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I declare this is my own work.

# 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            |      |
| <b>TOTAL</b> |      |



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**

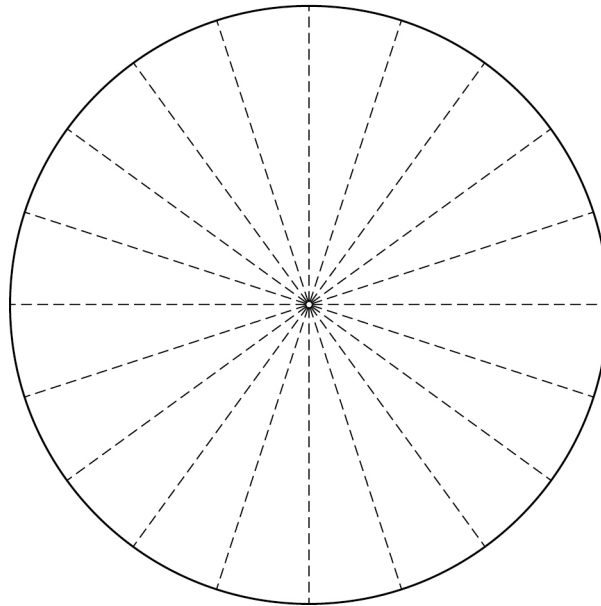
| Condition of peatland | Percentage of total UK peatland |
|-----------------------|---------------------------------|
| Used for agriculture  | 15                              |
| Natural               | 25                              |
| Woodland              | 15                              |
|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



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****Turn over ►**

**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]**

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**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]**

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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]**

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**Question 2 continues on the next page**

**Turn over ►**

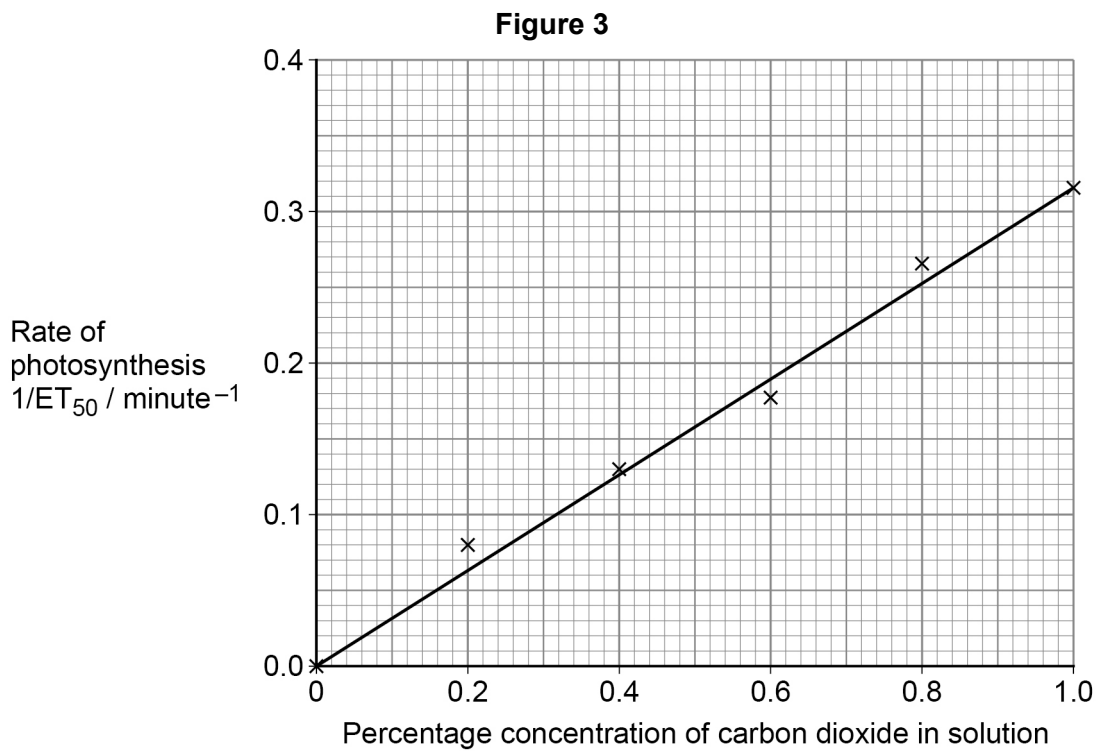
0 2 . 2

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.



Evaluate the student's conclusion.

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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.

[illegible]

8

**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 \_\_\_\_\_

\_\_\_\_\_

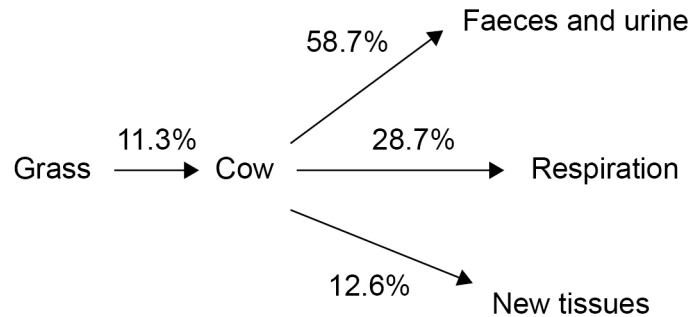
Equation NPP = \_\_\_\_\_



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  $21\,135\text{ kJ m}^{-2}\text{ year}^{-1}$

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

Use information from **Figure 4**.

Give your answer to 3 significant figures.

**[2 marks]**

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

**Question 3 continues on the next page**

**Turn over ►**



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:

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

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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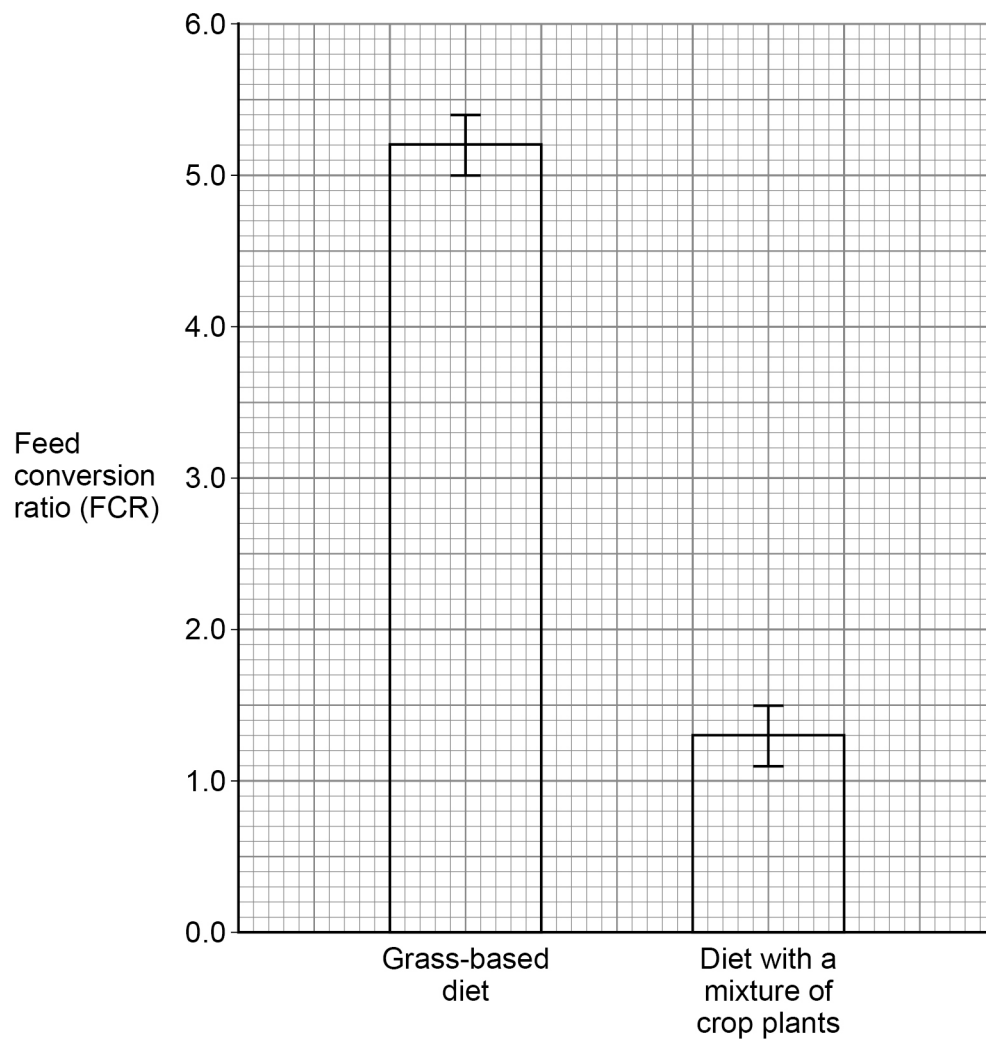
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**Figure 5** shows the scientists' results.

The error bars show  $\pm$  standard error.

**Figure 5**



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.

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

[illegible]

10

**Turn over ►**



0 4

Some genetic conditions are sex-linked.

0 4 . 1

Explain what a sex-linked condition is.

**[2 marks]**


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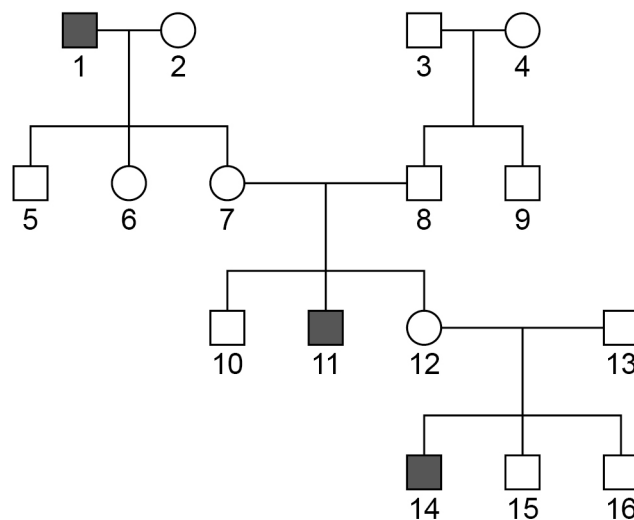
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Ocular albinism (OA) is a genetic condition that prevents pigment production in the eyes.

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



0 4 . 2

Give evidence from **Figure 6** that the allele for OA is recessive.**[1 mark]**


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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:

 $X^A$  = X chromosome with allele for pigmentation $X^a$  = X chromosome with allele for OA $Y$  = Y chromosome**[4 marks]**

|                            | Individual <b>12</b>              | Individual <b>13</b>            |
|----------------------------|-----------------------------------|---------------------------------|
| Parental phenotypes        | Female with pigment<br>production | Male with pigment<br>production |
| Parental genotypes         | <hr/>                             | <hr/>                           |
| Genotypes of gametes       | <hr/><br><hr/>                    | <hr/><br><hr/>                  |
|                            |                                   |                                 |
| Offspring genotypes <hr/>  |                                   |                                 |
| Offspring phenotypes <hr/> |                                   |                                 |
| <hr/>                      |                                   |                                 |

**Question 4 continues on the next page****Turn over ►**

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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]**

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0 5

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

**Figure 7** shows a horse with LCS.

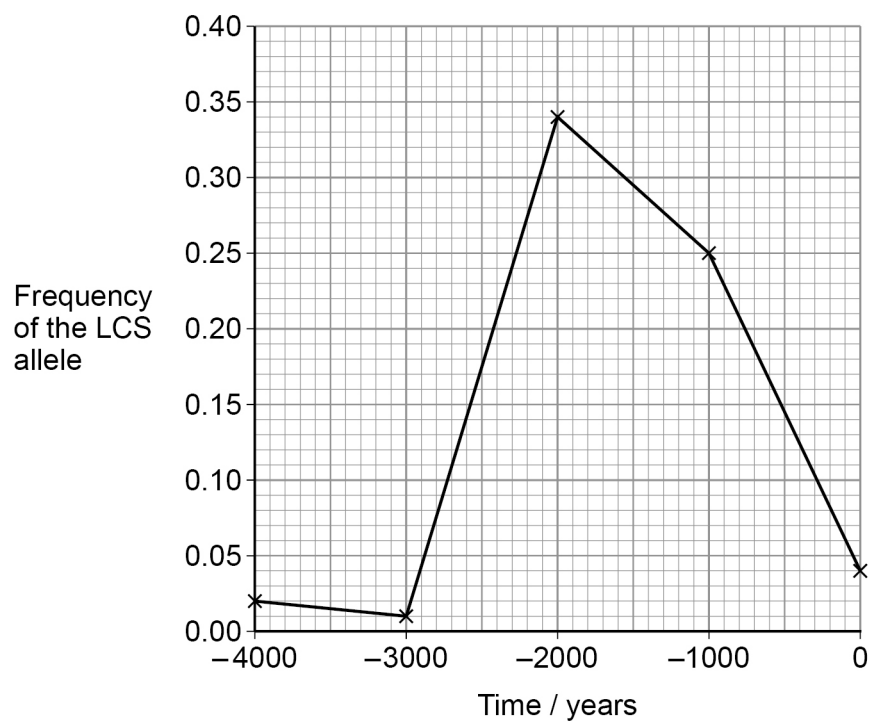
**Figure 7**



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**



**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 \_\_\_\_\_

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Between 3000 and 2000 years ago \_\_\_\_\_

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**[5 marks]**

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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<sup>3</sup> of glucose solution containing yeast to a test tube
2. adds 2 cm<sup>3</sup> 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]**

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**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]**

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**0 6 . 4**

Explain why the student did **not** use temperatures above 50 °C

**[2 marks]**

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**0 6 . 5**

The student sets up a control experiment by adding 2 cm<sup>3</sup> of methylene blue to a test tube containing 2 cm<sup>3</sup> of boiled yeast and glucose solution.

Suggest why the student sets up this control experiment.

**[1 mark]**

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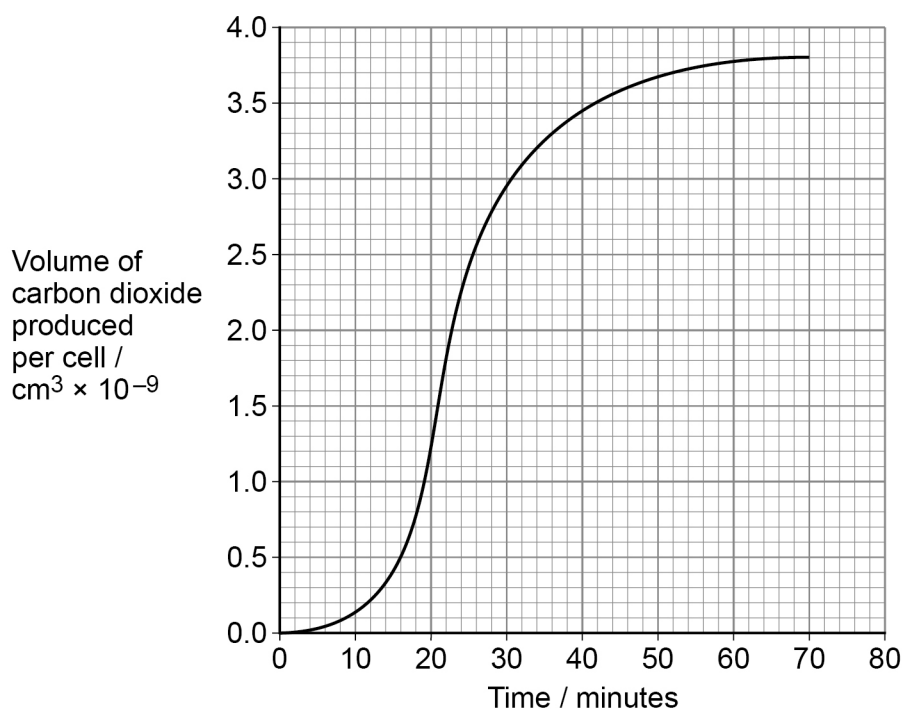
**Question 6 continues on the next page**

**Turn over ►**

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  
 $1.4 \times 10^{-10} \text{ cm}^3 \text{ per cell minute}^{-1}$

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 = \_\_\_\_\_  $\text{cm}^3 \text{ per cell minute}^{-1}$

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

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**[6 marks]**

[illegible]

**[5 marks]**

[illegible]

**Turn over ►**



Two biochemical cycles are:

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

[illegible]

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**END OF QUESTIONS**



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