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A Level Biology A
H420/03 Unified biology
Sample Question Paper

Date – Morning/Afternoon
Time allowed: 1 hour 30 minutes

You must have:
- the Insert

You may use:
- a scientific or graphical calculator

First name									
Last name									
Centre number						**Candidate number**				

SPECIMEN

INSTRUCTIONS
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided.
- Additional paper may be used if required but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the bar codes.

INFORMATION
- The total mark for this paper is **70**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in questions marked with an asterisk (*).
- This document consists of **16** pages.

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Answer **all** the questions.

1 A group of students set up a simple respirometer, as shown in **Fig. 1.1**, and used it to determine the rate of respiration in germinating mung beans.

- They placed a small muslin bag of soda lime into the syringe and then added five germinating mung beans, which were held in place with the syringe plunger.
- The students measured the movement of the red fluid in the capillary tube.
- After each set of readings the plunger was reset to return the fluid to its original position.

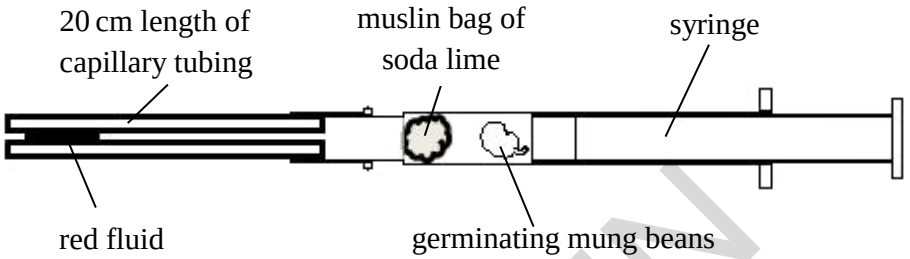


Fig. 1.1

The results are shown in **Table 1.1**.

Time (s)	Distance moved by the red fluid in capillary tube (mm)		
	1	2	3
0	0.0	0.0	0.0
30	11.5	12.0	12.5
60	22.5	21.5	17.5
90	31.0	32.0	32.5
120	41.5	42.0	42.5
150	53.0	54.0	53.5
180	63.0	63.0	64.0
210	72.5	71.0	71.5
240	78.5	79.5	79.0
270	87.5	88.5	87.0

Table 1.1

(a) Give **one** limitation of using this method to investigate respiration rate.

……

…… **[1]**

SPECIMEN

(b) Read the procedure carefully. Identify **one** variable that had not been controlled in this experiment **and** suggest an improvement to control that variable.

Variable ……

……

Improvement……

……

[2]

(c) Describe how you would add the red fluid to the capillary tube at the start of the experiment.

……

……

[1]

(d) The data shows an anomalous result at 60 seconds.

Explain why the result is considered to be anomalous **and** describe one correct way of dealing with this type of result.

……

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[2]

(e) Using the data the student obtained, calculate the mean rate of respiration for germinating mung beans between 90 and 150 seconds.

Answer…… **[1]**

(f) What additional information would be needed to calculate:

(i) the volume of oxygen taken up by the seeds.

…… **[1]**

(ii) the oxygen uptake for this batch of seeds to be comparable with data from another type of bean.

…… **[1]**

SPECIMEN

(g)* The group of students wanted to find out if the rate of respiration of a small invertebrate animal was comparable to that of the mung beans.

Adapt the procedure used to investigate the respiration rate of a small invertebrate, such as a woodlouse or caterpillar, with that of mung beans.

Comment on the results you might expect from this experiment and the conclusions you might draw.

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…… **[6]**

SPECIMEN

2 This question is about the impact of potentially harmful chemicals and microorganisms.

(a) **(i)** Salts that a plant needs, such as nitrates and phosphates, are taken into root hair cells by active transport.

For which macromolecule does a plant need both nitrogen **and** phosphorus?

…… **[1]**

(ii) Flooding of fields by seawater can damage crops. Seawater contains dissolved salts, including sodium chloride.

How would flooding affect soil water potential?

…… **[1]**

(iii) Sodium chloride in solution dissociates into Na^+ and Cl^-.

Explain how the Casparian strip prevents these ions from reaching the xylem of the plant by the apoplast pathway.

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…… **[2]**

(b) Plague is caused by the bacterium, *Yersinia pestis.*

(i) The bacterium is a rod-shaped cell that is approximately 3 μm long.

Yersinia pestis is viewed using a light microscope with a magnification of 1250.
What would be the length of the cell in the image produced by this microscope?

Answer**……**mm **[2]**

(ii) Photographs taken of the image obtained by the light microscope could be further enlarged using a projector.

Why might the enlarged image be unable to tell us more about the structure of *Yersinia pestis*?

……

…… **[1]**

SPECIMEN

(iii) Outbreaks of plague still occur occasionally. Plague is transmitted by several methods including droplet infection, close contact between people and fleas moving between infected rats and people.

Suggest **two** ways to minimise the spread of an outbreak of plague.

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……

……

…… **[2]**

(c) Herbicides work in a number of different ways.

(i) Some herbicides, known as phenoxy herbicides, mimic the action of the auxin, indoleacetic acid (IAA).

What is the normal action of IAA in plant cells?

…… **[1]**

(ii) The herbicide atrazine works by disabling plastoquinone, one of the proton pumps in photosystem II.

Explain how atrazine would kill a susceptible plant.

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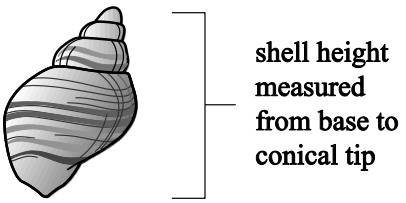
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…… **[5]**

SPECIMEN

3 The effect of wave action on the height of the shells of the dog whelk (*Nucella lapillus*) was investigated by comparing an exposed shore and a sheltered shore.



- A random sampling technique was used to collect 50 shells from an exposed shore.
- The shell height was measured from the base to the conical tip. The whelk was returned to its location.
- The process was repeated for the sheltered shore.
- All the results were recorded in **Table 3.1**.

Location	Height of shell (mm)										Range	Mean	SD
Sheltered shore	26	28	27	26	28	23	28	23	26	28			
	29	29	29	29	29	28	29	29	29	29			
	30	31	30	29	32	29	30	29	30	32			
	33	35	34	32	35	32	34	32	33	35			
	37	39	38	37	39	35	38	36	37	39	16	31.3	4.1
Exposed shore	15	17	16	15	23	15	23	16	13	15			
	17	24	18	17	17	14	17	18	16	17			
	19	19	20	24	18	20	19	20	18	20			
	23	14	24	14	21	20	23	17	21	23			
	25	25	28	26	25	27	25	28	25	27	15	20.0	4.2

Table 3.1

(a) The t test can be used to determine the significance of the differences between shell height on the exposed shore and the sheltered shore.

(i) Calculate the *t* value for the data using the formula:

$$t = \frac{\left|\bar{x}_1 - \bar{x}_2\right|}{\sqrt{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)}}$$

where,

$\left|\bar{x}_1 - \bar{x}_2\right|$ is the difference in mean values of sample 1 and sample 2

s_1^2 and s_2^2 are the squares of the standard deviations of the samples

n_1 and n_2 are the sample sizes.

Give your answer to **two** decimal places.

Answer…… **[2]**

SPECIMEN

(ii) The null hypothesis is that there is no difference between the means of the two shell populations.

The critical values at 98 degrees of freedom are shown in **Table 3.2**.

Degrees of freedom	***p* = 0.10**	***p* = 0.05**	***p* = 0.01**	***p* = 0.001**
98	1.67	2.00	2.64	3.41

Table 3.2

Using the table of critical values, explain whether the student would be able to accept or reject the null hypothesis as a result of the *t* value you calculated in part **(i)**.

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……

…… **[1]**

(b) The students organised the data from **Table 3.1** into classes.

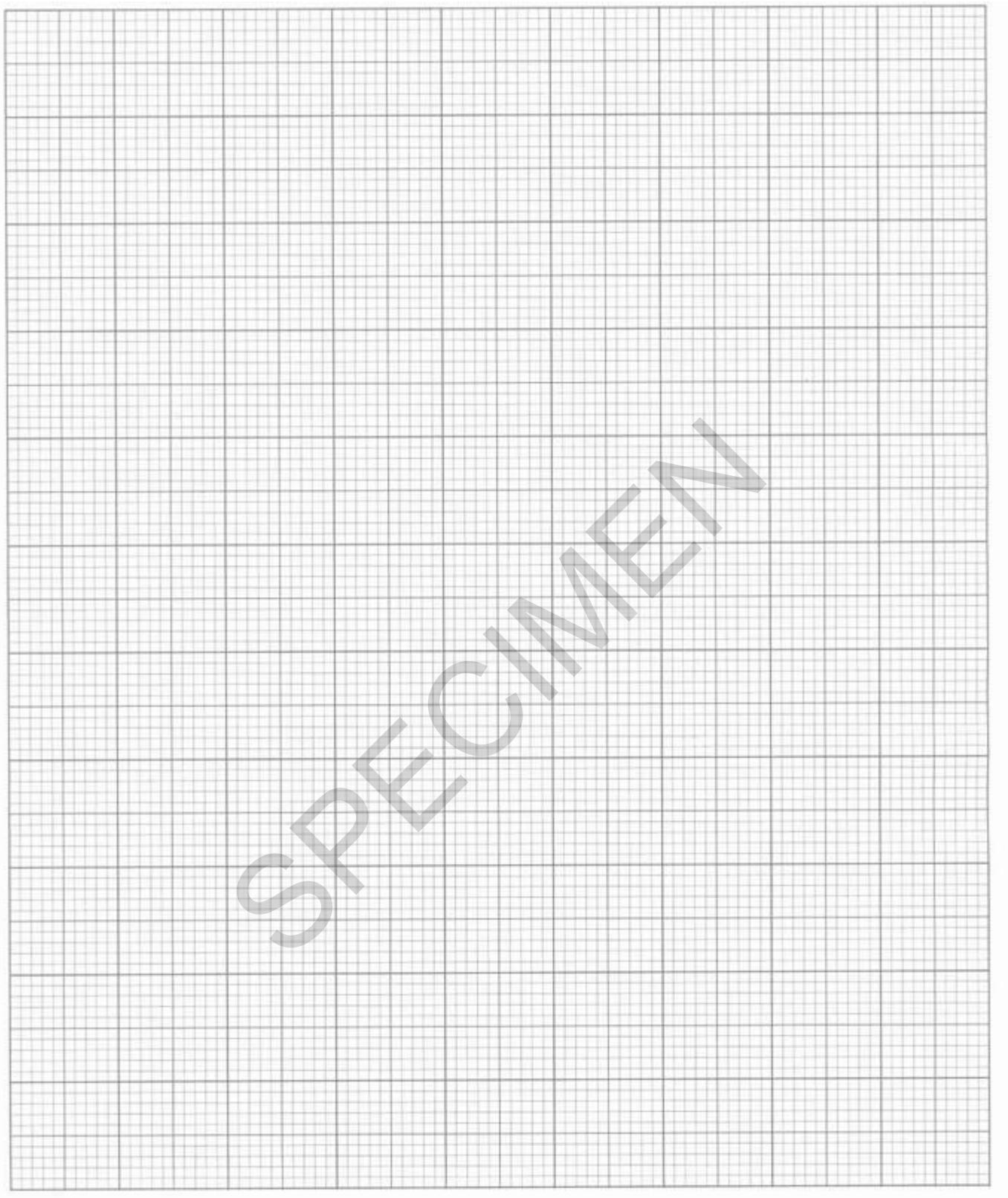
The organised data is shown in **Table 3.3**.

Sheltered shore			**Exposed shore**		
Height (mm)	**Tally**	**Total**	**Height (mm)**	**Tally**	**Total**
23–26	𝍸I	5	11–14	IIII	4
27–30	𝍸I 𝍸I 𝍸I 𝍸I II	22	15–18	𝍸I II	7
31–34	𝍸I 𝍸I I	11	19–22	𝍸I 𝍸I II	12
35–38	𝍸I IIII	9	23–26	𝍸I 𝍸I II	12
39–42	III	3	27–30	IIII	4

Table 3.3

Plot the most suitable graph of the data given in **Table 3.3**.

SPECIMEN



[4]

(c) Use the data and graph to discuss any correlation between the height of the whelk shell and the type of shore.

Suggest explanations for your findings.

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…… **[3]**

(d) Suggest a limitation of the procedure used to gather the data in this experiment and recommend how you could improve this.

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…… **[2]**

(e) How could the students improve the accuracy of their data?

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…… **[1]**

(f) Discuss the validity of the conclusions you have made during this experiment.

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…… **[3]**

SPECIMEN

4 Botulism is a condition resulting from the action of botulinum toxin. The main symptom of botulism is skeletal muscle weakness, which can be fatal.

(a) **(i)** Botulinum toxin is produced by the anaerobic bacterium *Clostridium botulinum*.
What information does the word 'anaerobic' suggest about the bacterium?

……

…… **[1]**

(ii) The toxin is initially produced as a large single polypeptide that has low potency.
After the toxin has been acted upon by a protease, two chains are produced which remain connected by a disulfide bond. In this form it is far more toxic.

Describe the action of the protease when it acts on the toxin.

……

…… **[1]**

(b) A mouse assay, using 99 mice, was used to determine the median lethal dose of the toxin.

(i) Suggest what is meant by the term *median lethal dose*.

……

…… **[1]**

(ii) The median lethal dose of the toxin is in the range of 5 – 50 ng kg^{-1} body mass, depending on the toxin type and the method of introduction into the body.

Calculate the probable lethal dose of the **least toxic** botulinum toxin for an individual with a body mass of 85 kg.

Show your working and give your answer in µg.

Answer…… µg **[2]**

SPECIMEN

(iii) The toxin acts primarily at the cholinergic nerve terminals of stimulatory motor neurones. Part of the molecule binds irreversibly to specific receptors on the presynaptic membrane. The toxin–receptor complex is then taken into the cytoplasm of the neurone where the disulfide bond is broken, releasing the section of the molecule which acts to block the release of the neurotransmitter.

Explain why botulism can be fatal.

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…… **[2]**

(c)* There are a number of different strains of the *Clostridium botulinum* bacterium. Different strains produce immunologically distinct forms of the toxin.

Explain why the toxins produced by the different strains are described as being 'immunologically distinct' and how they will be dealt with by the immune system.

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…… **[6]**

SPECIMEN

5 Termites are highly social insects. They are thought to have evolved from earlier forms of insect at least 150 million years ago, in the Jurassic geological period. They are related to cockroaches.

(a) **(i)** How might scientists a century ago have known that termites evolved in the Jurassic geological period?

……

…… **[1]**

(ii) What new source of evidence might help today's scientists to find out how closely related termites are to cockroaches?

……

…… **[1]**

(b) **Fig. 5.1**, on the insert, shows a termite mound, the nest of approximately one million individuals. The photograph was taken in Queensland Australia, about 3000 kilometres south of the equator.

(i) **Fig. 5.1** shows that the interior of the termite mound is full of interconnecting chambers. At the top of the mound some of these chambers open to the air outside.

Worker termites spend all their time working in brood chambers low in the mound, where eggs and larvae develop.

Explain how carbon dioxide produced in the respiring body cells of worker termites is removed to the air outside the termite mound.

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…… **[4]**

(ii) In Africa, closer to the equator, the mounds built by some species of termite are blade-shaped, with the long axis pointing North–South. **Fig. 5.2**, on the insert, shows an example of a termite mound in Africa.

Suggest why the African termites need to build mounds in this shape and orientation.

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…… **[2]**

SPECIMEN

(c) Most termites eat only dead vegetable material, so their principle food source is cellulose. Cellulose is a polymer.

State the name of the monomer in cellulose.

…… **[1]**

(d)

Termites such as the species that built the mound in **Fig. 5.1** on the insert can be classed as 'keystone species'.

Use the information given to state one argument that supports this statement and one argument that does not.

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…… **[2]**

END OF QUESTION PAPER

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A Level Biology A
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Date – Morning/Afternoon
Time allowed: 1 hour 30 minutes

You must have:
- the Question Paper

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INFORMATION
- This document consists of **4** pages. Any blank pages are indicated.



Fig. 5.1



Fig. 5.2

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Fig. 5.1: photo of three rocks © permission granted by Mr John Beazley

Fig. 5.2: picture of tree © permission granted Photoshot Holdings Ltd: http://www.alamy.com/

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