Handling Data (Maths Skills MS1): Eduqas A Level Biology Exam Questions

20 questions · 41 marks · about 49 minutes. Answer in the spaces, then check the mark schemes at the end.

Question 1 · A level Component 3 · June 2019 · Q6(b)(i) · 2 marks

(b) Figure 6.1 is a photomicrograph showing an individual *Paramecium*.

Figure 6.1



The organism shown in the image is approximately cylindrical and has the following dimensions:

length	300 µm
average diameter	40 µm
approximate surface area	40 200 μm^2
approximate volume	377 000 μm^3

(i) Calculate the surface area to volume ratio for this organism. **Give your answer to one decimal place.** [2]

Surface area to volume ratio = ... : 1

Question 2 · A level Component 2 · June 2025 · Q4(c)(i) · 3 marks

(c) Before soaking and germination, it was found that 30% of the mass of the grains was due to water content.

(i) Calculate the total dry mass of 420 g of grains. **Give your answer to two significant figures.** [3]

Total dry mass of grains = ... g

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Question 3 · information from earlier in the question

3. Protein synthesis involves two stages, transcription and translation. Different types of RNA are involved in each stage.

(a) The table below shows the percentages of the different types of RNA present in a rabbit body cell.

RNA	Percentage of total RNA
RNA present in nucleus	11.5
mRNA	3.5
rRNA	69.5
tRNA	15.5

Question 3 · AS Component 1 · June 2018 · Q3(a)(ii) · 3 marks

(ii) The total mass of RNA in a typical rabbit cell contains about 50 000 000 000 nucleotides.

Calculate the approximate number of nucleotides contained in the tRNA of a typical rabbit cell. **Give your answer in standard form to two significant figures.** [3]

Number of nucleotides in tRNA = ...

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Question 4 · AS Component 2 · June 2018 · Q2(b) · 3 marks

(b) In the study, mitochondrial DNA base pairs were analysed.
The following number of differences were found between giant panda DNA and that of the other species analysed:

Red panda	17
Black bear	12
Raccoon	21

One estimate of the mutation rate for the mitochondrial DNA sequence analysed is 3.95×10^{-7} mutations yr^{-1}.

Estimate how many years ago the giant panda and the red panda last shared a common ancestor. **Give your answer in standard form to two significant figures.** [3]

Answer: .....

Question 5 · A level Component 2 · June 2024 · Q4(b)(i) · 2 marks

(b) The energetic cost of tissues can be measured as the oxygen demand per gram of tissue per hour ($mg\,O_2\,g^{-1}hour^{-1}$).

The scientists investigated the energetic cost of vision in Mexican tetra fish. Eight fish of each form were studied. The oxygen demand for the whole body and for the eyes was calculated.

The results for the **surface form** are shown in **Table 4.2**.

Table 4.2

	Oxygen demand per g of fish / $mg\,O_2\,g^{-1}\,hour^{-1}$								
	Fish 1	Fish 2	Fish 3	Fish 4	Fish 5	Fish 6	Fish 7	Fish 8	Mean
whole body	0.844	0.852	0.861	0.841	0.839	0.848	0.850	0.840	.....
eyes	0.102	0.095	0.104	0.083	0.084	0.101	0.103	0.098	0.096

(i) Calculate the mean whole body oxygen demand per g of fish.

Write your answer in the space in Table 4.2. [2]

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(b) Gas exchange in earthworms was investigated by measuring the percentage saturation of their blood with oxygen. They were maintained at 10 °C and were studied in three different conditions:

- in air;
- in moist soil;
- in air, following a low dose of adrenaline.

The readings are shown in **Table 1.2**.

Table 1.2

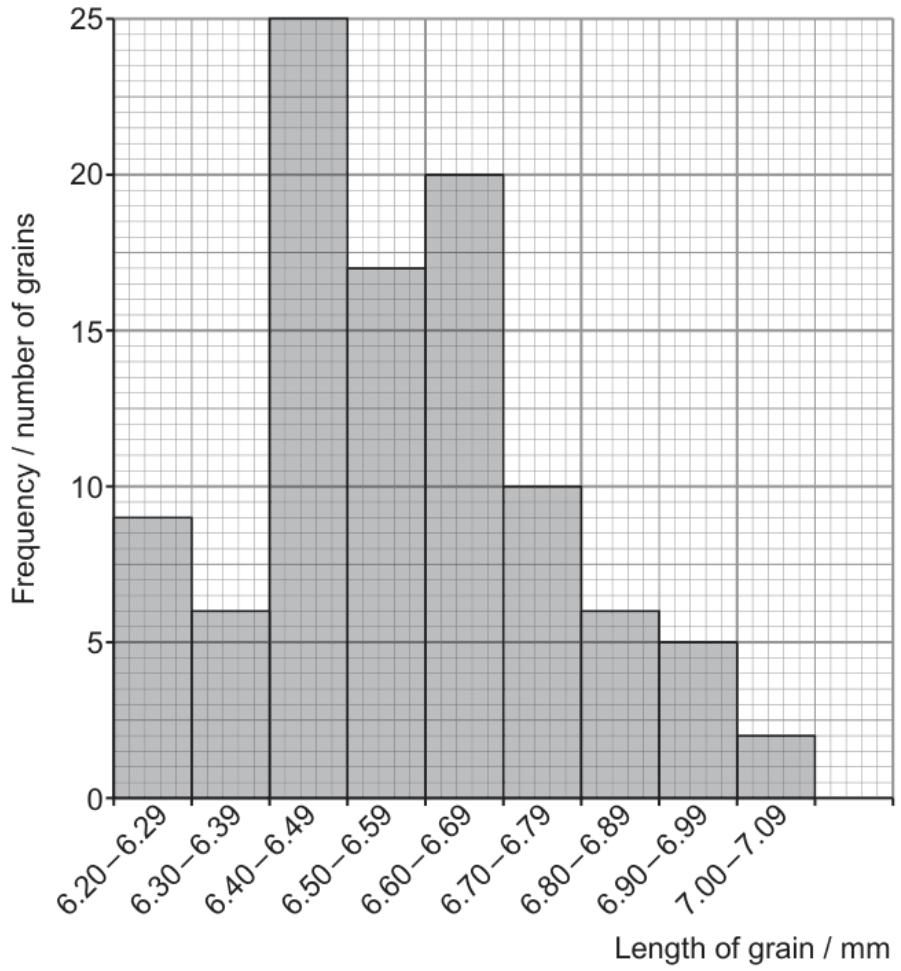
Earthworm	Percentage oxygen saturation of blood		
	In air	In moist soil	+ adrenaline
1	48	73	not tested
2	40	82	
3	41	65	
4	46	77	30
5	51	not tested	24
6	46		4
7	57		19
8	52		25
9	57		19
10	5		5
11	37		8
Mean	43.6	74.3	.....

(i) Calculate the mean percentage oxygen saturation in the blood of earthworms treated with adrenaline.
Write your answer in Table 1.2. [2]

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Question 7 · A level Component 2 · June 2018 · Q4(b)(i) · 1 mark

The graph below shows the distribution of grain length in a sample of the hybrid wheat variety. The grains were measured to the nearest 0.01 mm.



(b) (i) What is the total number of grains in the sample? [1]

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Question 8 · A level Component 2 · June 2018 · Q4(b)(ii) · 2 marks

(ii) The student calculated three different averages for the length of hybrid grains. The mean was 6.57 mm. The other two values were 6.45 mm and 6.52 mm. With reference to the graph, state which of these values is more likely to be the mode and give a reason for your choice. [2]

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Question 9 · A level Component 2 · June 2018 · Q4(b)(iii) · 1 mark

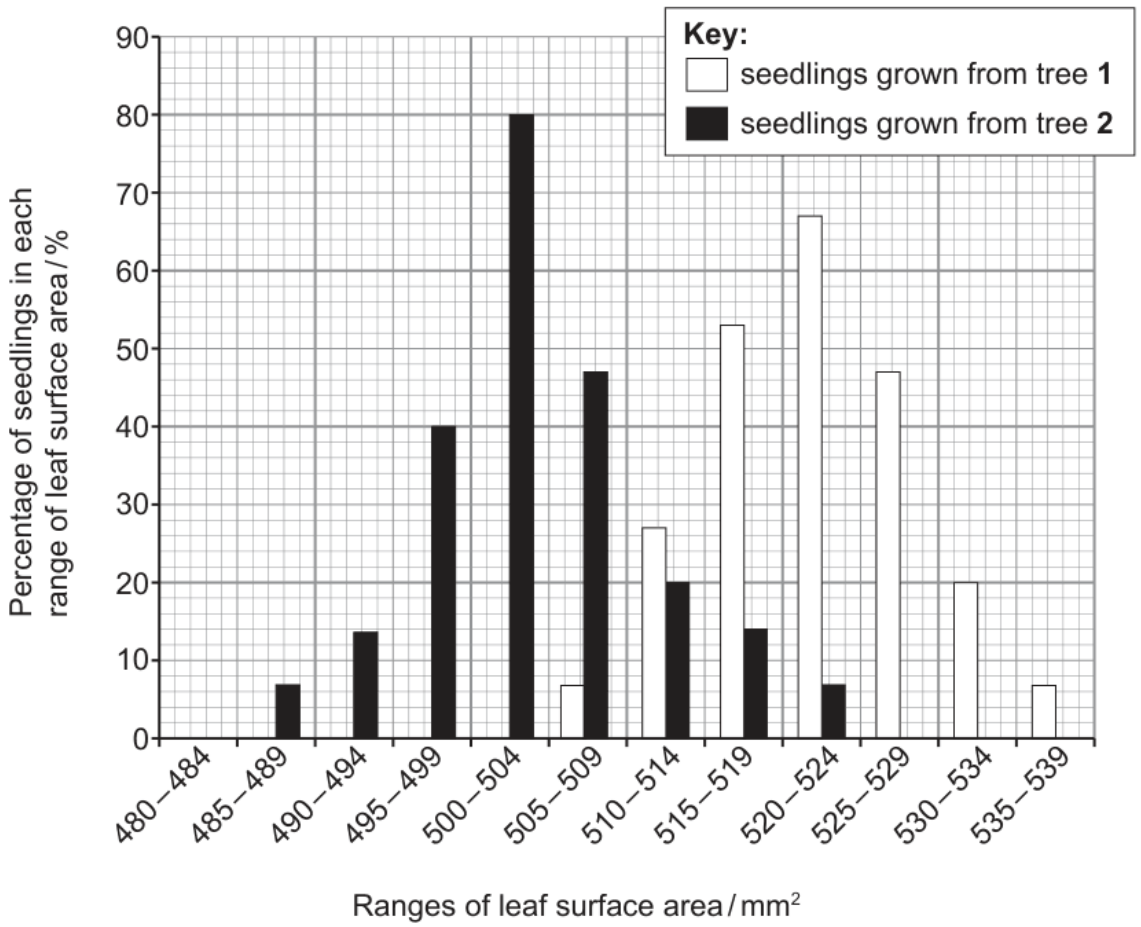
(iii) What evidence is there from the graph that the length of hybrid grains is not normally distributed? [1]

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Question 10 · A level Component 1 · June 2023 · Q2(d)(i) · 1 mark

The total leaf surface area (to the nearest mm^2) of the seedlings grown from each tree was grouped into 5 mm^2 ranges and the percentage of the seedlings in each leaf range calculated. A frequency histogram was plotted of the results. This is shown in **Graph 2.4**.

Graph 2.4



(d) (i) State the 5 mm^2 range of leaf surface area in which the modal value would be found for the seedlings grown from each tree. [1]

modal value tree **1** = ... – ..... mm^2

modal value tree **2** = ... – ..... mm^2

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Question 11 · A level Component 1 · June 2023 · Q2(d)(ii) · 2 marks

(ii) The mean leaf surface areas of the seedlings grown from each tree were:

Tree **1** 522 mm^2
Tree **2** 504 mm^2

With reference to the information provided give **two** ways in which the data from both trees show a normal distribution. [2]

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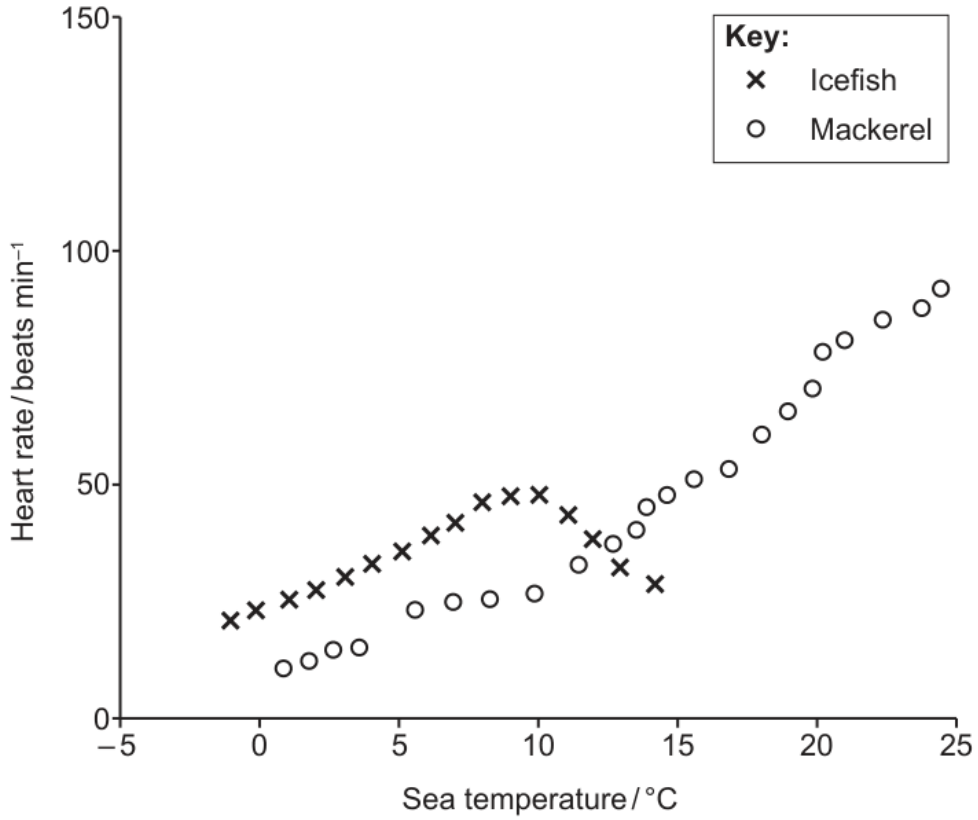
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(c) Scientists are concerned that global warming and increasing sea temperatures threaten the survival of icefish.

It is suggested that several species of fish acclimatise to increasing sea temperatures by increasing their heart rate.

Graph 2.4 shows heart rate in two species, icefish and mackerel, over a range of sea temperatures.

Graph 2.4



(i) It was concluded that icefish can adapt to increasing temperatures by increasing their heart rate. With reference to **Graph 2.4** evaluate this conclusion. [2]

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(c) An experiment was carried out to determine the time taken for a person to kick their leg in response to the following stimuli:

Stimulus **1**. direct stimulus of the patellar ligament by the tendon hammer

Stimulus **2**. hearing the tendon hammer hitting the table

The reaction times to both stimuli were collected for a group of ten people. Mean reaction times were calculated and used to calculate the standard deviations for each stimulus. A t-test value was calculated to assess whether any difference in the results was significant. The results are summarised in the table below.

	STIMULUS 1	**STIMULUS 2**
mean reaction time / s	0.026	0.236
number of measurements	$n_1 = 10$	$n_2 = 10$
standard deviation	0.006	0.108
t-test value	2.41	

(i) Explain why a t-test was used to assess the significance of the differences in the results and not a Chi-squared test. [2]

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(ii) The null hypothesis for this experiment was that *'there was no significant difference between the results for Stimulus **1** and Stimulus **2**'*. The degrees of freedom for this t-test were 18.

Use the t-test value and the information given in the table below to decide whether to accept or reject the null hypothesis at a suitable probability level. Explain your answer. [4]

degrees of freedom	probability			
	0.1	**0.05**	**0.01**	**0.005**
1	6.31	12.71	63.66	127.32
5	2.02	2.57	4.03	4.77
8	1.86	2.31	3.36	3.83
10	1.81	2.23	3.17	3.58
18	1.73	2.10	2.88	3.20
20	1.73	2.09	2.85	3.15

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An investigation was carried out into the number of snails with different numbers of bands at two sites on either side of an estuary. **Image 1.2** shows the position of the sample sites and information about the vegetation and soil at each site.

Image 1.2

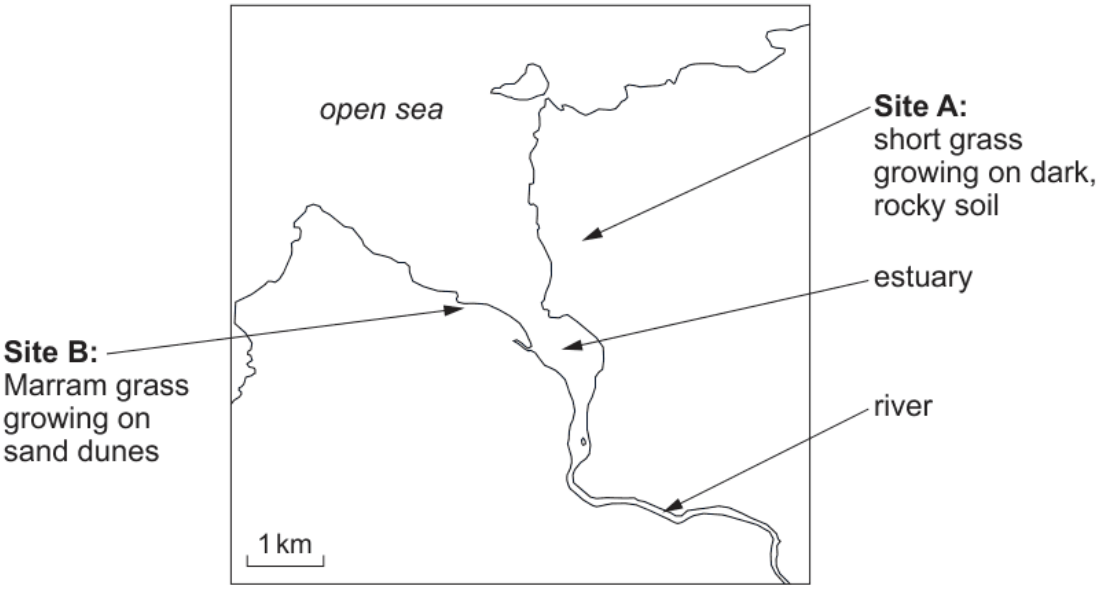
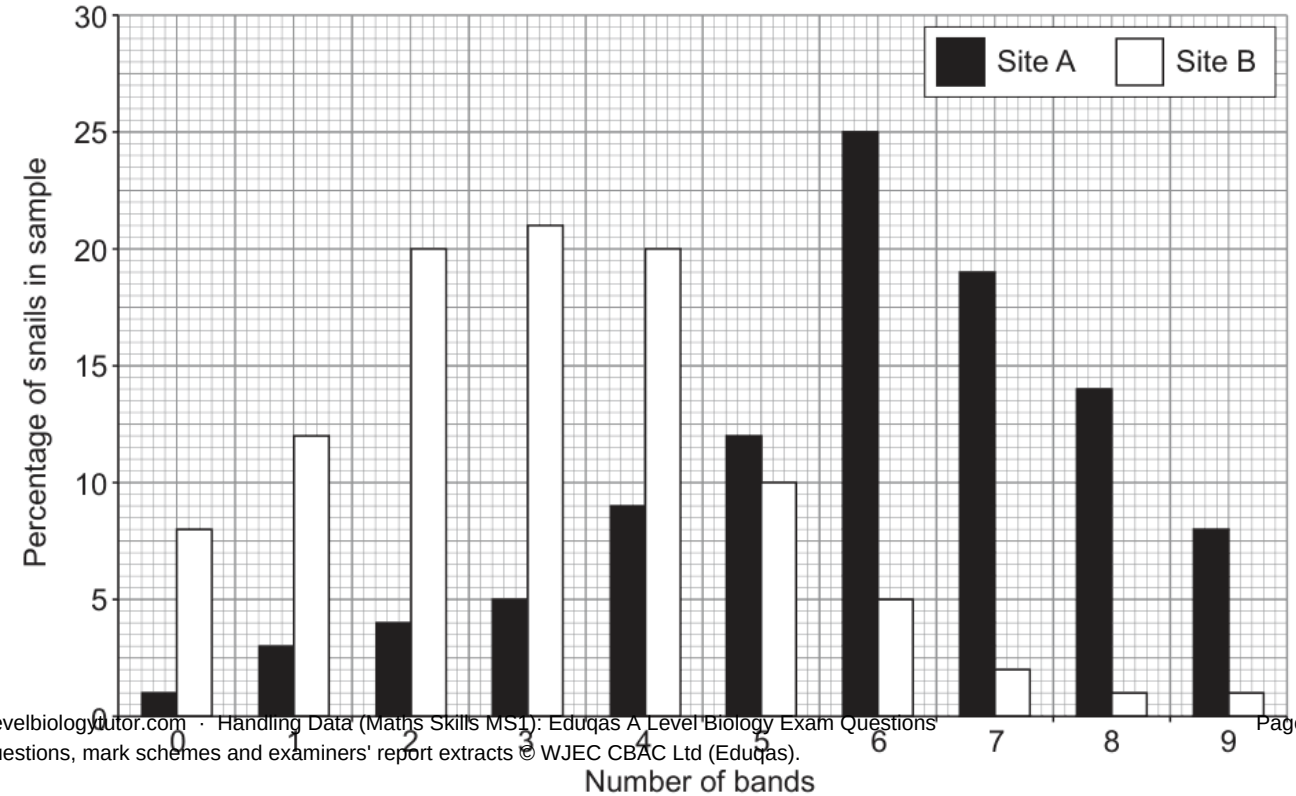


Image 1.3 shows the percentage of snails in each sample with different numbers of bands.

Image 1.3



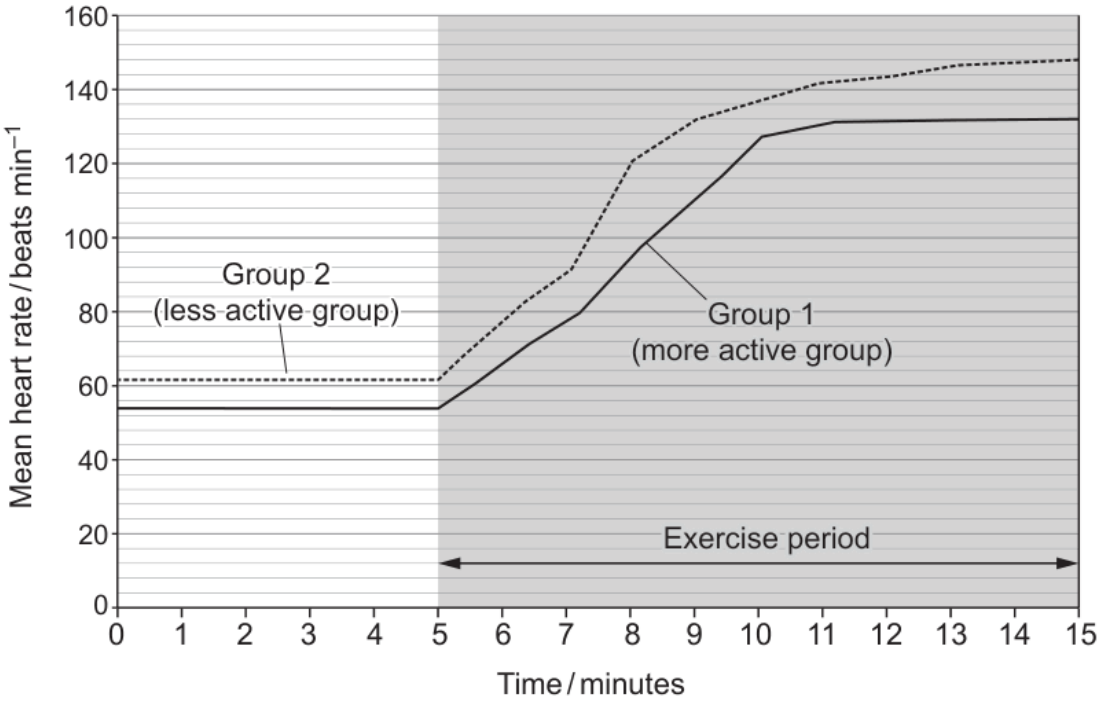
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(c) Scientists investigated the effect of exercise on heart rate in adult males with no history of smoking or cardiovascular disease. Two groups of 50 individuals, aged 18–21, were studied.

Group 1 (more active group) participated in aerobic activity for more than one hour at least 3 times a week.
Group 2 (less active group) participated in aerobic activity for less than one hour each week.

Participants were selected randomly from a larger number of volunteers. The heart rate of each participant was monitored while running on a treadmill for 10 minutes.
The mean heart rate for each group is shown in **Graph 5.2**.

Graph 5.2



(i) Data from group 1 showed a large standard deviation (SD).
Describe what is meant by the term 'standard deviation' and explain how the criteria used to place individuals in group 1 could contribute to a large SD value.

[2]

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Question 17 · AS Component 2 · June 2024 · Q5(c)(ii) · 1 mark

(ii) State **one** feature of the method that increases reliability of the data. [1]

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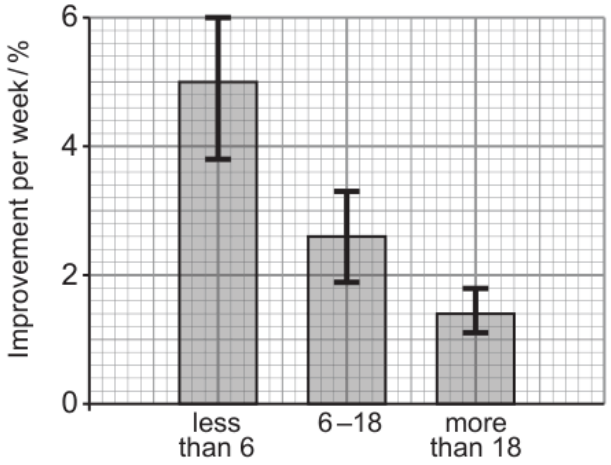
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Question 18 · A level Component 3 · June 2023 · Q9(b)(i) · 2 marks

(b) Studies have demonstrated that patients who receive therapy following brain injuries can recover some of the original function of their limbs over time.

Graph 9.2 shows the percentage rate of recovery of original limb function in patients with brain injury depending on how soon after the injury they received therapy.

Graph 9.2



(i) Use the data in **Graph 9.2** to conclude how the number of months after injury before therapy started affected the improvement. Explain how the range bars increase confidence in the conclusions made. [2]

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Question 19 · information from earlier in the question

Vitamin D can be ingested in foods such as milk and animal fats. UV light absorbed from the sun converts a molecule in the skin to vitamin D. However, melanin pigment in the skin reduces UV absorption.

Scientists investigated the effect of sunlight and vitamin D food supplements on bone growth in albino rats (rats with no melanin in their skin or fur).

- 36 young, male rats were kept in artificial 12-hour day and night cycles at 25°C in a laboratory for six weeks.
- The laboratory lights emitted no UV light.
- All the rats were fed adequate calcium but no vitamin D so that they **all** became vitamin D deficient.
- After six weeks, they were divided into three experimental groups, shown in **Table 8.6**
- The area of a growing region of the bone was measured in each of the three groups at the start and end of a ten-day period.

A summary of the results of the experiment is given in **Table 8.6**.

Table 8.6

Vitamin D Intake and UV Exposure of Experimental Groups			Mean area of new bone growth / mm^2 (+/– SD)	
Group	Diet	Environment	Day 0	Day 10
1	No vitamin D intake	placed outside in sunshine for 1 hour each day	13.48 (±0.35)	20.94 (±0.17)
2	Vitamin D supplement	remained in the laboratory	14.75 (±0.49)	19.78 (± 0.5)
3	No vitamin D intake	remained in the laboratory	15.56 (±2.73)	16.34 (±3.16)

Question 19 · A level Component 3 · June 2022 · Q8(c)(iii) · 3 marks

(iii) Describe the conclusions that can be made from the data in **Table 8.6** and explain whether the results can be considered significant. [3]

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Question 20 · information from earlier in the question

(b) The rate of movement of solutes through the phloem can be measured using radioactive carbon dioxide ($^{14}CO_2$) and aphids. Scientists set up the equipment as shown in **image 5.1**. The fluid from the stylets was tested every minute for the presence of radioactive sucrose.

Image 5.1

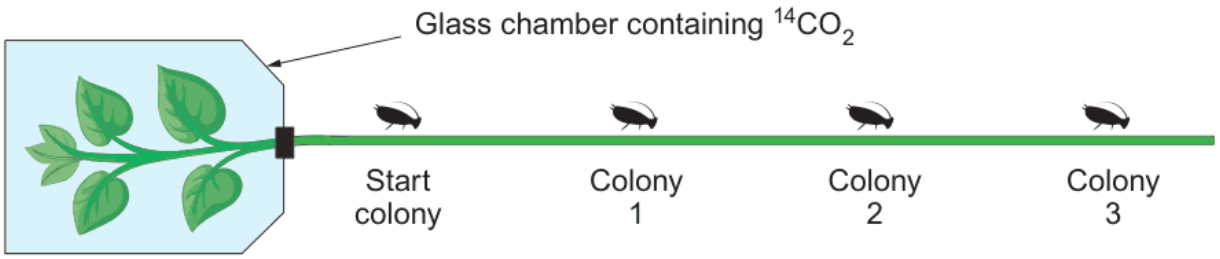


Table 5.2 shows the results of one experiment using a tomato plant.

Table 5.2

	Colony 1	Colony 2	Colony 3
Distance from start colony / mm	200	400	600
Time for radiation to be detected at colony / minutes	52	108	164

Question 20 · A level Component 3 · Autumn 2020 · Q5(b)(ii) · 2 marks

(ii) Calculate the percentage error of the equipment over the distance from the start colony to colony 2. [2]

Percentage error = ...

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Mark schemes

Question 1 · A level Component 3 · June 2019 · Q6(b)(i) · 2 marks

	(b)	(i)	0.1 (: 1) 2 marks **Award 1 mark for** 40 200 / 377 000 0.11 / 0.1066....	2 2		2

Question 2 · A level Component 2 · June 2025 · Q4(c)(i) · 3 marks

(c)	(i)	290g (3 marks) 2.9×10^2 (3 marks) **If incorrect award 2 marks for** 294 (not to 2sf) 420 – 126 **If incorrect award 1 mark for** 30% of 420g = 126g or 130 70/100 x 420	3	3	3

Question 3 · AS Component 1 · June 2018 · Q3(a)(ii) · 3 marks

(ii)	15.5/100 x 50 000 000 000 = 1 mark = 7 750 000 000 / 7.75×10^9 = 2 marks = 7.8×10^9 = 3 marks	3	3	3	

Question 4 · AS Component 2 · June 2018 · Q2(b) · 3 marks

(b)	17 differences/3.95×10^{-7} = 43037974.68 1 mark = 43 000 000 2 marks = 4.3×10^7 years 3 marks	3	3 3	3

Question 5 · A level Component 2 · June 2024 · Q4(b)(i) · 2 marks

	(b)	(i)		0.847 = 2 marks 0.846875 0r 0.85 = 1 mark	2	2	2

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Question 6 · AS Component 2 · June 2025 · Q1(b)(i) · 2 marks

(b)	(i)	16.8 (2 marks) 16.7 / 16.75 / 17 (1 mark)	2	2	2

Question 7 · A level Component 2 · June 2018 · Q4(b)(i) · 1 mark

(b)	(i)	100		1	1

Question 8 · A level Component 2 · June 2018 · Q4(b)(ii) · 2 marks

(ii)	mode = 6.45 (1) It is in the {most common class/6.40-6.49 class}/it has the greatest number at 25/it is the highest bar/the median is the middle value which would be the 50th grain which is in the 6.50-6.59 class (1)	2	2	

Question 9 · A level Component 2 · June 2018 · Q4(b)(iii) · 1 mark

(iii)	Mean, Mode and median are not the same/ correct reference to shape not being tallest in the middle/not bell shaped/not symmetrical/skewed to left	1	1	

Question 10 · A level Component 1 · June 2023 · Q2(d)(i) · 1 mark

(d)	(i)		tree 1 = 520-524 + tree 2 = 500-504 (1)	1	1	1		

Question 11 · A level Component 1 · June 2023 · Q2(d)(ii) · 2 marks

(ii)		mode and mean in the same range (1) {even distribution of values from/ symmetrical around} the mean/ bell shaped curve (1)	2	2	2	2

Question 12 · AS Component 2 · June 2023 · Q2(c)(i) · 2 marks

(c)	(i)	(conclusion is correct because) there is an increase in heart rate with temperature up to 10°C/there is a positive correlation between HR and temp up to 10°C/ owtte (1) (not completely correct as) there is a limit to the increase/increase in heart rate only to 10°C/HR decreases at temperatures above 10°C/no data for temperatures higher than 15°C/ owtte (1)	2	2	2

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Question 13 · A level Component 3 · June 2018 · Q5(c)(i) · 2 marks

(c)	(i)	**Any two (x1) from:** testing (significance of) differences between {means/ sets of {continuous / normally distributed/ interval }}data(1) Chi squared used to test significance of differences in {discontinuous / nominal} data /can calculate expected value (1) T test there are no expected values/ chi squared has expected values (1)	2	2 2

Question 14 · A level Component 3 · June 2018 · Q5(c)(ii) · 4 marks

(ii)	A. Critical value is 2.10 (1) NOT circled in table alone B. because t value is greater than critical value (at p=0.05)(1) C. reject null hypothesis (1) D. {results/ means } are significantly different(1) ECF MP b,c,d if incorrect critical value chosen		4	4 4

Question 15 · A level Component 2 · June 2022 · Q1(b)(ii) · 1 mark

(ii)	No {statistical/ significant} difference between the observed and expected (results/ bands) (1)		1	1 1

Question 16 · AS Component 2 · June 2024 · Q5(c)(i) · 2 marks

(c)	(i)	A measure of how the majority of the data / specified % is spread from the mean / the variation of the data from the mean. (1) Variation in the {quantity / type / intensity / history of participation in} aerobic activity / fitness levels / owtte} within the group (1)	1	1	2	1

Question 17 · AS Component 2 · June 2024 · Q5(c)(ii) · 1 mark

(ii)	**Any one (x1) from**; Individuals were chosen randomly (reduces bias) (1) Large numbers of individuals in each group (more representative) / large number of repeats (to calculate mean) (1) Reduce (confounding) variables / same {gender / age group} / no history of {smoking / CVD}) (1)	1	1	1

Question 18 · A level Component 3 · June 2023 · Q9(b)(i) · 2 marks

(b)	(i)	The sooner therapy is started after the injury the faster the rate of recovery (1) Range bars do not overlap suggesting high confidence (1)	2	2	1	

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Question 19 · A level Component 3 · June 2022 · Q8(c)(iii) · 3 marks

(iii)		**Any three (×1) from** • Both {UV/sunlight/1} and {Vitamin D supplements/2} increase {area of growing region/ bone growth}/ all three increase bone growth (1) • UV causes a greater increase than Vitamin D supplements/use of data (1) • For group 1 and group 2, SD at 0 and 10 days do not overlap so difference (at 0 and 10 days) is significant. (1) • No significant difference in the data for group 3/ SD causes sets of data to overlap (1)		3	3	1

Question 20 · A level Component 3 · Autumn 2020 · Q5(b)(ii) · 2 marks

(ii)	± 0.5 % = 2 marks (error at both ends of distance) Accept= ±0.25 % = 2 marks (error at one end of distance) If answer incorrect allow 1 or 2 / 400 x 100 = 1 mark	2	2	2	2

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