow, and how this energy is used in the cow.

Figure 4



0 3 . 2 The NPP of the grass is 21 135 kJ m^{-2} $year^{-1}$

Calculate the energy stored in new tissues of the cow in kJ m^{-2} $year^{-1}$

Use information from **Figure 4**.

Give your answer to 3 significant figures.

[2 marks]

Energy stored in new tissues = _____ kJ m^{-2} $year^{-1}$

Question 3 continues on the next page

Do not write outside the box

Dairy cows are used for producing milk.

A feed conversion ratio (FCR) can be used to measure how efficiently dairy cows convert their food into milk. FCR can be calculated using:

$$\frac{mass\ of\ food\ ingested}{mass\ of\ milk\ produced}$$

A lower FCR means a more efficient food conversion.

Scientists investigate the FCR for two different types of food.

The scientists:

- randomly put 18 cows in either a control group or a test group
- feed the control group a standard grass-based diet
- feed the test group a diet containing a mixture of crop plants
- measure the milk yield of the cows every day
- compare the FCR of the two groups after 7 weeks.

0 3 . 3 Suggest **two** variables the scientists should control to give valid results.

[2 marks]

1 _____

_____

2 _____

_____

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Question 3 continues on the next page

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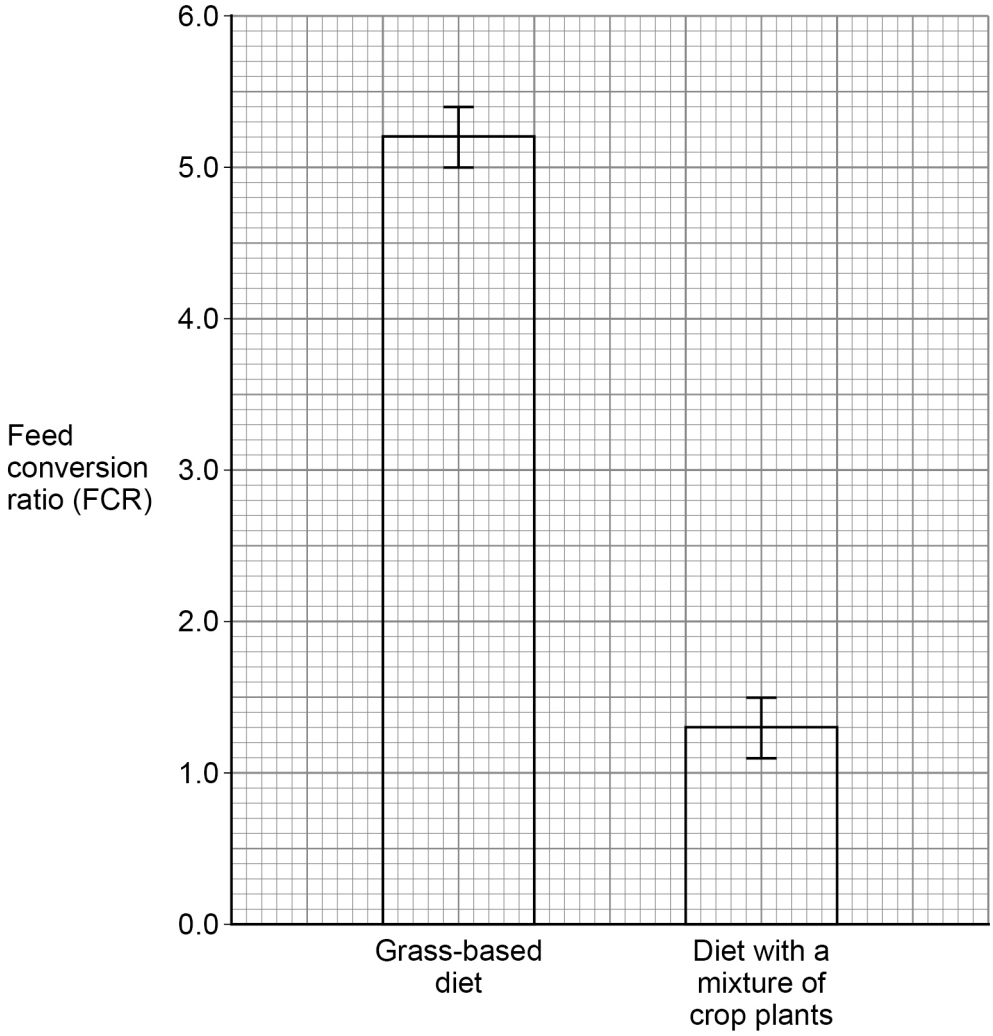
Figure 5 shows the scientists' results.

The error bars show ± standard error.

Figure 5



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0 3 . 4 A dairy farmer concludes from the scientists' results that cows should be fed a diet containing a mixture of crop plants instead of the standard grass-based diet.

Evaluate this conclusion.

Use the scientists' method (on page 10) and data from **Figure 5**.

[4 marks]

10

Turn over for the next question

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0 4 Some genetic conditions are sex-linked.

0 4 . 1 Explain what a sex-linked condition is.

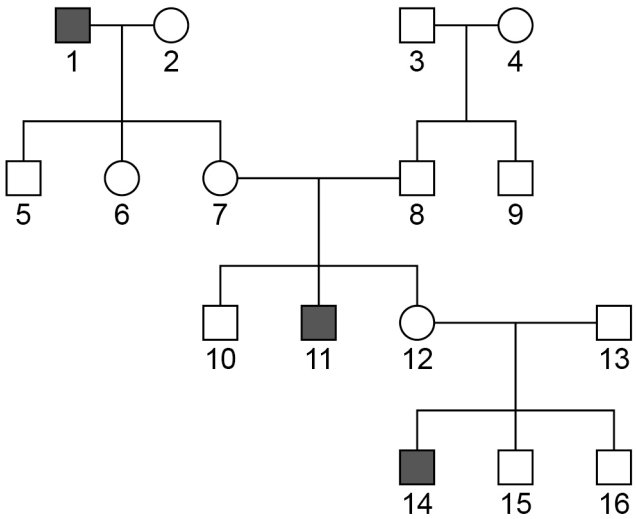
[2 marks]

Ocular albinism (OA) is a genetic condition that prevents pigment production in the eyes.

OA is a sex-linked condition.

Figure 6 shows the inheritance of OA in one family.

Figure 6



Key

- Male with ocular albinism
- Male with pigment production
- Female with pigment production

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0 4 . 2 Give evidence from **Figure 6** that the allele for OA is recessive.

[1 mark]

_____

_____

_____

0 4 . 3 Individuals **12** and Individuals **13** have another child.

Draw a genetic diagram to show the expected ratio of phenotypes.

Use the following symbols:

$\mathbf{X^A}$ = X chromosome with allele for pigmentation

$\mathbf{X^a}$ = X chromosome with allele for OA

Y = Y chromosome

[4 marks]

	Individual **12**		Individual **13**	
Parental phenotypes	Female with pigment production		Male with pigment production	
Parental genotypes	_____		_____	
Genotypes of gametes	_____	_____	_____	_____

Offspring genotypes _____

Offspring phenotypes _____

_____

Question 4 continues on the next page

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0 4 . 4 A student uses the chi-squared test on the results of a genetic cross.

The calculated value of chi-squared gives P = 0.1

Explain what the student can conclude from this P value.

[2 marks]

9

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0 5 Leopard complex spotting (LCS) is a coat colour in horses.

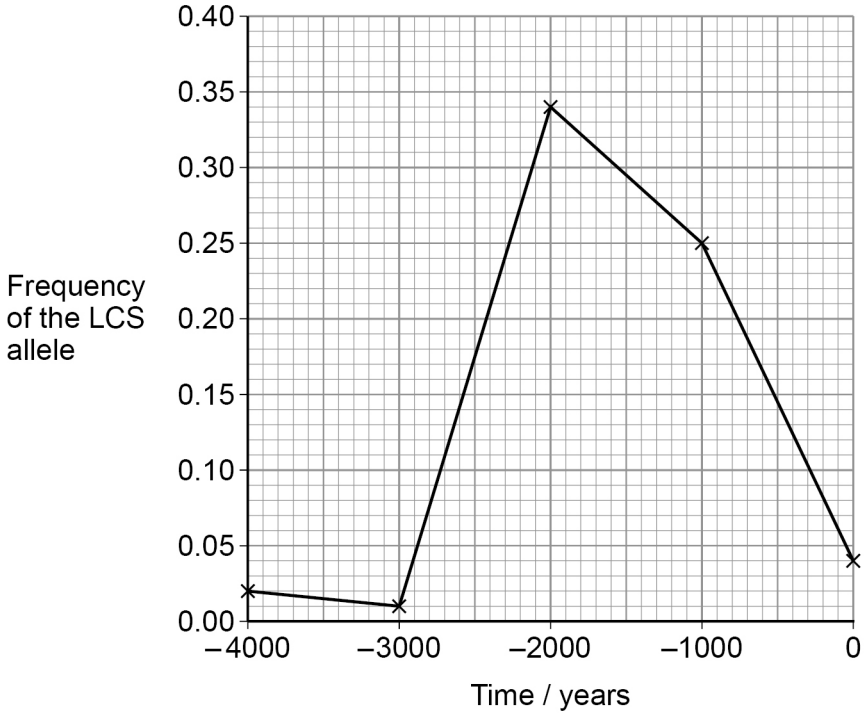
Figure 7 shows a horse with LCS.

Figure 7

LCS is caused by a dominant allele.

Figure 8 shows the frequency of the LCS allele in a population of horses for the last 4000 years.

Figure 8



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0 5 . 1 Calculate the percentage of the horse population with LCS 2000 years ago.

Use the Hardy–Weinberg equation and data from **Figure 8**.

[3 marks]

Percentage of horse population with LCS 2000 years ago = _____ %

0 5 . 2 Horses with the LCS coat colour have been popular with humans for thousands of years.

Horses homozygous for the LCS allele cannot see well in the dark.

Explain the change in frequency of the LCS allele:

- between 4000 and 3000 years ago
- between 3000 and 2000 years ago.

Use information from **Figure 8**.

[3 marks]

Between 4000 and 3000 years ago _____

_____

_____

_____

Between 3000 and 2000 years ago _____

_____

_____

_____

_____

_____

Question 5 continues on the next page

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0 5 . 3 All domesticated horses are the same species but there are different breeds.

Suggest how allopatric speciation in wild horses could result in a new species of horse.

[5 marks]

11

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0 6 A student uses methylene blue solution to investigate the effect of temperature on the rate of respiration in yeast.

Methylene blue is a blue dye. The dye can accept hydrogen atoms and become reduced.

Reduced methylene blue solution is colourless.

The reduced dye can also be oxidised by oxygen.

The student:

1. adds 2 cm^3 of glucose solution containing yeast to a test tube
2. adds 2 cm^3 of methylene blue solution to a second test tube
3. puts both test tubes in a water bath at 10 °C for 5 minutes
4. pours the methylene blue solution into the glucose and yeast solution and then shakes the test tube containing the mixture
5. puts the test tube containing the mixture back in the water bath and does not shake the tube again
6. starts a stopwatch and measures the time it takes for the methylene blue to become colourless
7. repeats steps 1 to 6 at 20, 30, 40 and 50 °C

0 6 . 1 The student puts both test tubes in a water bath for 5 minutes (step 3).

Explain how the student could determine if 5 minutes in the water bath is a suitable time.

[2 marks]

0 6 . 2 Explain why the student did **not** shake the test tube containing the mixture again after putting it back in the water bath (step 5).

[2 marks]

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0 6 . 3 The student measures the time it takes for methylene blue to become colourless (step 6).

Describe how the student could produce a colour standard so that the end-point of the reaction can be determined.

[2 marks]

0 6 . 4 Explain why the student did **not** use temperatures above 50 °C

[2 marks]

0 6 . 5 The student sets up a control experiment by adding 2 cm^3 of methylene blue to a test tube containing 2 cm^3 of boiled yeast and glucose solution.

Suggest why the student sets up this control experiment.

[1 mark]

Question 6 continues on the next page

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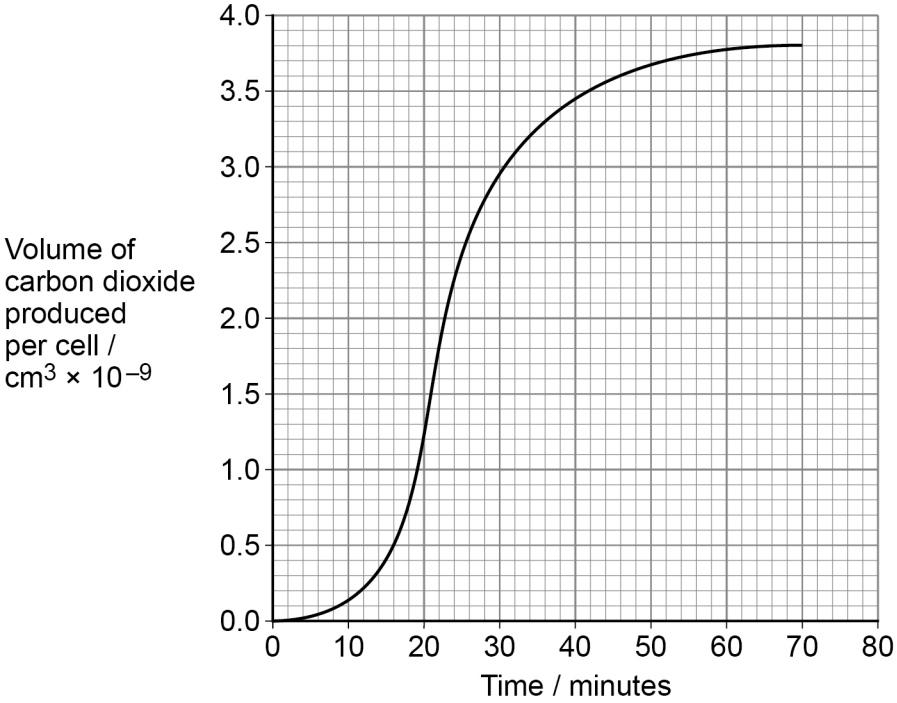
Another student investigates the optimum temperature for yeast respiration.
The student measures the total volume of carbon dioxide produced by the yeast for 70 minutes.

Figure 9 shows the student's results for 30 °C

Figure 9



0 6 . 6 **Figure 9** shows the volume of carbon dioxide produced per cell.

Suggest how the student calculates the volume per cell.

[2 marks]

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0 6 . 7 The rate of carbon dioxide production at 25 minutes is 1.4×10^{-10} cm^3 per cell $minute^{-1}$

Draw a tangent on the curve on **Figure 9** at 35 minutes.

Calculate the rate of carbon dioxide production at 35 minutes using the tangent.

Give your answer in standard form.

[2 marks]

Rate of carbon dioxide production = _____ cm^3 per cell $minute^{-1}$

0 6 . 8 Suggest **two** reasons why the rate of carbon dioxide production at 35 minutes is different from the rate at 25 minutes.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

15

Turn over for the next question

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0 7 . 1 Glycolysis is a process in both aerobic and anaerobic respiration.

Describe glycolysis.

[6 marks]

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0 7 . 2 Anaerobic respiration can occur in muscle cells during exercise.

Anaerobic respiration in muscle cells produces lactate.

Explain why lactate production is important during exercise.

[5 marks]

Question 7 continues on the next page

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0 7 . 3 Two biochemical cycles are:

- the Krebs cycle in aerobic respiration
- the Calvin cycle in the light-independent reaction of photosynthesis.

Contrast the reactants and products of the Krebs cycle with those of the Calvin cycle.

[4 marks]

15

END OF QUESTIONS

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