OXFORD AQA
INTERNATIONAL QUALIFICATIONS

Please write clearly in block capitals.

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I declare this is my own work.

INTERNATIONAL A-LEVEL
BIOLOGY (9610)

Unit 3 Populations and Genes

Tuesday 7 January 2025 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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0 1 A lake is an example of an ecosystem.

0 1 . 1 In the following passage, the numbered spaces can be filled with biological terms.

An ecosystem is made up of interacting _____(1)_____ (living) and _____(2)_____ (non-living) factors.
There are many habitats in an ecosystem. All the organisms of all species in a habitat is called a _____(3)_____.
Within a habitat, each species occupies a _____(4)_____ governed by adaptation to the living and non-living factors around it.

Write the correct biological term beside each number below that matches the space in the passage.

[2 marks]

1 _____

2 _____

3 _____

4 _____

Figure 1 shows a food chain for some organisms in a lake.

Figure 1

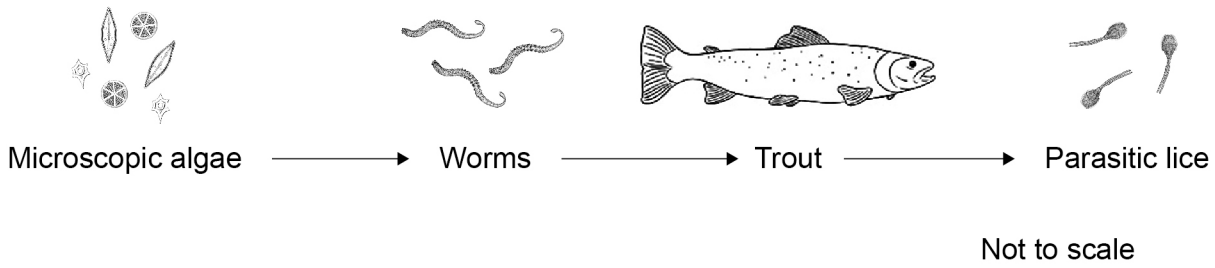

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Table 1 shows the chemical energy store in organisms at each trophic level of the food chain shown in **Figure 1**.

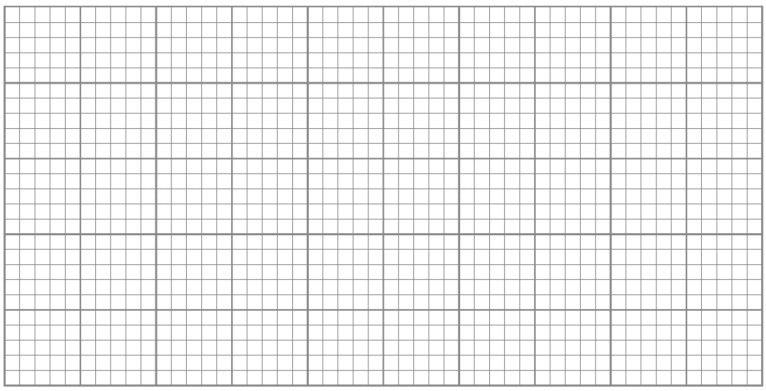
Table 1

Organism	Energy / kJ m^{-3} $year^{-1}$
Microscopic algae	980
Worms	220
Trout	50
Parasitic lice	10

0 1 . 2 Draw a labelled pyramid of energy for the food chain shown in **Figure 1**.

Use data from **Table 1**. Use a suitable scale.

[2 marks]



0 1 . 3 Explain the change in energy store between worms and trout in the food chain.

Use information from **Table 1**.

[2 marks]

_____

_____

_____

_____

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0 1 . 4 The mean number of microscopic algae in 1 mm^3 of water is 1200

Calculate the number of algae in 1 m^3 of water.

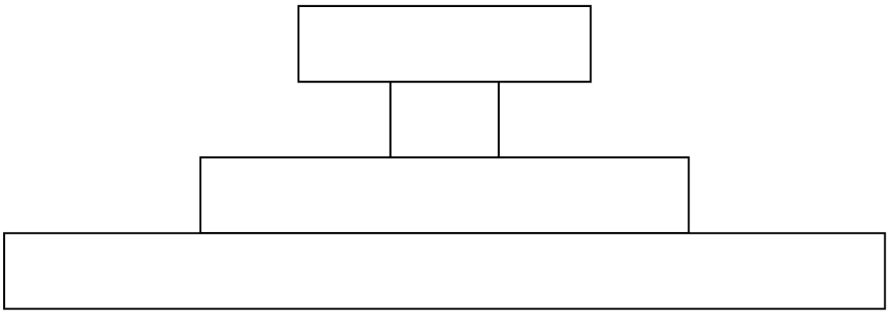
Give your answer in standard form.

[2 marks]

Number of algae = _____

Figure 2 shows a sketch of a pyramid of numbers for the food chain shown in **Figure 1** (on page 2).

Figure 2



0 1 . 5 Explain why the pyramid of numbers in **Figure 2** has a different shape from a pyramid of energy.

[2 marks]

_____

_____

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_____

10

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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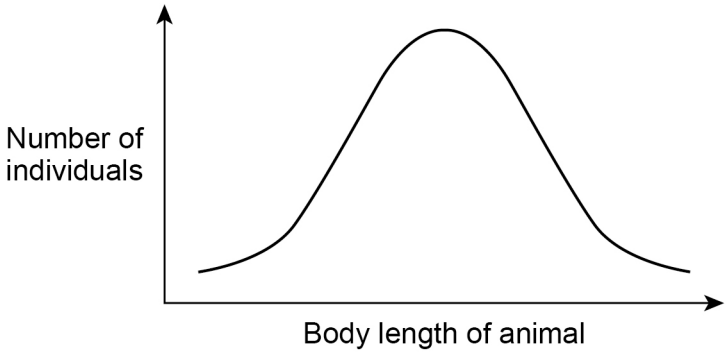
0 2 Individuals in a population may show a wide range of variation.

Figure 3 shows the distribution of body lengths in a population of animals.

Figure 3



Temperature changes are having an effect on animal body length in certain habitats.

An increase in temperature is selecting **for** smaller body length and **against** larger body length.

0 2 . 1 Name the type of selection shown by the effect of temperature on body length.

[1 mark]

_____

0 2 . 2 Draw a new distribution curve on **Figure 3** to show the effect of an increase in temperature.

[1 mark]

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A salamander is a small animal.

Figure 4 shows a salamander.

Figure 4

Question 2 continues on the next page

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The salamander *Ensatina eschscholtzii* has seven **sub-species**.

A sub-species is a group within a species, for example:

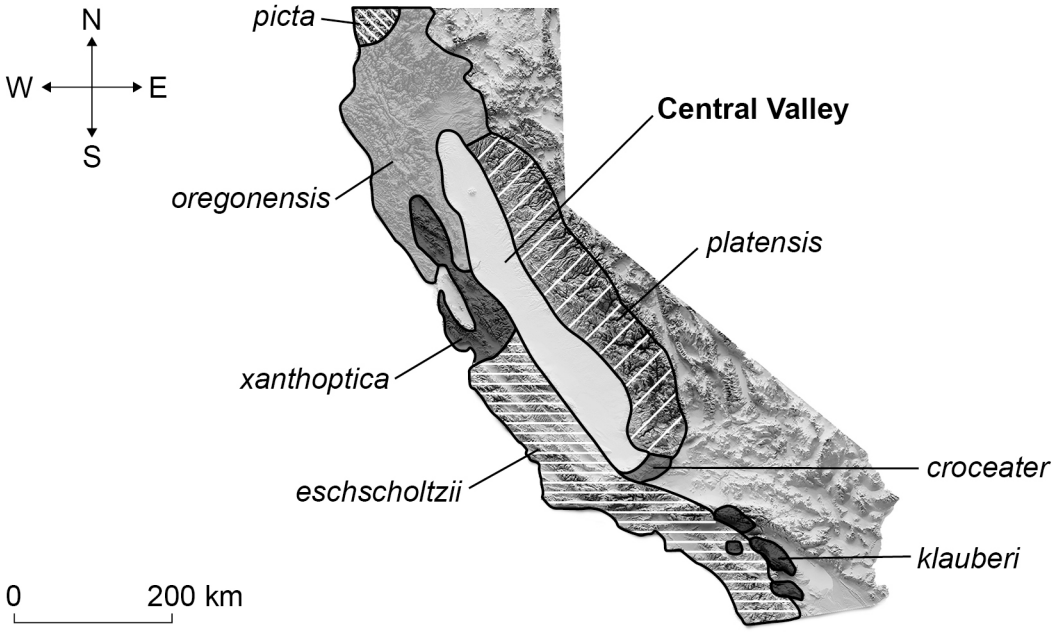
- *Ensatina eschscholtzii eschscholtzii*
- *Ensatina eschscholtzii platensis*.

The seven sub-species are distributed around California's Central Valley.

Central Valley is too hot and dry for salamanders.

Figure 5 shows the distribution ranges for the seven sub-species of *Ensatina* in California.

Figure 5



Genetic evidence suggests that *Ensatina eschscholtzii* originated in the north and gradually spread south on either side of California's Central Valley.

In the east:

- the sub-species have skin with bright spots of colour on a dark background
- there is interbreeding between the sub-species *platensis*, *croceater* and *klauberi*.

In the west:

- the sub-species have skin that is all one colour
- there is interbreeding between the sub-species *xanthoptica* and *eschscholtzii*.

Although the ranges of *eschscholtzii* and *klauberi* overlap in south California, the two sub-species do **not** interbreed.

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0 2 . 3 A student suggests that allopatric speciation is occurring in the salamander populations around Central Valley.

Evaluate the student's suggestion.

Do **not** refer to the names of the sub-species in your answer.

[5 marks]

7

Turn over for the next question

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0 3 Soluble nutrients including nitrates can dissolve in rainwater and be washed out of soil.

The nutrients can build up in lakes or rivers.

0 3 . 1 Give the terms used to describe:

- washing nutrients from the soil
- the build-up of nutrients in lakes and rivers.

[2 marks]

Washing nutrients from the soil _____

Build-up of nutrients _____

0 3 . 2 Describe how a build-up of nutrients could affect a population of fish in a lake or river.

[3 marks]

_____

_____

_____

_____

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Question 3 continues on the next page

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A farmer adds nitrogen-containing fertiliser to his land.

Table 2 shows the effect that the mass of fertiliser has on the yield and protein content of his grain crop, and the value added to the grain crop.

The value added does not include the cost of the fertiliser.

A hectare is a unit of area equivalent to 10 000 m^2

Table 2

Mass of nitrogen-containing fertiliser added / kg $hectare^{-1}$	Yield of grain crop / tonnes $hectare^{-1}$	Protein content of grain crop / %	Value added by using fertiliser / \$ $hectare^{-1}$
0	2.4	11.7	–
25	2.5	12.5	24
50	2.5	12.9	32
75	2.5	13.3	39
100	2.5	13.5	47

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0 3 . 3 The farmer decides to add 25 kg of fertiliser per hectare.

The fertiliser costs $14 for 25 kg

Give reasons that support the farmer's decision to use this mass of fertiliser.

Use data from **Table 2**.

[4 marks]

9

Turn over for the next question

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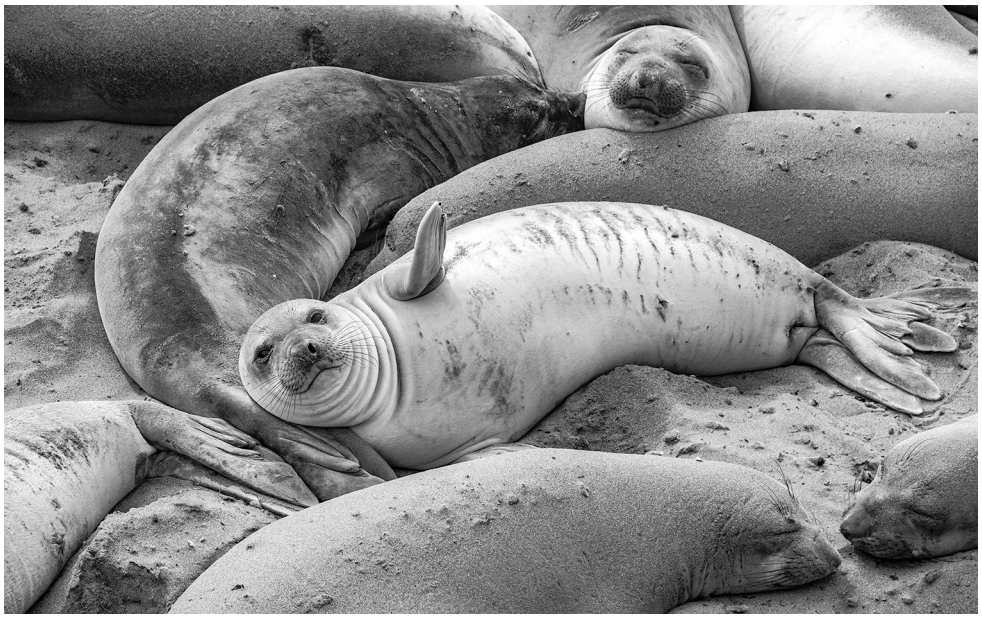
0 4 Northern elephant seals are animals found in North America.

Figure 6 shows a group of northern elephant seals.

Figure 6



In the late 1800s, northern elephant seals were hunted by humans. Only about 20 of the seals survived.

There are about 300 000 northern elephant seals alive today. These are all related to the ones that survived.

0 4 . 1 Genetic diversity is the number of different alleles of genes in a population.

Explain why northern elephant seals have a **low** genetic diversity.

[3 marks]

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Question 4 continues on the next page

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Northern elephant seals breed in large groups called colonies.

The female seals give birth to a single pup each breeding season.

The female does not hunt or eat for an average of 25.3 days while she is feeding her pup.

Some scientists study a colony of northern elephant seals.

The scientists measure the mass of a group of female seals 3 days and 22 days after the seals give birth.

Table 3 shows the scientists' results.

Table 3

Mean mass on day 3 / kg (± standard deviation)	**Mean mass on day 22 / kg (± standard deviation)**
509 ± 50	329 ± 47

0 4 . 2 Calculate the mean mass lost by the female seals in kg per day.

Use data from **Table 3**.

[1 mark]

Mean mass loss = _____ kg day^{-1}

Do not write outside the box

0 4 . 3 Explain what the standard deviations in **Table 3** show about the difference in the mean mass of the seals from day 3 to day 22.

[2 marks]

The scientists find that female seals can recognise the sound of their own pup 1–2 days after giving birth.

They also observe female seals feeding a lost pup or a pup whose mother has died.

0 4 . 4 Suggest the advantage of female seals:

- recognising the sound of their own pup
- feeding other pups in the colony.

Use all of the information provided.

[2 marks]

Recognising their own pup

Feeding other pups

8

Turn over for the next question

Do not write outside the box

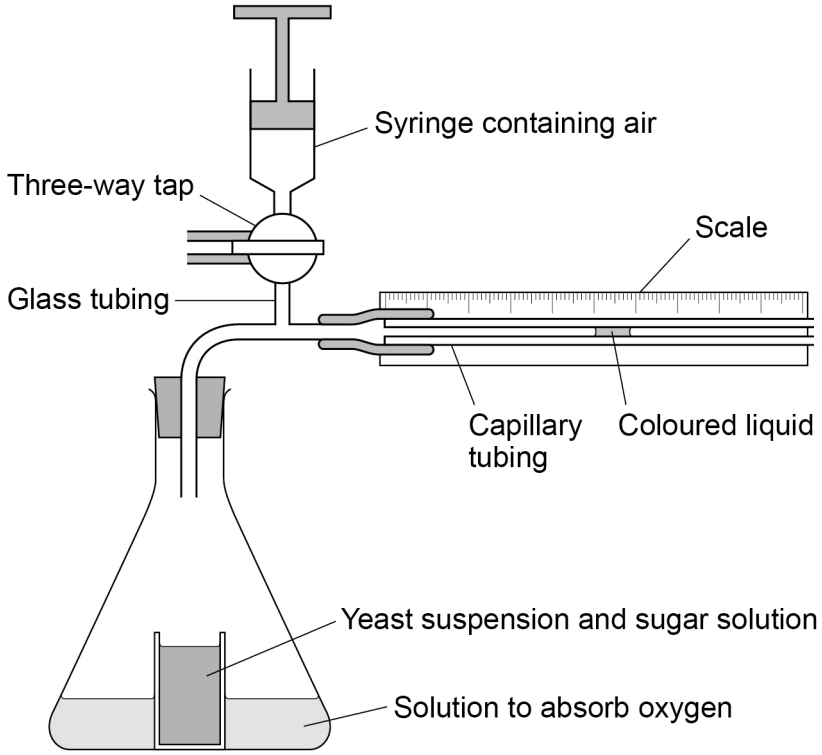
0 5 A student investigates the effect of using different respiratory substrates on the rate of respiration in yeast.

The respiratory substrates the student investigates are the sugars:

- fructose
- glucose
- lactose
- maltose.

The student uses a simple respirometer like the one shown in **Figure 7**.

Figure 7



This is the method the student uses.

1. Prepare a yeast suspension by adding 1 g of dried yeast to 10 cm^3 of distilled water.
2. Add the yeast suspension and 100 cm^3 of fructose solution to the respirometer.
3. Seal the respirometer and start a stopwatch.
4. Record the distance moved by the coloured liquid every 5 minutes for 120 minutes.
5. Repeat steps 1–4 using different sugar solutions.

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0 5 . 1 The student controls the mass of yeast and the volume of sugar solution in the respirometer.

Describe how two **other** variables should be controlled.

[2 marks]

Variable 1 _____

How controlled _____

Variable 2 _____

How controlled _____

Question 5 continues on the next page

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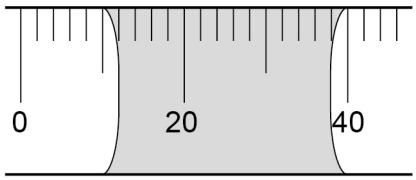
The student finds the volume of carbon dioxide produced by measuring the position of the coloured liquid on the scale.

Figure 8 shows part of the respirometer scale.

Figure 8



0 5 . 2 The coloured liquid started at 0 mm on the scale.

Give the distance moved by the coloured liquid shown on the scale in **Figure 8**.

[1 mark]

Distance moved = _____ mm

0 5 . 3 The coloured liquid moves 14 mm in 20 minutes.

The internal diameter of the capillary tube is 1 mm

Calculate the rate of carbon dioxide production by the yeast in $mm^3\ g^{-1}\ hour^{-1}$

Use $\pi = 3.14$

Give your answer to 1 decimal place.

[3 marks]

Rate of carbon dioxide production = _____ $mm^3\ g^{-1}\ hour^{-1}$

Do not write outside the box

0 5 . 4 The student could use the respirometer to determine the respiratory quotient (RQ).

What **two** readings would the student need to calculate RQ?

[1 mark]

Reading 1 _____

Reading 2 _____

Question 5 continues on the next page

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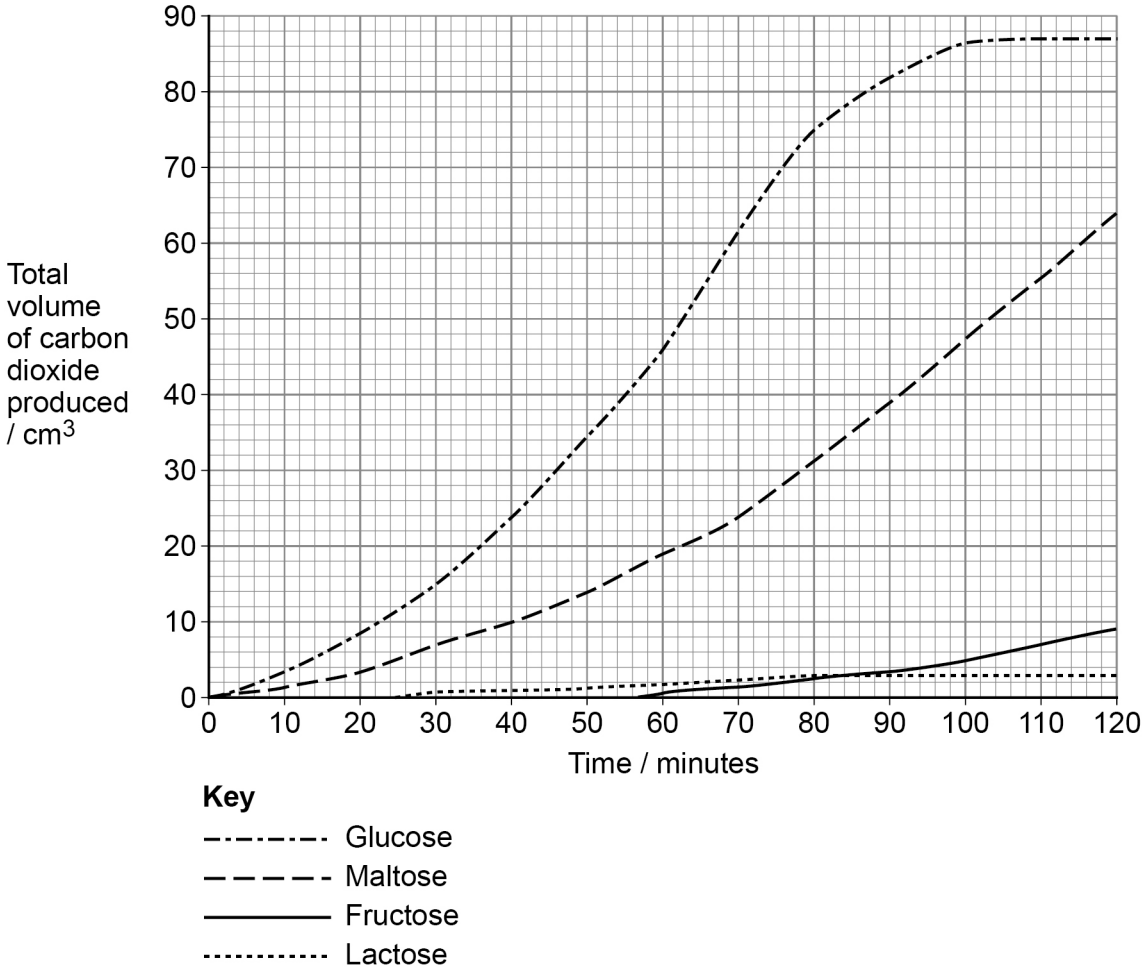
Figure 9 shows the student's results.

Figure 9



0 5 . 5 More carbon dioxide is produced in 120 minutes using glucose as a respiratory substrate than using maltose.

Calculate how many times more.

Use **Figure 9**.

[2 marks]

Number of times more = _____

Do not write outside the box

0 5 . 6 The student concludes that glucose is the best respiratory substrate for yeast.

Evaluate the student's conclusion.

Use information from **Figure 9**.

[3 marks]

0 5 . 7 Compare fructose and lactose as respiratory substrates.

Use data from **Figure 9**.

[3 marks]

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0 5 . 8 Lactose is a disaccharide formed from a glucose molecule and a galactose molecule.

Suggest why a low volume of carbon dioxide is produced from lactose.

[1 mark]

_____

_____

_____

16

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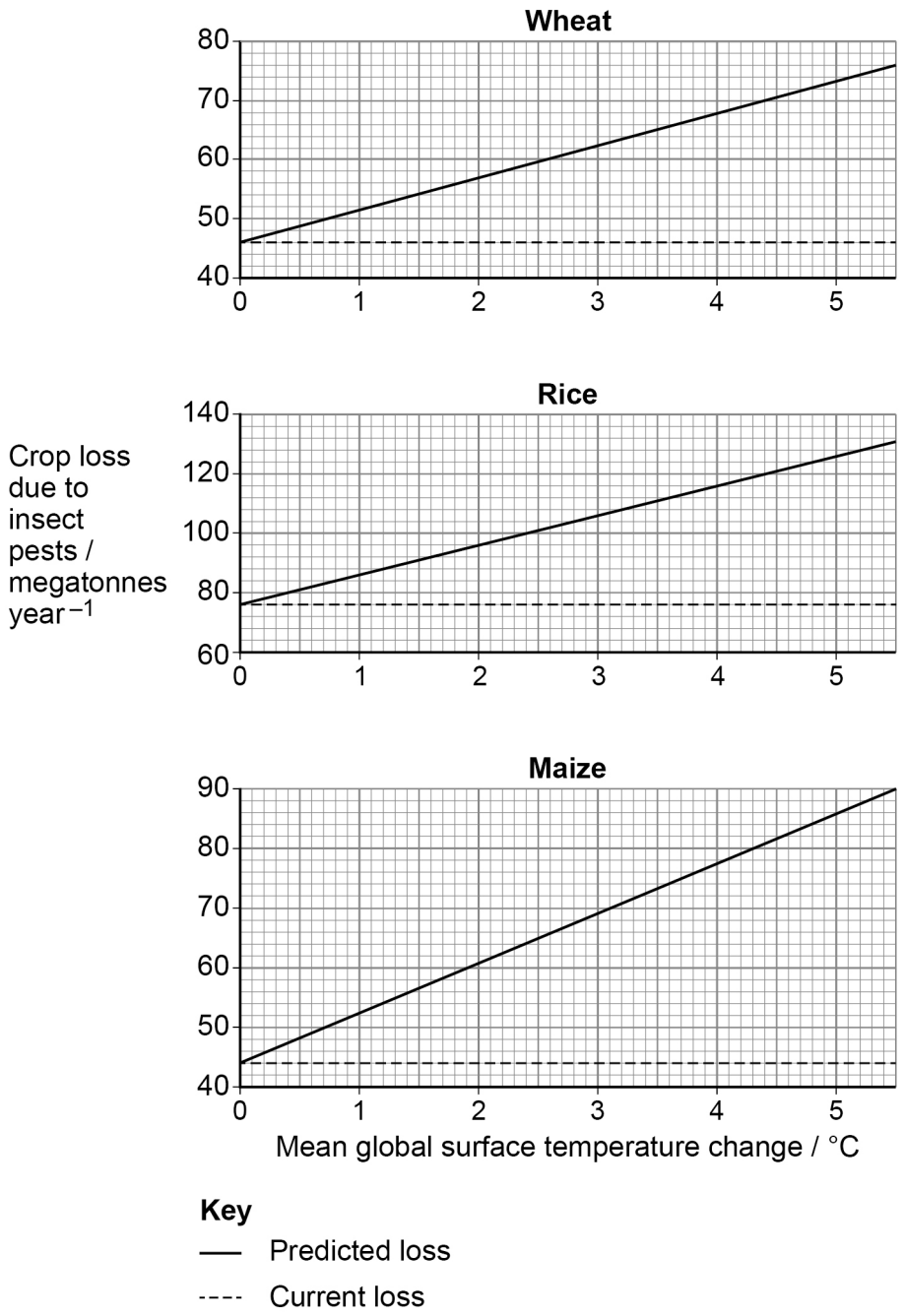
0 6 Insect pests currently eat 5–10% of grain crops produced globally.

Scientists:

- measure the metabolic rates and population growth rates of insects for a range of temperatures
- use a wide range of insect types, including pest species
- use their results to predict grain crop losses to insect pests with increasing temperature.

Figure 10 shows the scientists' results for **three** important grain crop plants.

Figure 10



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The scientists use computer programs to predict the global surface temperature change if greenhouse gas levels continue to rise.

The programs predict a global surface temperature change of +4 °C by 2100

0 6 . 1 Predict the crop loss to insect pests for **wheat** in 2100

Use data from **Figure 10**.

[1 mark]

_____ megatonnes

0 6 . 2 Calculate the predicted percentage increase in crop loss per °C of temperature change for **rice** in 2100

Use data from **Figure 10**.

[3 marks]

_____ %

0 6 . 3 Suggest **two** reasons why an increase in global surface temperature could change the crop loss to insect pests.

[2 marks]

Reason 1 _____

_____

_____

Reason 2 _____

_____

_____

Question 6 continues on the next page

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0 6 . 4 A journalist concludes that the yields of grain crops lost to insects will increase by over 15% per °C of temperature increase by 2100

Do you agree with the journalist's conclusion?

Justify your answer using **all** of the information provided.

[4 marks]

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0 7 Life depends on the continuous transfer of energy.

0 7 . 1 Photosynthesis is the main way that energy enters an ecosystem.

Describe the role of chlorophyll in the production of ATP during photosynthesis.

[5 marks]

0 7 . 2 Describe the role of the Krebs cycle in the production of ATP during aerobic respiration.

[4 marks]

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0 7 . 3 Energy is transferred from producers to consumers.

Describe how farming practices can increase the efficiency of energy transfer.

[6 marks]

END OF QUESTIONS

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