Algebra (Maths Skills MS2): 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 · AS Component 1 · June 2025 · Q2(b)(iii) · 1 mark

(iii) Fick's Law states that:

$$\text{Rate of diffusion} = \frac{\text{surface area of exchange surface} \times \text{difference in concentration}}{\text{thickness of exchange surface}}$$

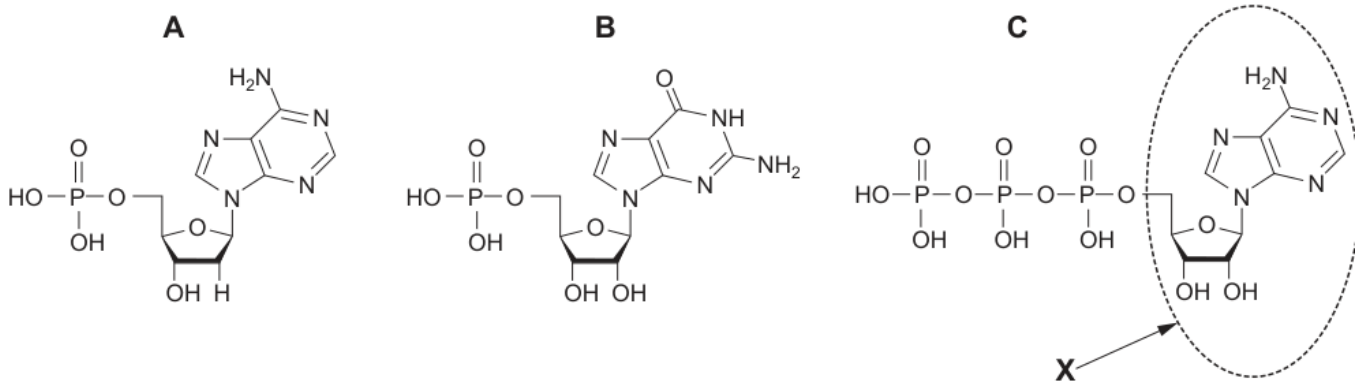
State how an increase in the thickness of the cell membrane would affect the rate of diffusion. [1]

.....

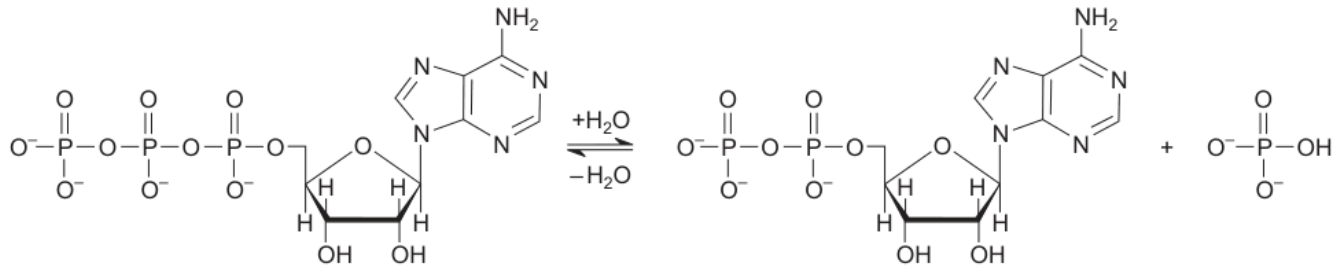
.....

Question 2 · information from earlier in the question

1. Nucleic acids and related molecules are found in all forms of life on Earth. The diagrams below show the structural formulae of three molecules called nucleotides.



(b) Molecule **C** is mainly synthesised in two organelles found in eukaryotic cells as shown in the equation below.



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Question 2 · AS Component 1 · June 2019 · Q1(b)(iii) · 1 mark

(iii) The removal of all three phosphate groups from molecule **C** one after the other would release a total of 75.4 $kJ\,mol^{-1}$ of energy. Assuming the removal of the first and second phosphate groups yield the same quantity of energy, calculate the available energy stored in the bond between the third phosphate and the pentose sugar. [1]

Available energy = ... $kJ\,mol^{-1}$

Question 3 · AS Component 1 · June 2018 · Q4(d)(i) · 3 marks

(d) (i) Fick's Law states that the rate of diffusion of a substance is affected by the surface area, the concentration gradient and the distance the substance travels. His law can be used to calculate the time taken for a substance to diffuse using the formula below:

$$\text{time taken to diffuse} = \text{distance}^2 \times \frac{1}{\text{diffusion coefficient}}$$

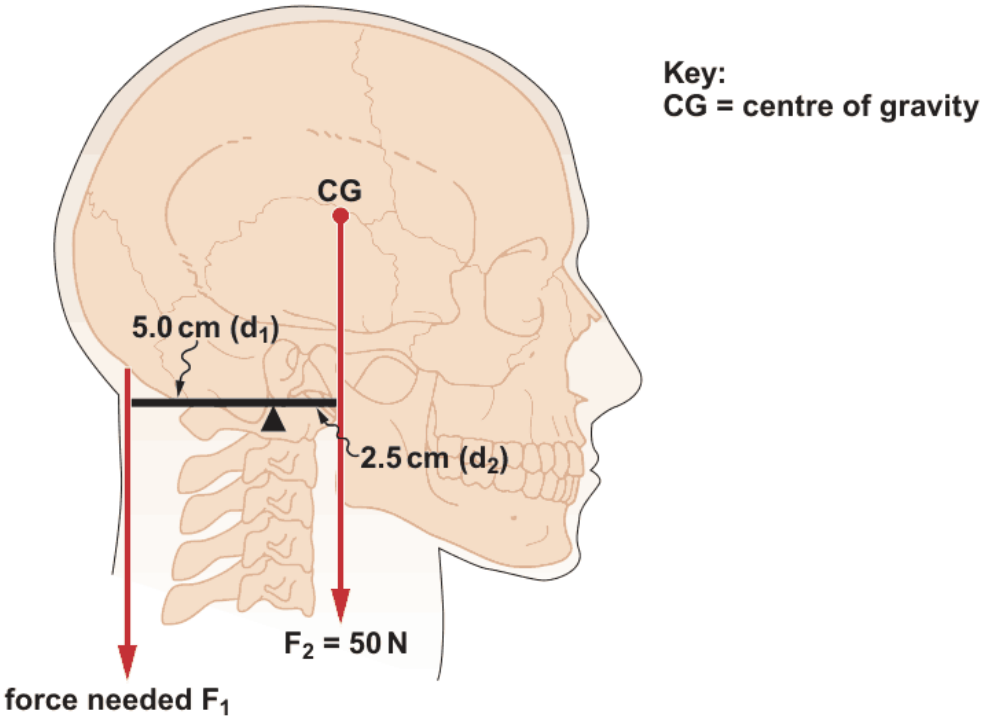
Use this formula to calculate the distance (in μm) between a xylem vessel and a phloem sieve tube given that: [3]

time taken to diffuse = 5s
diffusion coefficient (at 20°C) = $5 \times 10^4\ \mu m^2\ s^{-1}$

distance = ... μm

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Even when the head is held erect, its centre of gravity is not directly over the principal point of support (the atlanto-occipital joint). The muscles at the back of the neck exert a force to keep the head erect. That is why your head falls forward when you fall asleep.



(iv) Using the formula below, calculate the force needed to hold the head erect in the position shown [2]

$F_1 \times d_1 = F_2 \times d_2$

Force = ... N

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Question 5 · A level Component 1 · June 2025 · Q6(b)(ii) · 3 marks

(ii) Under optimal conditions, African elephants have a generation time of 22 years.
This is the time taken for a population to double in number.
Generation time (G) is calculated using the formula:

$$\text{Generation time (G)} = \frac{t}{3.3 \times \log_{10}\left(\frac{N_{final}}{N_{start}}\right)}$$

where:

t = time
N_{final} = the final number of individuals in the population
N_{start} = the initial number of individuals in the population

Use the formula above to estimate the time it would take for a starting population of 10 elephants to reach a population of 1000.
Give your answer to two significant figures. [3]

Time taken to reach final population of 1000 = ... years

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Question 6 · AS Component 2 · June 2024 · Q5(c)(iii) · 2 marks

In addition to the mean maximum heart rate, the following measurements were taken:

- The stroke volume (mean maximum volume of blood leaving the left ventricle per beat).
- The cardiac output (mean maximum volume of blood leaving the left ventricle per minute).

The measurements for each group are shown in **Table 5.3**.

Table 5.3

Group	Mean maximum heart rate / beats min^{-1}	Mean stroke volume (maximum volume of blood leaving the left ventricle per beat) / dm^3	Mean cardiac output (maximum volume of blood leaving the left ventricle per minute) / $dm^3 min^{-1}$
1 (more active)	135	.....	24.3
2 (less active)	150	0.13	19.5

(iii) Calculate the mean stroke volume for group 1.
Write your answer in **Table 5.3**. [2]

Space for working

Question 7 · AS Component 2 · June 2024 · Q4(b)(i) · 2 marks

(b) (i) One way to measure the extent of stomatal opening is to calculate the aspect ratio.

$$\text{Aspect ratio (AR)} = \frac{\text{length of stomatal opening (L)}}{\text{width of stomatal opening(W)}}$$

The aspect ratio of an open stoma was found to be 1.75 : 1.
The length (L) was 63 µm.

Calculate the width of the stoma (W). [2]

Width of stoma = ... µm

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Question 8 · AS Component 2 · June 2024 · Q4(b)(ii) · 2 marks

(ii) A student produced a scale drawing of the stoma and guard cells described in (b)(i) and drew a line to represent the length of the stoma (L). This line measured 31.5 mm.

Calculate the magnification of the drawing. [2]

Magnification = × .....

Question 9 · A level Component 1 · June 2023 · Q3(d)(i) · 3 marks

(d) **Table 3.3** shows the blood glucose ranges for a non-diabetic, a pre-diabetic (high risk of developing diabetes) and a diabetic, 12 hours before eating and two hours after eating. The blood glucose concentrations are recorded as mg per decilitre (mg/dL).

Table 3.3

Time of glucose test	Blood glucose concentration / mg/dL		
	Non-diabetic	Pre-diabetic	Diabetic
12 hours before eating	< 100	100 to 125	≥ 126
two hours after eating	< 140	140 to 199	≥ 200

(i) Following 12 hours without eating, a blood test was carried out on an adult with a total blood volume of 4.8 dm^3 and total blood glucose mass of 4.6 g. Use the formula below to calculate the blood glucose concentration of this patient. **Give your answer to the nearest mg/dL.** [3]

$$\text{blood glucose concentration / mg/dL} = \frac{\text{mass of glucose (mg)}}{18} \times \frac{\text{volume of blood } (dm^3)}{10}$$

Blood glucose concentration = ... mg/dL

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Question 10 · A level Component 3 · June 2024 · Q4(c) · 2 marks

(c) In a dog, the nerve impulse takes 6 milliseconds to travel 0.3 m.
Calculate the rate of transmission of the nerve impulse.
Give your answer in metres per second. [2]

Rate = ... ms^{-1}

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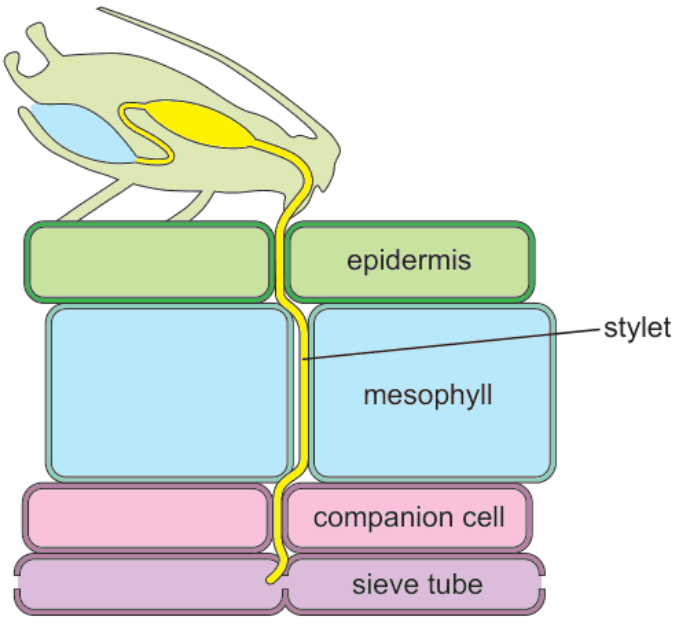
(b) An experiment to investigate the rate of transport of organic molecules in the phloem of tomato plants used aphids to sample phloem contents.

Aphids are insects that insert a tubular mouthpart called a stylet into the phloem, through which it feeds on phloem solution.

Plants may respond to phloem damage by blocking some pores in the sieve plates and restricting flow. Aphids can suppress this response.

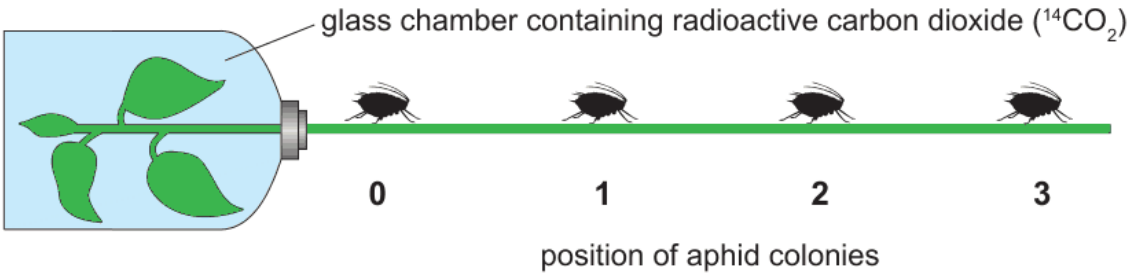
Image 3.2 shows a diagram of an aphid feeding on phloem.

Image 3.2



The experiment was set up as shown in **Image 3.3**

Image 3.3



- Aphid colonies were placed at 25 cm intervals from a start point (0) near the leaves on a branch and allowed to feed.
- The aphids were detached from their stylets which were left in place penetrating the phloem.
- Leaves were covered by a sealed glass chamber and provided with $^{14}CO_2$ containing the radioisotope ^{14}C. Organic compounds became radioactive as ^{14}C was incorporated during and after photosynthesis.
- Phloem solution, collected from the stylet at regular intervals, was tested for radioactivity. The time taken for radioactivity to reach each colony position was recorded.

Table 3.4 shows the time taken for the radioactivity to travel between positions on the branch.

Table 3.4

Direction of movement of radioactivity	Time taken for radioactivity to travel

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Question 12 · A level Component 2 · June 2024 · Q6(c)(i) · 2 marks

(c) (i) To predict the increase in the number of cancer cells over time, the following equation can be used:

$$N_t = N_c e^{rt}$$

Where:

N_t = number of cancer cells after a given time

N_c = number of cancer cells at the start

e = 2.72 (base of natural log)

r = growth rate

t = time period in hours over which r applies

A group of 150 cancer cells were grown on nutrient gel in a Petri dish.

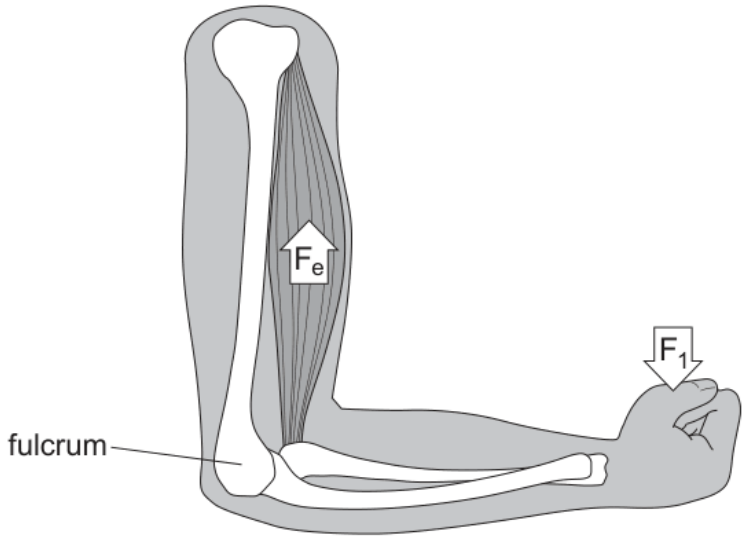
Use the equation above to calculate the predicted number of cancer cells that would be present after 24 hours if the growth rate is 0.05 (5%). [2]

Predicted number of cancer cells = ...

Question 13 · information from earlier in the question

(c) Studies have shown that load bearing exercises give the greatest benefit in preventing osteoporosis. Repetitively lifting an object by flexing the elbow as shown in **Image 8.4**, is an effective load bearing exercise that can easily be performed at home.

Image 8.4



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Question 13 · A level Component 3 · June 2023 · Q8(c)(ii) · 2 marks

(ii) In **Image 8.4** the elbow to hand distance is 36 cm and elbow to biceps is 4 cm. Use this information and the formula below to calculate the force required to lift a weight with a mass of 1.2 kg. **Give your answer in Newtons.** [2]

$$F_e = F_1 \times \frac{D1}{D2}$$

Where:

F_e = force exerted by the effort

F_1 = mass (kg) × 9.8 N

D1 = distance from load to fulcrum

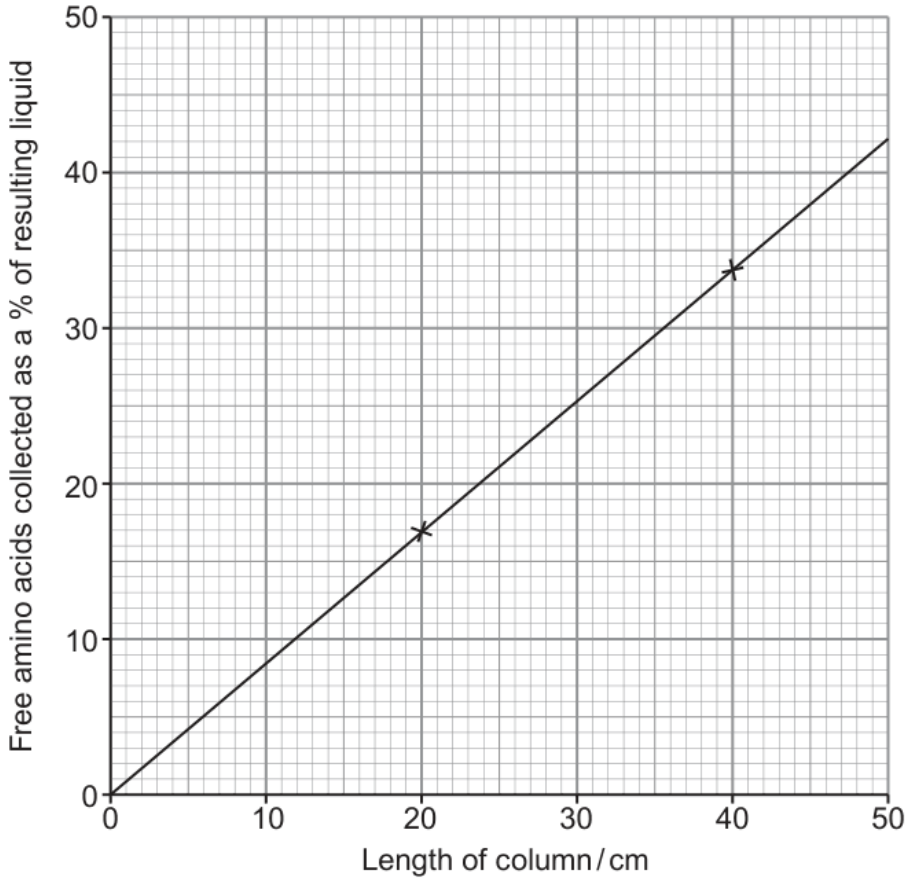
D2 = distance from effort to fulcrum

Force = ... Newtons

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The initial column used was 20 cm in length. When the scientists used a 40 cm long column containing endopeptidase and exopeptidase the resulting liquid contained 34% free amino acids.
They plotted the results on **Graph 3.3**.

Graph 3.3



The scientists found the line on the graph to follow the equation

$$y = mx + c$$

The gradient of the line in this graph was found to be 0.85.

(iii) Using the equation and the information provided, estimate the concentration of the free amino acids collected as a percentage of the resulting liquid when the column is 70 cm long. [2]

Concentration of the free amino acids = ... %

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Question 15 · A level Component 2 · Autumn 2021 · Q4(b)(ii)I · 2 marks

(ii) In Europe, the proportion of the populations of both women and men who are rhesus negative is 0.16. Use the Hardy-Weinberg equations to answer the questions that follow.

$p + q = 1$

$p^2 + 2pq + q^2 = 1$

I. Determine the proportion of the population in Europe who are homozygous dominant. [2]

Proportion of population who are homozygous dominant = ...

Question 16 · A level Component 2 · Autumn 2021 · Q4(b)(ii)II · 1 mark

II. Determine the proportion of the population in Europe who are heterozygous for RhD. [1]

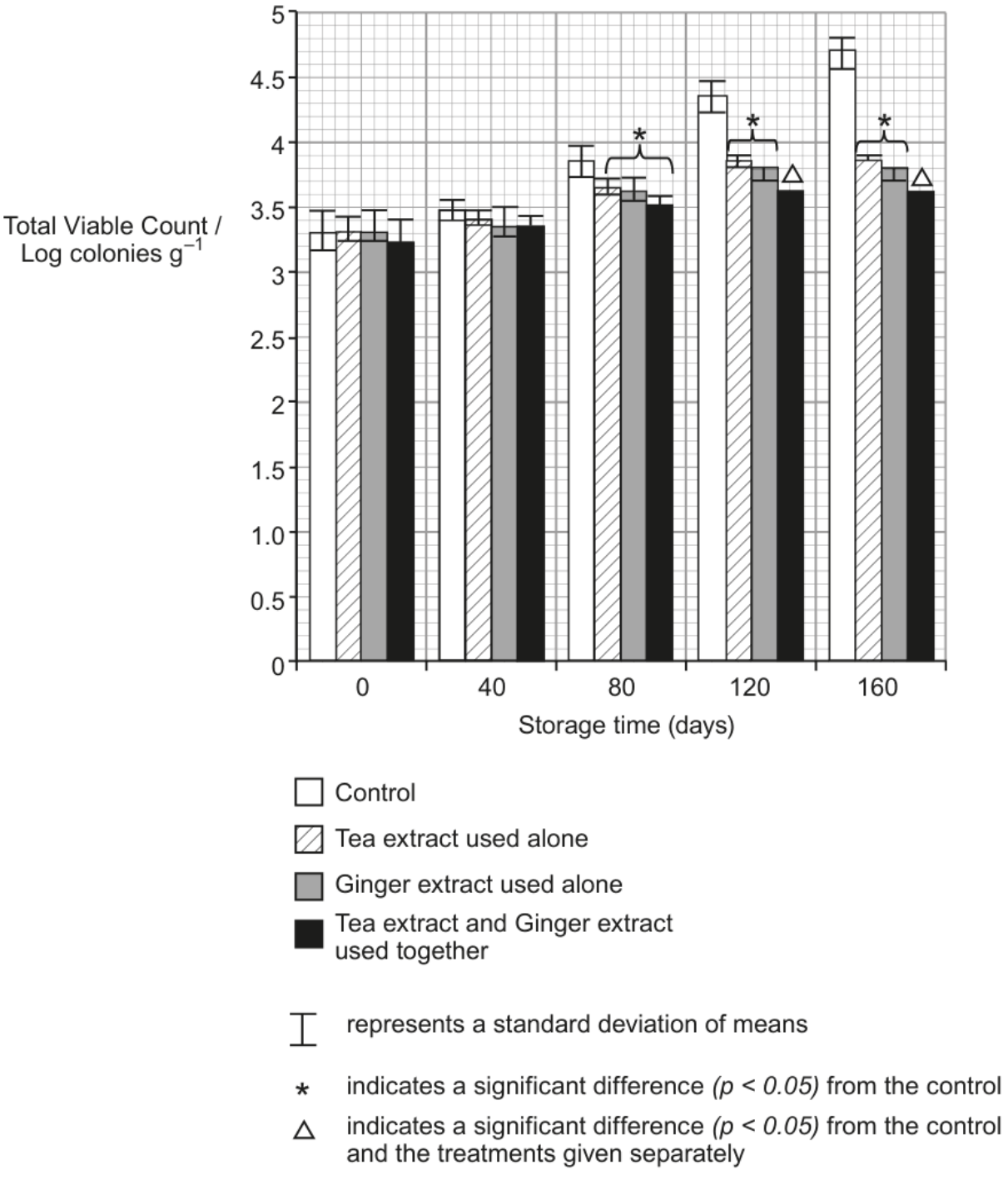
Proportion of population who are heterozygous for RhD = ...

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5. An experiment was carried out to determine the effects of natural preservatives on shrimp paste, a common additive in Chinese food. These were tea extract and ginger extract. They were tested separately and then in combination.

Shrimp paste samples were stored at 25 °C for 160 days and samples were taken at regular intervals. Total viable counts (TVC) were determined on agar plates by counting the number of colonies after incubation at 35 °C for 48 hours. Three replicates were made for each sample.

The mean results were plotted as logarithms of the number of colonies (colonies g^{-1}). The standard deviations for each sample are also shown.



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Question 17 · A level Component 1 · June 2017 · Q5(b) · 2 marks

(b) Explain why the numbers of colonies were converted to logarithms before they were plotted on the graph. [2]

.....

.....

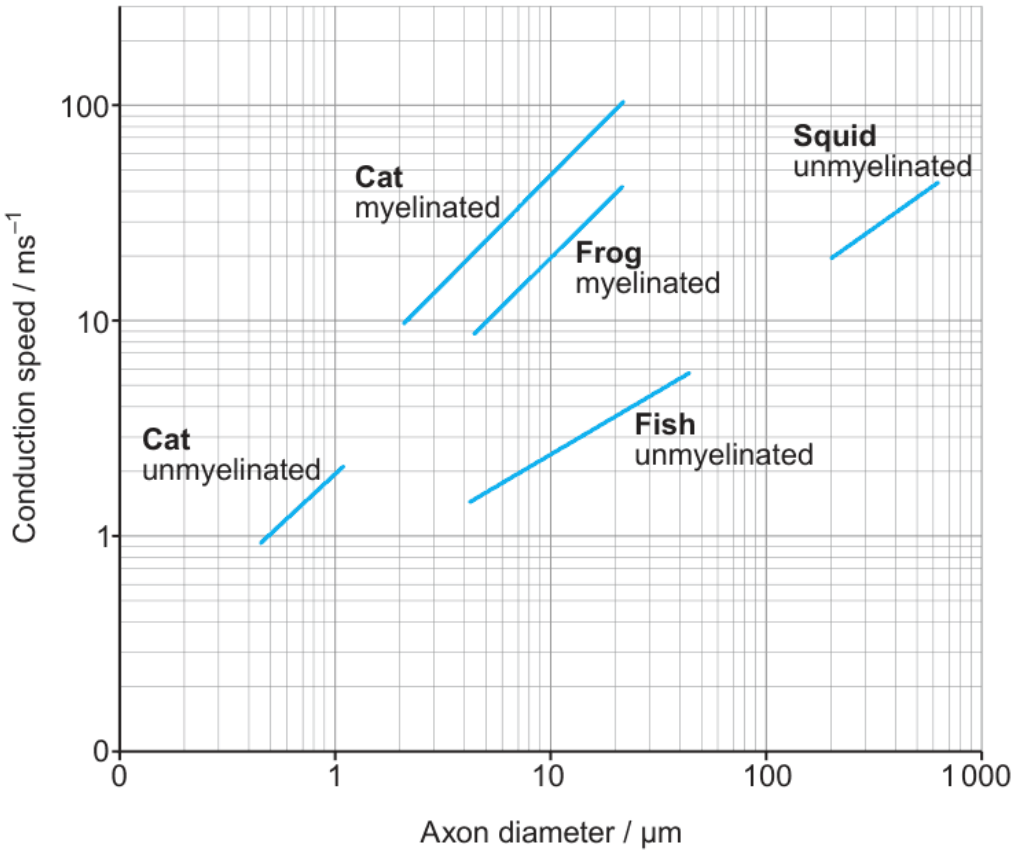
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Question 18 · A level Component 3 · Autumn 2021 · Q4(a)(i) · 1 mark

4. **Image 4.1** shows the speed of conduction of nerve impulses in myelinated and unmyelinated axons of different diameters in a range of organisms.

Image 4.1



(a) (i) Suggest why log scales are used on the axes of the graph. [1]

.....

.....

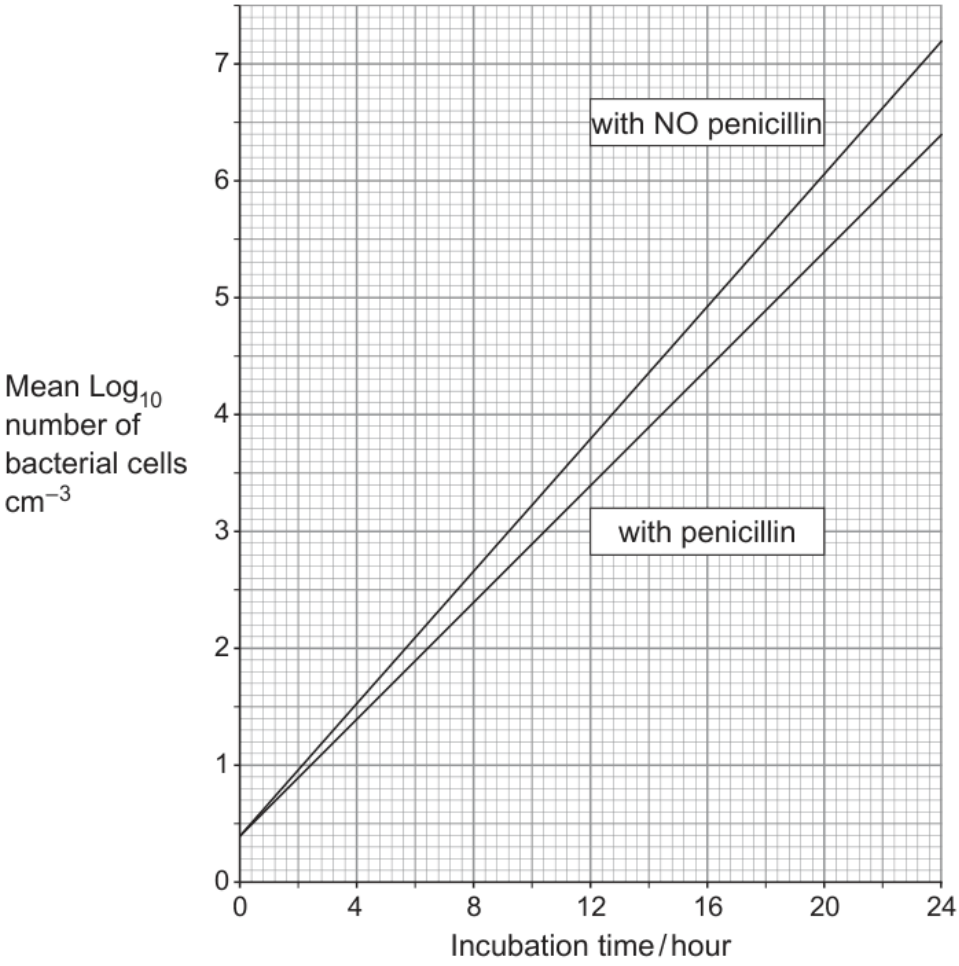
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(e) Scientists investigated the effect of penicillin on the number of *C.diphtheria* cells growing in a nutrient broth in a laboratory.

A culture of *C. diphtheria* was incubated at 37°C in nutrient broth containing penicillin. A second culture was incubated at the same temperature in the same volume of nutrient broth containing no penicillin. Samples were taken from each culture at hourly intervals and the number of bacteria counted.

The mean $\log_{10}$ numbers of bacterial cells were plotted on a graph as shown in **graph 8.4**.

Graph 8.4



After 24 hours incubation with **no** penicillin, a $\log_{10}$ value of 7.2 on the graph indicated that the actual number of bacteria was 15 848 932 cm^{-3}

(i) Calculate the **actual** number of bacteria after 24 hours incubation with penicillin.

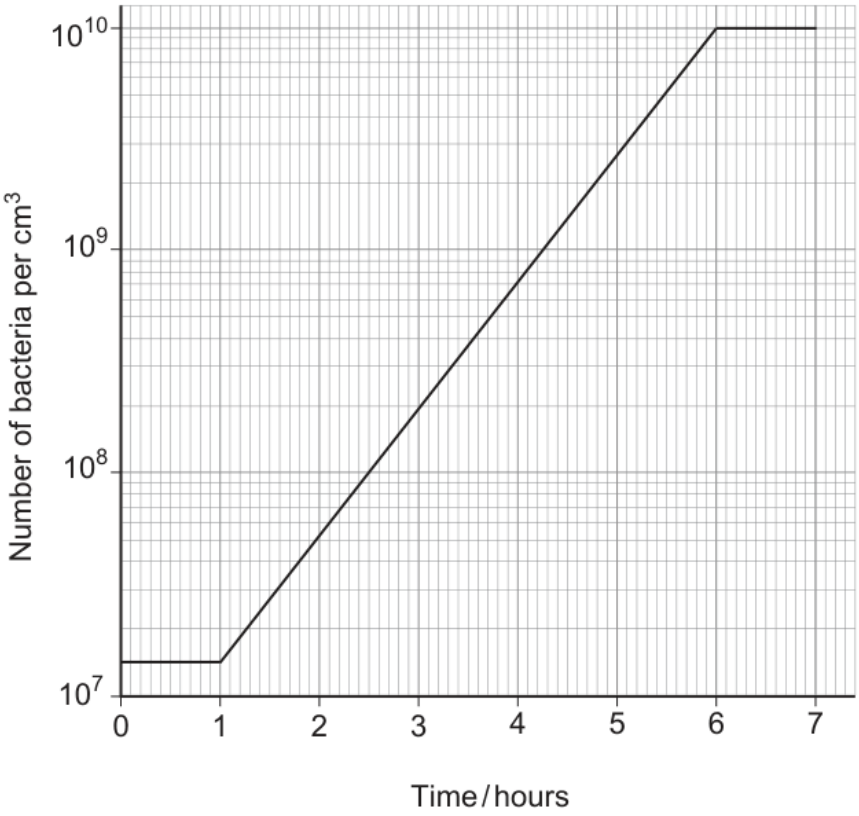
[2]

Actual number of bacteria = cm^{-3}

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(c) A different method of assessing the growth of bacterial populations is to determine the number of generations of bacteria produced in a given time period. **Image 1.2** shows the number of bacteria per cm^3 present in a culture over a seven hour period.

Image 1.2



(i) Use the graph in **Image 1.2** and the formula given below to calculate the number of generations produced per hour between **2.5** hours and **6** hours. **Express your answer to one decimal place.** [3]

$$\text{Number of generations per hour} = \frac{\log_{10}[X_t] - \log_{10}[X_0]}{0.301 \times t}$$

Where:

X_t = number of bacteria per cm^3 at the end of the growth period
X_0 = number of bacteria per cm^3 at the start of the growth period
t = length of growth period in hours

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Mark schemes

Question 1 · AS Component 1 · June 2025 · Q2(b)(iii) · 1 mark

		(iii)		(rate of diffusion would) decrease	1		1	1

Question 2 · AS Component 1 · June 2019 · Q1(b)(iii) · 1 mark

	(iii)	14.2 ($kJmol^{-1}$)	1		1 1	

Question 3 · AS Component 1 · June 2018 · Q4(d)(i) · 3 marks

(d)	(i)	$5s = distance^2 \times 1/5 \times 10^4$ $distance^2 = 250000$ / $distance^2 = 5 \times 5 \times 10^4$ = 1 mark (rearrangement of equation) distance = $\sqrt{}$ 250000 or $\sqrt{}25 \times 10^4$ = 2 marks = 500µm = 3 marks	3	3 3	

Question 4 · A level Component 3 · June 2018 · Q9(d)(iv) · 2 marks

		(iv)	F = 25N = 2 marks If incorrect allow 1 mark for sight of $\frac{2.5 \times 50}{5}$ $F_1 \times 5 = 50 \times 2.5$	2	2 2	

Question 5 · A level Component 1 · June 2025 · Q6(b)(ii) · 3 marks

(ii)	150 (3) **If incorrect award 2 marks for:** 145 / 145.2 (2) t = 22 x 6.6 t = 22 x (3.3 x 2) **If incorrect award 1 mark for:** t = 22 x (3.3 x log(1000/10)) (1) 22 = t / (3.3 x (log(1000/10)) (1)	3	3	3

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Question 6 · AS Component 2 · June 2024 · Q5(c)(iii) · 2 marks

(iii)	0.18 (dm^3) (2) $\frac{24.3}{135}$ (1)	2 2	2

Question 7 · AS Component 2 · June 2024 · Q4(b)(i) · 2 marks

	(b) (i)		36µm (2); **If incorrect award 1 mark for** $\frac{63}{1.75}$	2		2 2

Question 8 · AS Component 2 · June 2024 · Q4(b)(ii) · 2 marks

(ii)	×500 (2) **If incorrect award 1 mark for either of** $\frac{31.5}{6.3 \times 10^{-2}}$ (1); (calculation) 6.3×10^{-2} /0.063 (1); (conversion of units)	2 2 2 2

Question 9 · A level Component 1 · June 2023 · Q3(d)(i) · 3 marks

(d)	(i)	123 (3) If incorrect: **Award 2 marks for**: 122.66… / 122.7/ 122.67 (2) **Award 1 mark for**: 122.6 (1) 0.123 (1) (has not converted g to mg) (4600 / 18) x (4.8/10) (4.6 or 46 or 460 / 18) x (4.8 / 10) (1)		3		3	3	

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Question 10 · A level Component 3 · June 2024 · Q4(c) · 2 marks

	(c)	$50ms^{-1}$ [2] If incorrect award 1 mark for either 0.3 / 0.006 [1] 0.05 or 0.3 / 6 [1] 5 or 0.5 [1] incorrect conversion		2		2		2		

Question 11 · AS Component 2 · June 2023 · Q3(b)(i) · 3 marks

(b)	(i)		18.3; (3) 18.29/18.292/18.293 (2) 75 ÷ 4.1; (1) OR 18.5; (3) 18.46/18.458; (2) 55.36 ÷ 3; (1)	3	3	3		

Question 12 · A level Component 2 · June 2024 · Q6(c)(i) · 2 marks

(c)	(i)		Award two marks for 498 / 499 If incorrect award one mark for any one of: 498.45 / 498.39/ 498.40 0.05 × 24 = 1.2 2.72 ×1.2 = 3.320 150 × 3.323 150 x $2.72^{0.05 \times 24}$ 498.0175 / 498.02 (done on calculator with e^x)		2		2	2

Question 13 · A level Component 3 · June 2023 · Q8(c)(ii) · 2 marks

(ii)	105.8(4) or 106 Newtons 2 marks If incorrect award one mark for: Substitution into equation = 1 mark Sight of 11.76 = 1 mark		2		2	**2**				

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Question 14 · A level Component 3 · June 2022 · Q3(c)(iii) · 2 marks

(iii)	59.5 or 60 = 2 marks Award 1 mark for substitution Y= 0.85 x 70 +0	2	2	2

Question 15 · A level Component 2 · Autumn 2021 · Q4(b)(ii)I · 2 marks

	(ii)	I	homozygous for D = p^2 = 0.36 (2) If incorrect award 1 mark for q^2 = 0.16 so q = $\sqrt{0.16}$ = 0.4 p = 1 – q = 1 - 0.4 = 0.6 Accept proportion only	2	2	2

Question 16 · A level Component 2 · Autumn 2021 · Q4(b)(ii)II · 1 mark

		II	2pq = 2 x 0.6 x 0.4 = 0.48 (1) Ecf If answer given as a % accept if (ii) I given as a %	1	1	1

Question 17 · A level Component 1 · June 2017 · Q5(b) · 2 marks

(b)	**Any 2 (x1) from** Large numbers/ large range of numbers (1) which would be difficult to plot (1) Log scale increases by a factor of 10 for each number/or correct description (1)	2	2	2

Question 18 · A level Component 3 · Autumn 2021 · Q4(a)(i) · 1 mark

4	(a)	(i)	Makes it easy to compare values that cover a large range/ order of magnitude differences in values	1	1	1

Question 19 · A level Component 3 · Autumn 2020 · Q8(e)(i) · 2 marks

(e)	(i)	Antilog of 6.4 = 2,511,886 = 2 marks Reject decimal place/s 1 mark only (6.4) Reading from graph (1)	2	2	2

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Question 20 · A level Component 1 · June 2022 · Q1(c)(i) · 3 marks

(c)	(i)		1.9 = 3 marks For 2 marks: 1.8984337 (or any correct rounding) For 1 mark: (10 – 8) or 2 / 0.301 x 3.5 Incorrect rounding of 1.8984337	3	3	3

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