

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname *StemUp Model Solution*

Forename(s)

Candidate signature

I declare this is my own work.

INTERNATIONAL A-LEVEL BIOLOGY (9610)

Unit 3 Populations and Genes

Wednesday 21 May 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	
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TOTAL	



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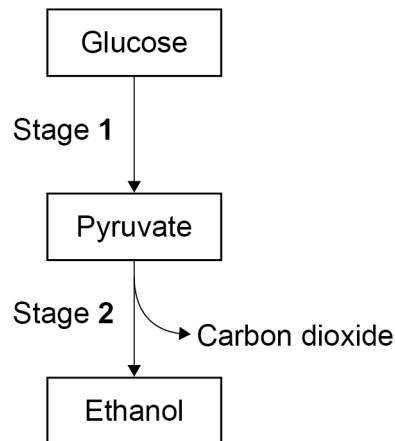
Answer **all** questions in the spaces provided.

0 1

Yeast is a microorganism that can use anaerobic respiration.

Figure 1 shows some of the stages of anaerobic respiration in a yeast cell.

Figure 1



0 1 . 1

Name Stage 1 shown in **Figure 1**.

[1 mark]

Glycolysis

0 1 . 2

Table 1 shows the stages of anaerobic respiration from **Figure 1**.

Complete **Table 1**.

Tick (✓) the boxes that show the molecules that each stage produces or uses.

[2 marks]

Table 1

Molecules each stage produces or uses	Stage 1 Glucose → Pyruvate	Stage 2 Pyruvate → Ethanol
Produces reduced NAD	✓	
Uses reduced NAD		✓
Produces ATP	✓	
Uses ATP	✓	



0 1 . 3

Describe why Stage 2 in **Figure 1** is important in anaerobic respiration in yeast.**[3 marks]**

Stage 2 uses reduced NAD, so NAD is regenerated (oxidised NAD is reformed).

This NAD is needed to accept hydrogen in glycolysis (Stage 1), so glycolysis can continue.

So ATP can still be produced (from glycolysis) without oxygen.

0 1 . 4

Anaerobic respiration can occur in muscle cells.

Give **two** differences between anaerobic respiration in a yeast cell and anaerobic respiration in a muscle cell.

[2 marks]

1 *Yeast produces ethanol, but muscle cells produce lactate (lactic acid).*

2 *Carbon dioxide is produced in yeast, but carbon dioxide is not produced in muscle cells.*

8

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0 2

Some bacteria can photosynthesise.

Purple bacteria contain pigments called bacteriochlorophylls that have a similar role to chlorophyll in photosynthesis in plants.

0 2 . 1

Suggest the role of bacteriochlorophylls.

[2 marks]

Bacteriochlorophylls absorb light energy, so electrons in them become excited (raised to a higher energy level) and are lost.

The energy from the excited electrons is used to generate ATP (photophosphorylation), and the electrons are used to reduce NADP.

0 2 . 2

The purple bacteria use hydrogen sulfide (H_2S) in photosynthesis instead of water.

Suggest the role of hydrogen sulfide.

[2 marks]

Hydrogen sulfide is split to provide protons (H^+) for the reduction of NADP, and for producing ATP.

It also provides electrons to replace those lost from the bacteriochlorophyll, so electrons pass along the electron transfer chain.

0 2 . 3

The purple bacteria do **not** produce oxygen during photosynthesis.

Suggest what the bacteria produce instead.

[1 mark]

Sulfur (S)



0 2 . 4

Purple bacteria and green bacteria are found in the same habitat.

Purple bacteria contain bacteriochlorophylls that absorb light with wavelengths between 750 and 800 nm

Green bacteria contain **different** bacteriochlorophylls that absorb light with wavelengths between 625 and 675 nm

Suggest why it is an **advantage** for the different types of bacteria to have different pigments.

[2 marks]

They absorb different wavelengths of light, so they are not competing for light.

So both types of bacteria can photosynthesise and survive in the same habitat.

7

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0 3

Some plants release chemicals that can:

- affect the growth of other plants
- defend plants against pathogens or pests.

These chemicals are called allelochemicals and the plants are called allelopathic plants.

0 3 . 1

Suggest **one** advantage to allelopathic plants of releasing allelochemicals.

[1 mark]

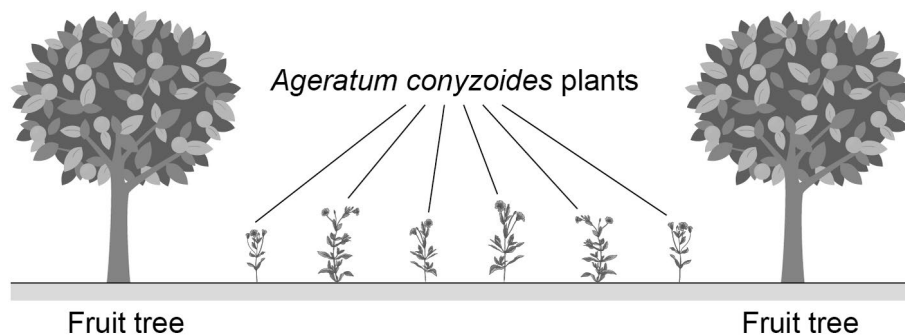
Less competition from other plants for light, water and minerals (eg nitrate), so more growth.

Fruit trees can be grown as crops.

Ageratum conyzoides is an allelopathic plant that can be planted between fruit trees. This is called intercropping.

Figure 2 shows this example of intercropping.

Figure 2



Red mites are pests that feed on the leaves and fruits of trees.

Figure 3 shows a red mite on a leaf.

Figure 3



A. conyzoides plants release chemicals into the air that attract predatory mites.

The predatory mites are natural predators of red mites.

0 3 . 2

Suggest the advantages and disadvantages of intercropping between fruit trees.

Use the information provided and your own knowledge of pest control.

[3 marks]

Advantages *Predatory mites are specific to red mites. They reproduce, so less pesticide is needed and it does not need reapplying. No resistance to pesticide develops and no chemicals accumulate in food chains. Less damage to the crop, so higher yield.*

Disadvantages *May take longer to control red mites than pesticide. Predatory mites may become pests (no natural predator). *A. conyzoides* competes with the trees for water and minerals, and may attract other pests. No cost comparison.*

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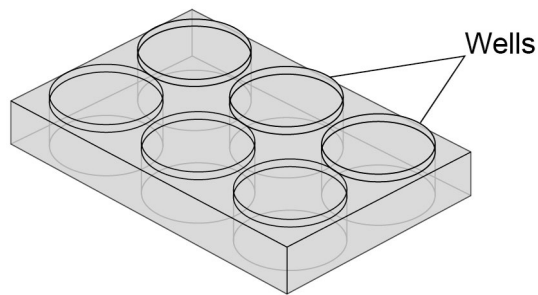
Lettuce is a common crop plant.

Scientists research the effect of allelopathic plants on the growth of lettuce seedlings.

The scientists use leaves from four allelopathic plants **W**, **X**, **Y** and **Z**.
The scientists use plates with six wells.

Figure 4 shows one of the plates.

Figure 4



This is the method the scientists use.

1. Add growth medium to three of the wells.
2. Add growth medium containing leaves from plant **W** to the other three wells.
3. Put five lettuce seeds in each of the six wells.
4. Repeat steps 1 to 3 using 19 more plates.
5. Repeat steps 1 to 4 with each of plants **X**, **Y** and **Z**.
6. Keep the plates at 25 °C

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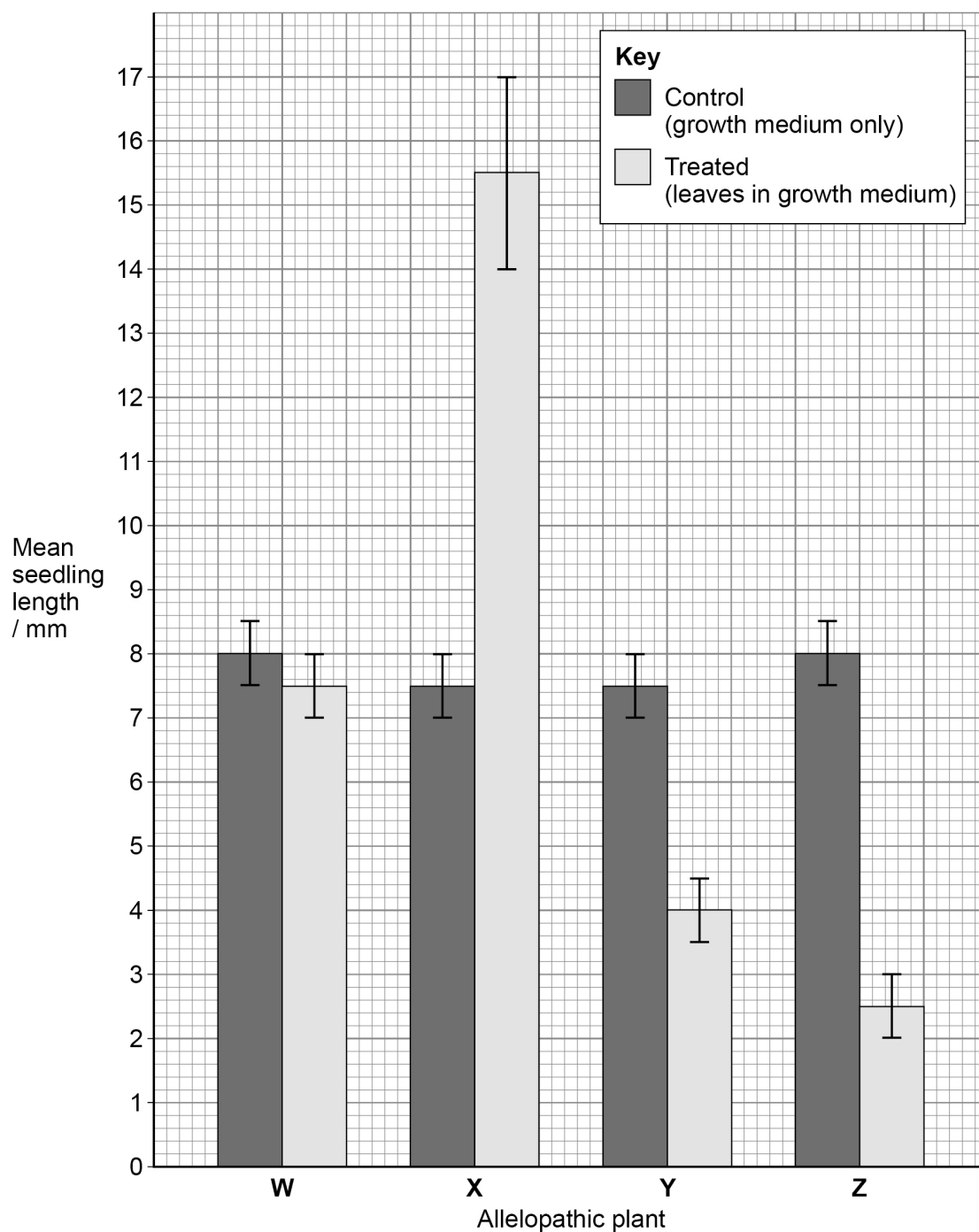
The scientists:

- measure the total length of each lettuce seedling from root tip to shoot tip after 1 week
- calculate the mean lengths.

Figure 5 shows the scientists' results.

The error bars show $\pm$ standard error.

Figure 5



0 3 . 3

Describe what the scientists can conclude from the results shown in **Figure 5**.**[4 marks]**

Plant W has no significant effect on mean seedling length, as the error bars of the control and treated overlap.

Plant X significantly increases the mean seedling length (about 15.5 mm compared with 7.5 mm), as the error bars do not overlap.

Plants Y and Z both significantly decrease the mean seedling length, as the error bars do not overlap with the control.

Z decreases the seedling length significantly more than Y (2.5 mm compared with 4 mm), as their error bars do not overlap.

0 3 . 4

Suggest **one** piece of information that would be needed before one of the allelopathic plants could be used for intercropping.**[1 mark]**

Whether it works outside in a field, as it was only tested in the lab, and whether it works on other crops (only lettuce tested).

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0 4

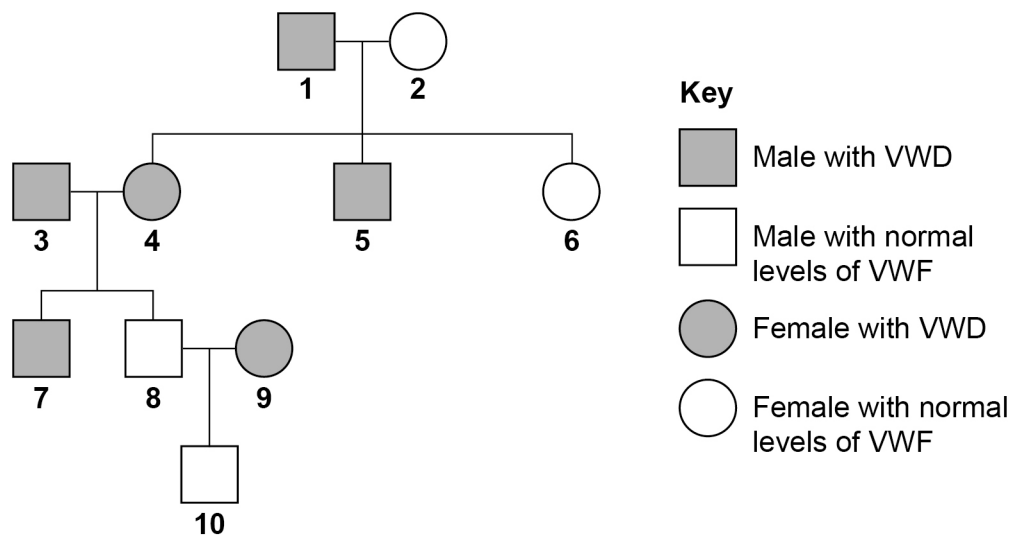
Von Willebrand Disease (**VWD**) is an inherited disease that can cause a person to lose more blood than normal after an injury.

People with VWD have low levels of a protein called von Willebrand factor (**VWF**) in their blood. VWF helps blood cells to stick together after an injury so a blood clot can form.

VWD is caused by a dominant allele, **A**. The recessive allele, **a**, causes normal levels of VWF.

Figure 6 shows the inheritance of VWD in one family.

Figure 6



0 4 . 1

Give the genotype of individual 1.

[1 mark]

Aa

0 4 . 2

Explain how **Figure 6** shows that VWD is caused by a dominant allele.

[2 marks]

Individuals 3 and 4 both have VWD but have a child (8) without VWD.

If VWD were recessive, all the offspring of 3 and 4 would have VWD.

So both parents must also have the recessive allele (both are heterozygous, Aa), and the allele for VWD must be dominant.



0 4 . 3

Explain **one** piece of evidence from **Figure 6** to show that inheritance of VWD is **not** sex-linked.

[2 marks]

Individual 1 (a male with VWD) has a daughter, 6, without VWD.

If VWD were X-linked (dominant), I would pass his X chromosome with the allele to 6, so all his daughters would have VWD.

0 4 . 4

Individuals **8** and **9** have another child.

Draw a genetic diagram to show all the possible genotypes and the ratio of phenotypes expected in the offspring.

[2 marks]

Parents

Individual **8**Individual **9**

Genotypes of parents

*aa**Aa**Gametes:**a a**A a*

		<i>A</i>	<i>a</i>
<i>a</i>		<i>Aa</i>	<i>aa</i>
<i>a</i>		<i>Aa</i>	<i>aa</i>

Genotypes of offspring *Aa and aa*

Phenotypes of offspring *Aa = VWD; aa = normal levels of VWF*

Ratio of phenotypes *1 VWD : 1 normal levels of VWF*

Question 4 continues on the next page

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0 4 . 5

The population of the United States is about 340 million people.

The frequency of the allele for VWD is 0.004

Calculate the number of people in the United States who are heterozygous for the gene for VWD.

Use the Hardy–Weinberg equation.

Give your answer in standard form.

[3 marks]

$$q = 0.004, \text{ so } p = 1 - 0.004 = 0.996$$

$$\text{Heterozygotes} = 2pq = 2 \times 0.996 \times 0.004 = 0.007968$$

$$0.007968 \times 340\,000\,000 = 2\,709\,120$$

$$\text{Number of people} = 2.71 \times 10^6$$

0 4 . 6

The Hardy–Weinberg principle can be used to predict the frequency of the VWD allele in the United States.

Give **one** reason why the principle might apply and **one** reason why it might not apply.

[2 marks]

Might apply *The population is large.*

Might not apply *Mutations arise, and there is allele flow into the population (immigration), so it is not isolated.*

0 4 . 7

Some people have VWD but did **not** inherit the dominant allele from one of their parents.

Suggest why these people have VWD.

[1 mark]

A mutation in the gene for VWF (changing the structure of VWF).



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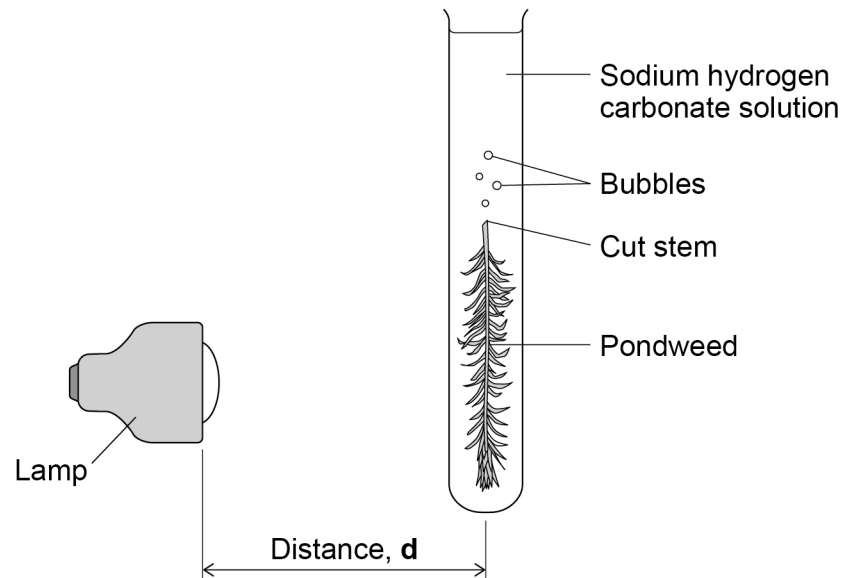


0 5

A student investigates the effect of light intensity on the rate of photosynthesis in pondweed.

The student uses the equipment shown in **Figure 7**.

Figure 7



The student changes the light intensity by putting the lamp at different distances, **d**, from the pondweed.

The student measures the rate of photosynthesis by counting the number of bubbles released in one minute.

0 5 . 1

Give the reasons why the pondweed stem is positioned so that the cut end:

- is pointing upwards
- is in the middle of the tube.

[2 marks]

Pointing upwards So bubbles are not caught in the leaves (they escape from the cut end).

In the middle of the tube So the student can see the bubbles rising to the surface and count them.



0 5 . 2

At each distance from the lamp, the student uses:

- the same concentration of sodium hydrogen carbonate solution
- the same piece of pondweed.

Explain why the student keeps these variables the same.

[3 marks]

So that the rates of photosynthesis at different light intensities can be compared (light intensity is the only variable).

A higher concentration of hydrogen carbonate gives more carbon dioxide, so a higher rate of photosynthesis and more bubbles produced.

A longer piece of pondweed has more leaves/cells/chloroplasts, so more bubbles are produced.

0 5 . 3

Suggest **two** limitations of the student's method.

[2 marks]

Limitation 1 *Bubbles do not only contain oxygen, and some oxygen dissolves in the water or is used in respiration.*

Limitation 2 *The size of the bubbles varies, and the heat from the lamp changes the temperature of the water.*

Question 5 continues on the next page

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Table 2 shows the student's results.

Table 2

Distance	Number of bubbles released in 1 minute		
0.3	24	19	23
0.25	27	31	29
0.2	40	37	40
0.15	46	48	50
0.1	51	47	46

0 5 . 4

Give **two** ways the student could improve the table of results.

[2 marks]

Improvement 1 *Add a unit for distance in the column heading, eg
Distance/m.*

Improvement 2 *Record the distances to a consistent number of decimal
places (eg 0.30, 0.25, 0.20).*



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The student processes the results by calculating $1/d^2$ where d is the distance between the pondweed and the lamp.

This gives a measure of relative light intensity as $1/d^2$ is proportional to light intensity.

Table 3 shows the student's processed results.

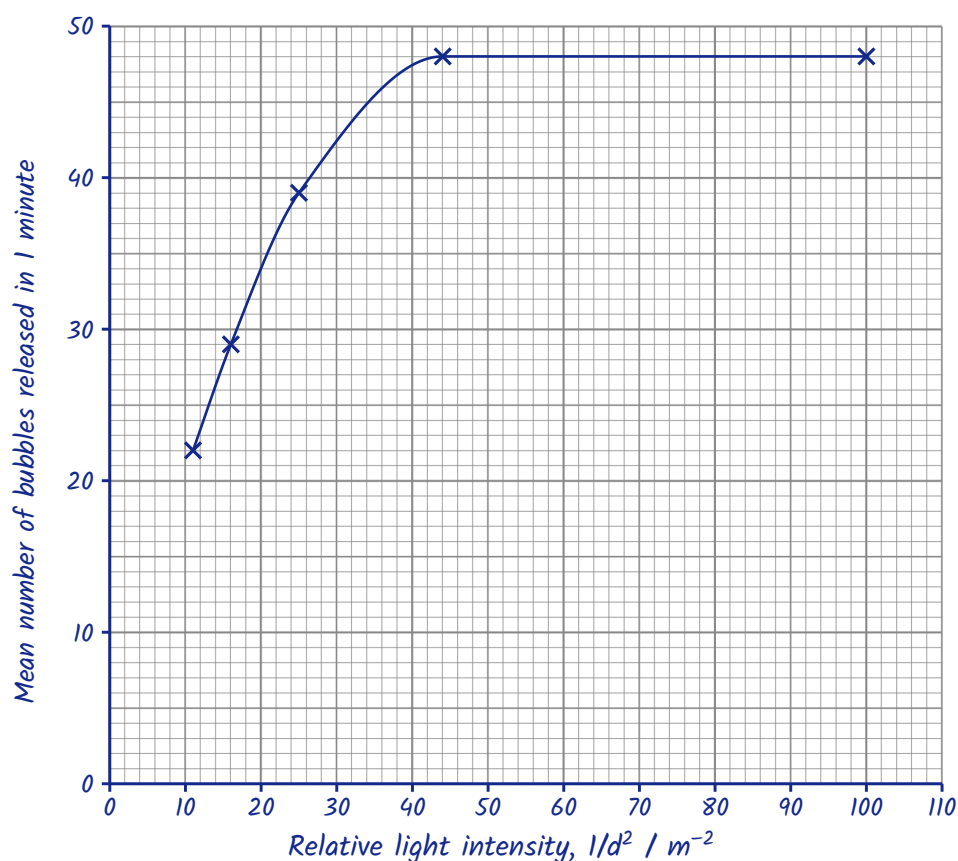
Table 3

Relative light intensity $1/d^2 / \text{m}^{-2}$	Mean number of bubbles released in 1 minute
11	22
16	29
25	39
44	48
100	48

0 5 . 5 Plot a graph of the student's processed results.

Draw a line of best fit on your graph.

[3 marks]



0 5 . 6 Explain the student's results.

Use **Table 3** and the graph you plotted in Question **05.5**.

[2 marks]

Between relative light intensities of 11 and 44, the number of bubbles increases as light intensity increases, so light intensity is the limiting factor up to 44.

Between 44 and 100 the number of bubbles stays constant (48), so another factor, such as carbon dioxide concentration or temperature, is limiting.

0 5 . 7 The student uses a statistical test to analyse the results.

Name the statistical test the student should use.

Give the reason for your choice of test.

[1 mark]

Name of statistical test *Spearman's rank correlation coefficient*

Reason for choice *The student is looking for a correlation (relationship) between light intensity and number of bubbles.*

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0 6

Some breeds of chickens are farmed for meat. The chickens are often kept in large buildings called barns.

Figure 8 shows some chickens in a barn.

Figure 8



0 6 . 1

Waste from chickens can be used as a natural fertiliser. Farmers spread the waste on their fields.

A lake near a chicken farm develops a green colour.

Suggest how chicken waste on the fields could cause the green colour of the lake.

[2 marks]

Nitrates/phosphates (eg ammonium ions) from the chicken waste are leached (run-off) into the lake, increasing their concentration (eutrophication).

This causes increased growth of algae and plants (an algal bloom), which makes the lake green.

Question 6 continues on the next page

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There are different chicken farming systems. Two of these are:

- standard indoor
- free-range indoor.

The two systems use different breeds of chicken.

Table 4 gives information about the chicken farming systems.

Table 4

Farming system	Minimum age when sold for food / days	Number of chickens per m ²	Breed of chicken
Standard indoor	36	19	Fast-growing
Free-range indoor	52	13	Slow-growing

0 6 . 2 A farm has a barn 21 m wide and 104 m long.

The farm could sell up to 198 744 chickens per year using the free-range indoor system.

The farm uses the standard indoor system.

Calculate the maximum number of chickens the farm could sell per year using the standard indoor system.

Use data from **Table 4**.

[2 marks]

$$\text{Area of barn} = 21 \times 104 = 2184 \text{ m}^2$$

$$\text{Free-range: } 2184 \times 13 = 28\,392 \text{ per flock; } 198\,744 \div 28\,392 = 7 \text{ flocks}$$

$$\text{Standard indoor: } 2184 \times 19 = 41\,496 \text{ chickens per flock}$$

$$365 \div 36 = 10 \text{ flocks per year; } 41\,496 \times 10 = 414\,960$$

Number of chickens 414 960 per year



Table 5 gives information about the two different breeds of chicken.

Table 5

	Fast-growing breed	Slow-growing breed
Mass of food in kg needed to gain 1 kg of body mass	1.46	1.76
Percentage of chickens that cannot walk properly	38	11
Percentage of chickens that die before they are sold for food	11	5

0 6 . 3 Evaluate the use of the two chicken farming systems **and** the two chicken breeds.

Use all of the information provided.

[4 marks]

The standard indoor system with the fast-growing breed can produce more chickens per year (414 960 compared with 198 744), and needs less food (1.46 kg compared with 1.76 kg) to gain 1 kg of body mass.

In the standard indoor system the chickens have less space so they move less, so less energy is lost in respiration and more is used for growth.

However, the fast-growing breed has a worse quality of life as there is less space (19 per m²), 3.5 times more chickens cannot walk properly (38% compared with 11%), and more die before being sold (11% compared with 5%).

There is no information about the start-up cost or the selling price of each type of chicken.

8

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0	7
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Surtsey is an island near the coast of Iceland. It was formed when a volcano erupted in the 1960s.

Figure 9 shows Surtsey Island.

Figure 9



New species are colonising the island every year. The island will eventually be covered by forest, but this will take 300 to 2000 years.

Scientists are studying succession on the island.



0 7 . 1

Describe how succession occurs on an island like Surtsey.

[5 marks]

The bare volcanic rock is first colonised by pioneer species, such as lichens and mosses, which can survive the hostile conditions.

The pioneer species change the environment (abiotic conditions): they break down rock and, when they die and decompose, form soil/humus containing organic matter and minerals, which holds more water.

The environment becomes less hostile and more suitable for new species, such as grasses and then shrubs, but less suitable for the previous species.

The pioneer/previous species are outcompeted by the new species.

Each change to the environment allows more species to colonise, so there is an increase in biodiversity.

This continues until a stable climax community, such as forest, is reached.

Question 7 continues on the next page

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07.2

Population sizes can vary.

Describe how **named** abiotic and biotic factors can increase population sizes.**[6 marks]**

Abiotic: a higher temperature increases the metabolic rate (enzyme activity), so organisms grow and reproduce faster.

Greater light intensity increases the rate of photosynthesis, so plants grow more.

pH closer to the optimum for enzymes increases growth.

More water availability, used for photosynthesis, increases plant growth.

More nitrates and phosphates (ions) are used to synthesise biological molecules (proteins, nucleic acids, ATP) for plant growth.

Biotic: less interspecific or intraspecific competition means more resources (food, space) for each individual.

Less predation or hunting, and fewer pathogens or parasites, mean more survive to reproduce.

More pollination and seed dispersal by animals means more offspring, and more food available means more survive to reproduce.



0 7 . 3 Populations can change over time.

Describe how natural selection can cause a population to change.

[4 marks]

There is variation within the population due to mutations, which produce new alleles.

There are selection pressures from the environment, such as predation, disease or competition for resources.

Organisms with alleles that give a selective advantage are more likely to survive and reproduce.

The survivors pass on their favourable alleles to their offspring, so the frequency of the favourable alleles increases in the population over many generations.

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