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A Level Biology A

H420/03 Unified biology

Sample Question Paper

Date – Morning/Afternoon

Version 2.0

Time allowed: 1 hour 30 minutes

**You must have:**

- the Insert

You may use:

- a scientific or graphical calculator



First name

Last name

Centre
numberCandidate
number**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.
- Where appropriate, your answers should be supported with working. Marks may be given for a correct method even if the answer is incorrect.
- 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.

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.

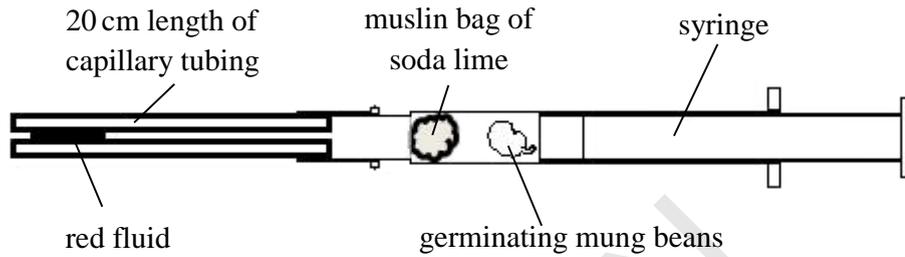


Fig. 1.1

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]

- (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]

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.

.....

.....

.....

..... [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]

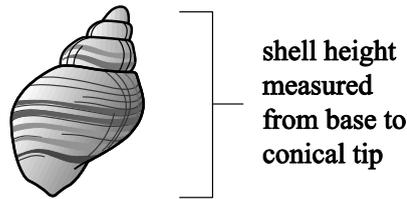
- (ii) Photographs taken of the image obtained by the light microscope could be further enlarged using a projector.

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

.....

..... [1]

- 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	16	31.3	4.1
	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			
Exposed shore	15	17	16	15	23	15	23	16	13	15	15	20.0	4.2
	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			

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:

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

where,

$|\bar{x}_1 - \bar{x}_2|$ 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]

- (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).

.....

.....

..... [1]

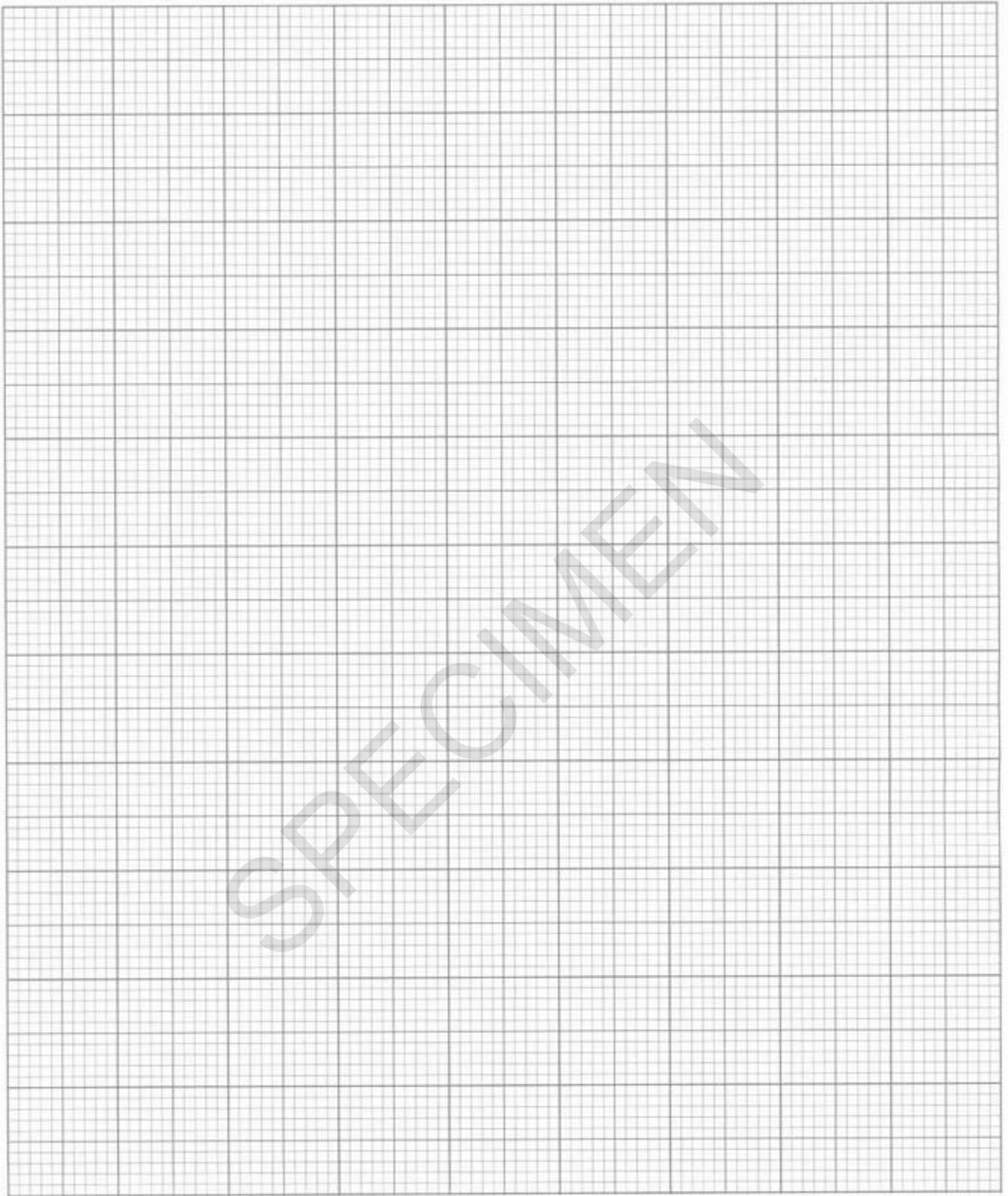
- (b) The students organised the data from **Table 3.1** into classes.

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

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

Table 3.3

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



[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]

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.

Give your answer in µg.

Answer..... µg [2]

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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.....
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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.

.....
.....
..... [2]

(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.

.....
.....
.....
..... [2]

END OF QUESTION PAPER

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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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Copyright Information:

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/](http://www.alamy.com/)

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