



Problem solving Tips

Averages

Add all the values (numbers) together and **divide** by how many you have added.

Eg. Find average of 10, 15 and 5.

$$10 + 15 + 5 = 30$$

Divide 30 by 3 (because 3 numbers were added)

$$\text{Average} = 10.$$

Ratios

You must divide all numbers involved by the same common denominator (a number which can divide evenly into all the numbers involved, without leaving any remainder).

Simplify it as much as possible.

Remember they must all be **whole numbers** i.e. no decimals.

Eg. 35:21:14 all these numbers divide by 7 so the **simple whole number ratio** is.

$$5:3:2$$

Percentages

To calculate a number as a percentage. Divide the number you are trying to find by the total and multiply by one hundred. Eg dividing your test score by the total.

$$22 \text{ out of } 30 = 22/30 \times 100 = 73\%$$

Percentage change (% increase or % decrease)

Calculate the change (increase or decrease) then divide answer by the original value.

This fraction must then be multiplied by 100 to convert it to a percentage.

Eg. 50 bacteria at the start, after 5 hours they had multiplied to 700. What is the percentage change in number? Difference = $700 - 50 = 650$.

$$\text{Divide by the starting value of } 50 = 13$$

$$\text{Multiply fraction } \times 100 = 13 \times 100 = 1300\%$$



Graphs & charts

Remember the **SLURP** rule.

Copy labels directly from the table column headings. Do not miss out anything, including the units.

You must put a starting value in the origin for each individual axis. This might be a zero, but not always.

Use a ruler to help you plot your points this will reduce the risk of you skipping boxes.

Remember each box on a scale must be the same value. If you have 10 boxes between 0 and 1 you must have 10 boxes between 1 and 2, 2 and 3 and so on.

Relationships

As one thing changes it affects another. You must mention both.

Variables

The only variable that can be changed is the one being investigated. Constant variables, you need to give an example not already mentioned in the question text or diagram. **Do not use the word amount.** You must say the **volume** of solution... or **the pH** of..... or the **concentration** of the the **mass** of etc.....

Control

A control is set up to make a comparison. You must state that everything is set up exactly as in the experiment but without the variable being investigated. A control shows that the variable being investigated is responsible for the results.

Reliability

The results can be made more reliable by repeating the experiment in exactly the same way.



National 5 Biology Problem Solving Questions

Averages, Number of times greater & calculating change

1. The table gives information on the numbers of mitochondria in different types of mammalian cells.

Cell type	Number of mitochondria per cell			
	Cell 1	Cell 2	Cell 3	Average
Muscle	1352	1203	1450	1335
Skin epithelium	250	330	275	
Lymphocyte	953	1112	860	975

- (i) Complete the table by calculating the average number of mitochondria per cell in skin epithelium.

1

2. Ions move in and out of cells by passive and active processes.

The table shows the concentration of three ions outside and inside a human cell.

Ions	Outside cell (mM)	Inside cell (mM)
Sodium (Na^+)	145	12
Potassium (K^+)	4	139
Chloride (Cl^-)	116	4

Calculate how many times greater the concentration of chloride ions is outside the cell compared to inside the cell.

1



3. The field of view of a light microscope measures 2 mm in diameter.
20 plant cells were counted in a line across the diameter.

1 mm = 1000 micrometres

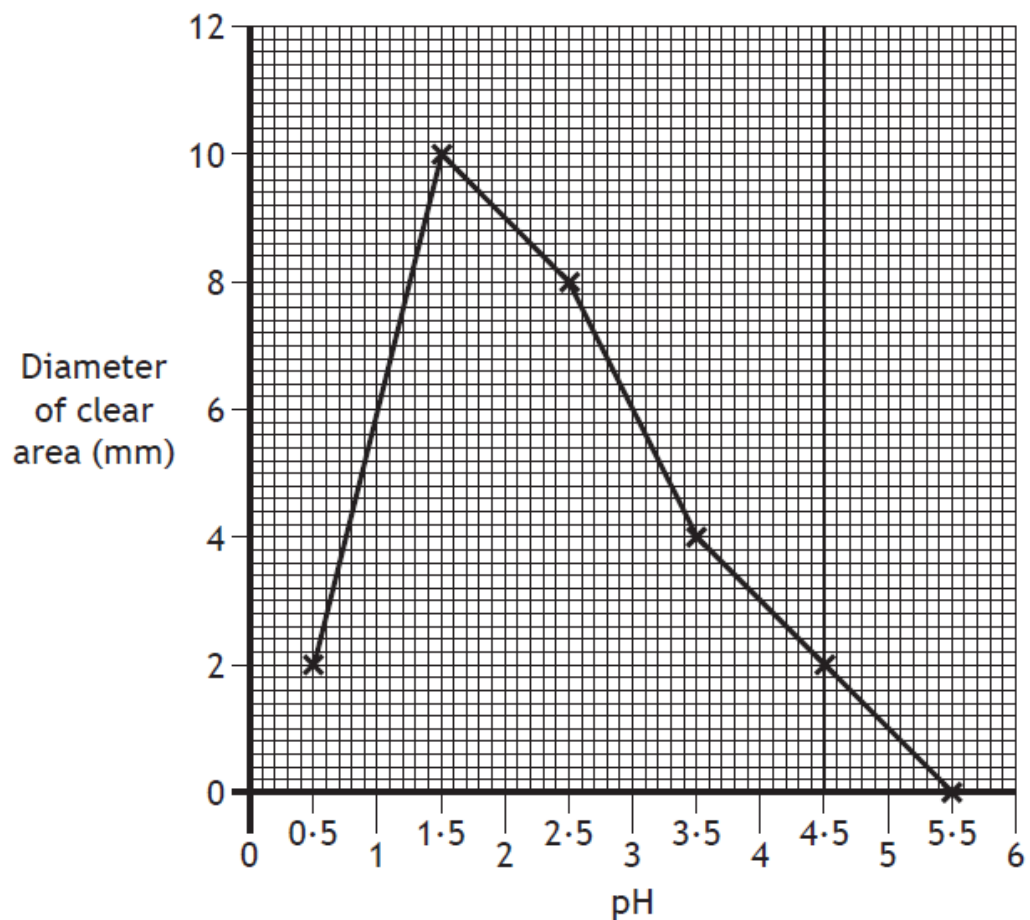
Calculate the average size of a cell in micrometres.

1

4. An investigation was carried out into the effect of pH on the activity of the enzyme pepsin.

When the protein is broken down, cloudy agar becomes clear.

The results are shown in the graph.

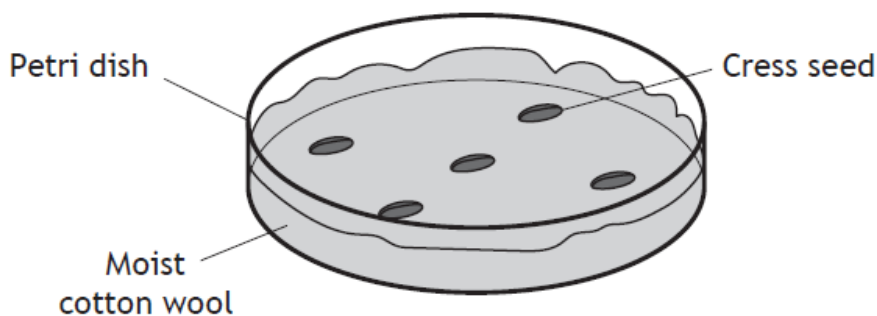


Calculate how many times more active the enzyme is at pH 2.5 than at pH 4.5.

1

5. To investigate the effect of competition on the growth of cress seeds, five Petri dishes, labelled A–E, were set up and left for six days. Each dish contained a layer of moist cotton wool with different numbers of cress seeds sown evenly across its surface.

Dish A is shown in the diagram.



The results are shown in the table.

<i>Dish</i>	<i>Number of seeds sown</i>	<i>Number of seedlings surviving after six days</i>	<i>Percentage of seedlings surviving after six days</i>
A	5	5	100
B	10	10	100
C	20		95
D	40	34	85
E	80	60	75

Complete the table by calculating the number of seedlings surviving in Dish C.



6. The distribution of organisms may be affected by abiotic factors.

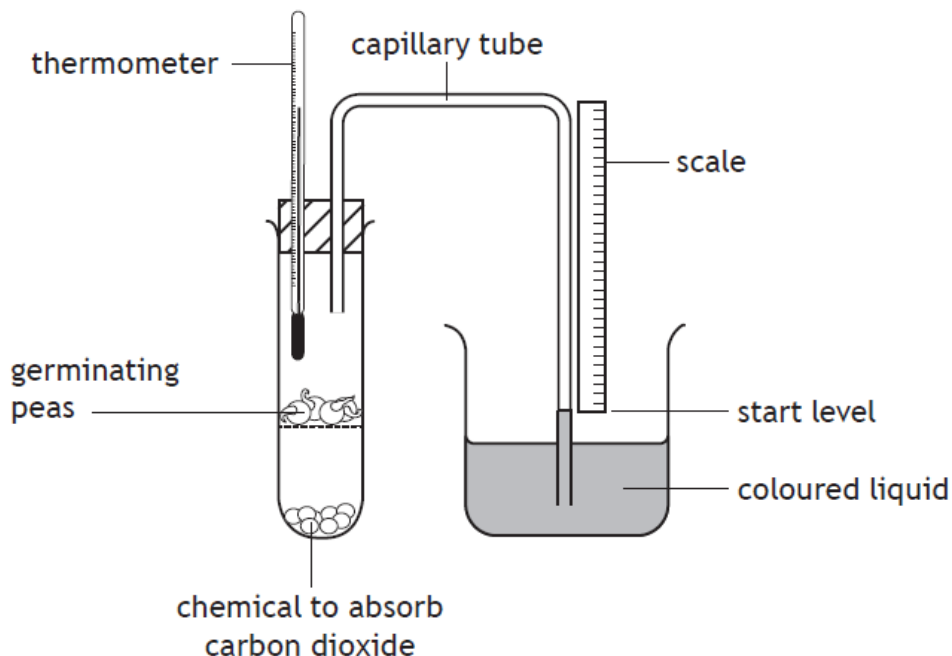
The table shows the results of a study into the effect of soil moisture levels on the distribution of three species of plant.

<i>Sample site</i>	<i>Soil moisture (units)</i>	<i>Number of plants</i>		
		<i>Species E</i>	<i>Species F</i>	<i>Species G</i>
1	20.2	11	15	12
2	23.4	13	14	11
3	22.1	12	16	10
4	24.5	15	17	15
5	26.6	18	13	12
6	28.4	19	15	14

Calculate the average number of plants per sample site for species F.

1

7. A student investigated the effect of temperature on the rate of respiration in germinating (growing) peas. Using the arrangement shown, four respirometers labelled A–D were set up at the temperatures shown in the table below.



The level of the coloured liquid was measured on the scale at the start of the investigation and again after 20 minutes. The rise in liquid level was due to oxygen uptake by the germinating peas. The results are shown in the table.

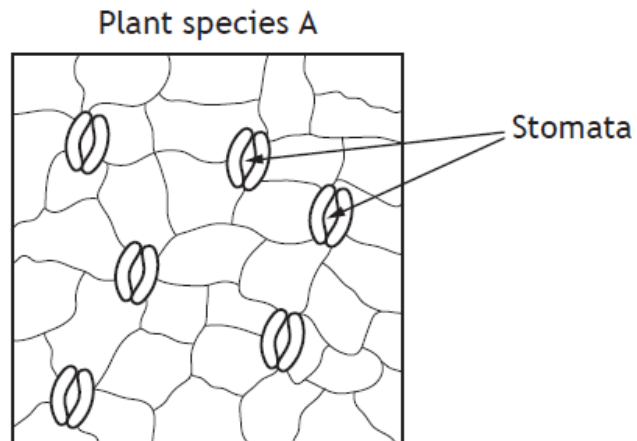
Respirometer	Temperature (°C)	Contents	Rise in liquid level (mm)	Rate of oxygen uptake (mm per minute)
A	15	Germinating peas	14	0.7
B	15	Dead peas	0	0
C	25	Germinating peas	26	
D	25	Dead peas	0	0

Complete the table above by calculating the rate of oxygen uptake per minute by the peas in respirometer C.



8. A student investigated the link between transpiration rate and the number of leaf stomata.

A microscope was used to look at the number of stomata on a leaf surface of plant species A as shown.



The area shown on the diagram above measures 0.04 mm^2 .

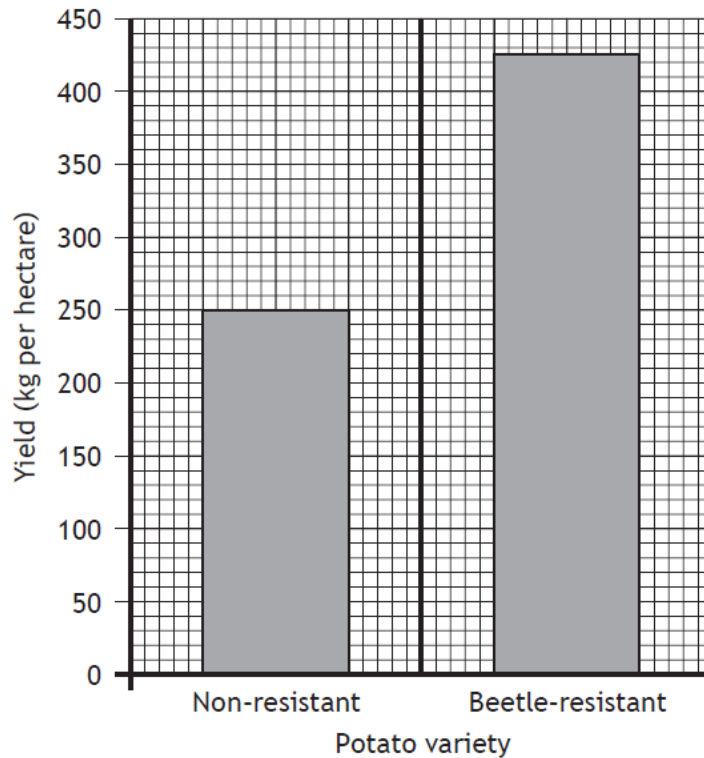
Calculate the expected number of stomata present in 1 mm^2 on this leaf surface.



9. Certain varieties of potato plant are eaten by beetles, reducing the yield of potatoes. A beetle-resistant variety of potato plant was developed.

In an investigation, the beetle-resistant variety was grown outdoors in one field and the non-resistant variety grown in another.

The yields of both varieties were recorded and the results are shown in the graph below.



Calculate the difference in yield between the two varieties.

1

10. Environmental scientists carried out a study on lichen species at four different sites and obtained the results shown in the table below.

Site	Number of lichen species present		
	Shrubby	Leafy	Crusty
A	0	5	19
B	3	2	0
C	16	3	0
D	7	14	2

Calculate the average number of leafy lichen species present at the four sites.

1



11. In an investigation, students estimated the population and biomass of some organisms found on part of a rocky shore.

The table below shows the results.

<i>Organism</i>	<i>Population</i>	<i>Average mass of one organism (g)</i>	<i>Biomass of population (g)</i>
Seaweed	220	500	110 000
Limpet	1 100		33 000
Crab	100	90	9 000
Gull	5	700	3 500

Complete the table to show the average mass of one limpet.

1

12. A group of students carried out a five year investigation into plant growth in an area of abandoned farmland.

They sampled the area using quadrats.

The results are shown in the table below.

	<i>Average abundance of each plant</i>		
<i>Year</i>	<i>Meadow grass</i>	<i>Ragwort</i>	<i>Pink campion</i>
2011	8	15	9
2012	16	14	7
2013	24	12	4
2014	25	8	2
2015	25	5	1

Calculate the average decrease per year in the abundance of ragwort over the five-year period.

1



13. During a reflex action, the speed at which the information flows was measured to be 90 metres per second.

Calculate how long it would take for the information to complete a reflex arc which was 0.9 m in length.

1

14. Five leaves were collected from a horizontal stem and another five from a vertical stem. The widths of the leaves were measured and the results are shown in the table below.

leaf	Leaf width (mm)	
	Horizontal stem	Vertical stem
1	52	32
2	60	34
3	56	35
4	50	44
5	52	35
average	54	

Complete the table by calculating the average width of the leaves from the vertical stem.

1

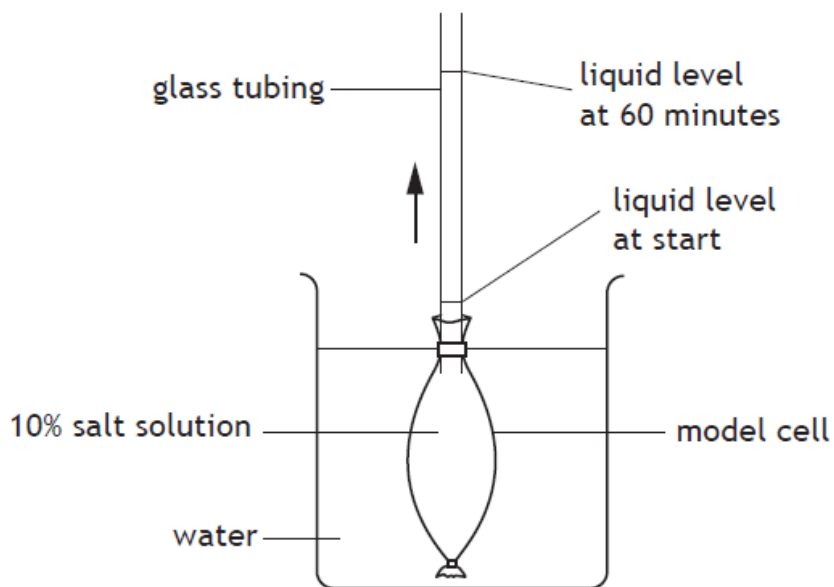
15. The table below shows the results of an investigation into the effect of temperature on egg laying in adult red spider mites.

Feature	Temperature (°C)		
	20 °C	25 °C	30 °C
Average length of egg laying period (days)	24	18	12
Average number of eggs laid per female during egg laying period	72	72	72

As the temperature increases, the average number of eggs laid per female per day

- A increases
- B decreases
- C stays the same
- D halves.

16. The apparatus shown below was used to investigate the movement of water into and out of a model cell. The model cell had a selectively permeable membrane.



The liquid level in the glass tubing was measured every 10 minutes for 60 minutes.

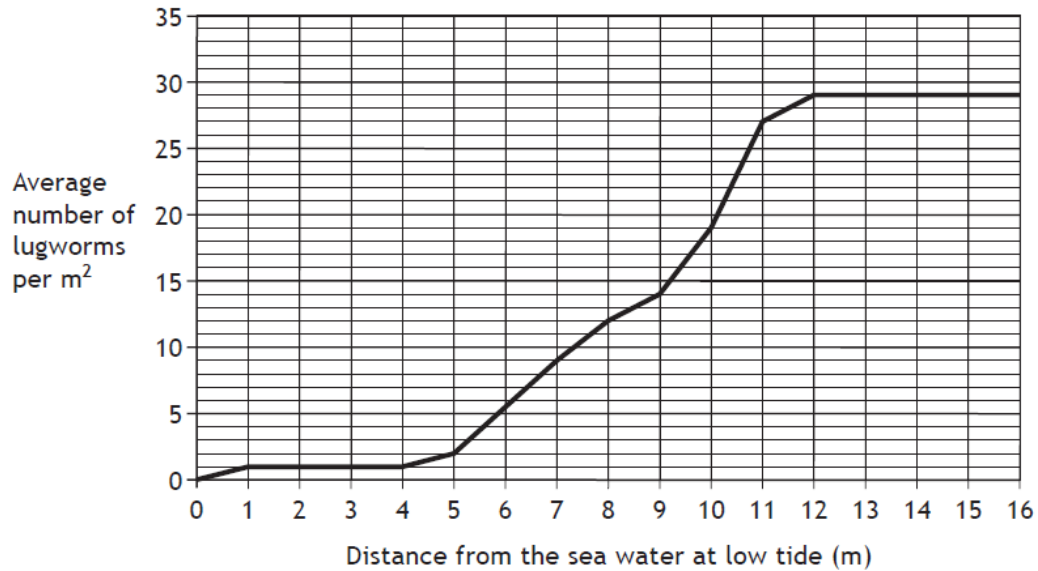
The results are shown in the table below.

<i>Time (minutes)</i>	<i>Liquid level (mm)</i>
0	10
10	22
20	32
30	40
40	48
50	56
60	64

Calculate the average rate of movement of liquid in the glass tubing.



17. Lugworms live on the seashore in dark moist burrows under the sand. The graph below shows the average number of lugworms at different distances from the seawater at low tide.

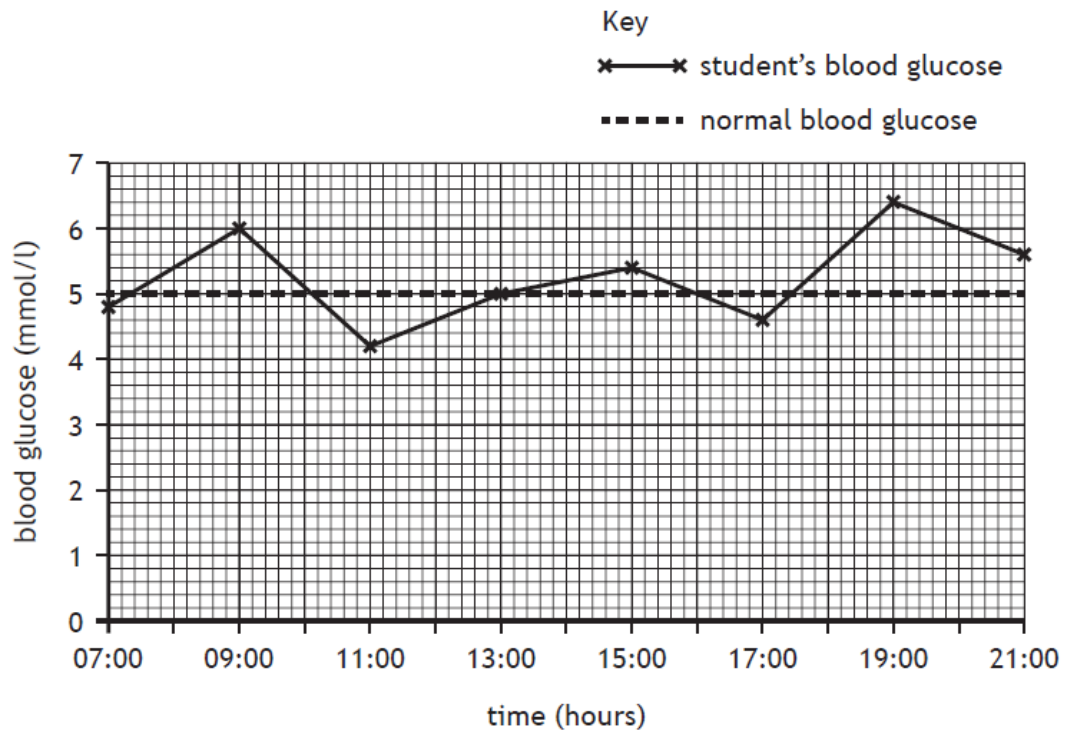


Calculate how many times greater the average number of lugworms at 11 metres is compared to 7 metres from the seawater at low tide.

Percentages

18. As part of a study into the health of a group of students, blood glucose readings were taken over a period of time.

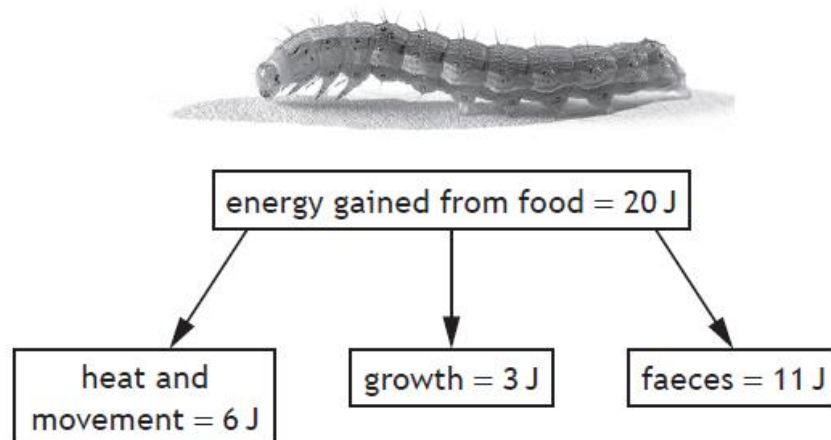
The graph shows the readings for one of the students.



Calculate the percentage decrease in blood glucose between 09:00 and 11:00 hours.

1

19. The diagram shows the fates of 20 joules (J) of energy gained by a caterpillar from food.



Calculate the percentage of the caterpillar's energy intake that is used for growth.

1



20. Antibiotic drugs are only effective in the treatment of bacterial infections. They either kill or prevent the growth of bacteria. Sometimes antibiotics are given but do not have any effect on the particular infection.

The table gives information about the number of cases treated with antibiotics and the success rate for a range of infections.

Type of infection	Number of these cases treated with antibiotics (millions)	Number of these cases successfully treated with antibiotics (millions)	Success rate (%)
ear	23	16.1	70
common cold	18	0	0
chest	16	3.2	20
throat	15		48

Complete the table by calculating the number of cases of throat infections successfully treated with antibiotics.

1

21. A gardener treated the soil in the area where he planted vegetables with a chemical to increase the yield.

When the vegetables were picked and weighed, the total yield was 42 kilograms. The previous year the total yield was 35 kilograms.

Calculate the percentage increase in yield.

1



22. Nutritional information helps people make an informed choice about the food they eat.

Table 1 – Label from a bar of chocolate

<i>Nutritional information</i>	<i>per 100 g</i>	<i>per bar</i>	<i>% RI*</i>
Energy (kJ)	2251	630	7.5
Sugar	65 g	18 g	15.6
Protein	10 g	2.8 g	3
Total fat	25 g	7 g	10
Saturated fat	20 g	5.6 g	28
Salt	0.4g	0.1 g	1.7

*RI = Reference Intake (formerly “guideline daily amount”)

- (i) As shown in Table 1, saturated fat makes up part of the total fat in this chocolate bar.

Calculate the percentage of total fat which is saturated.

1

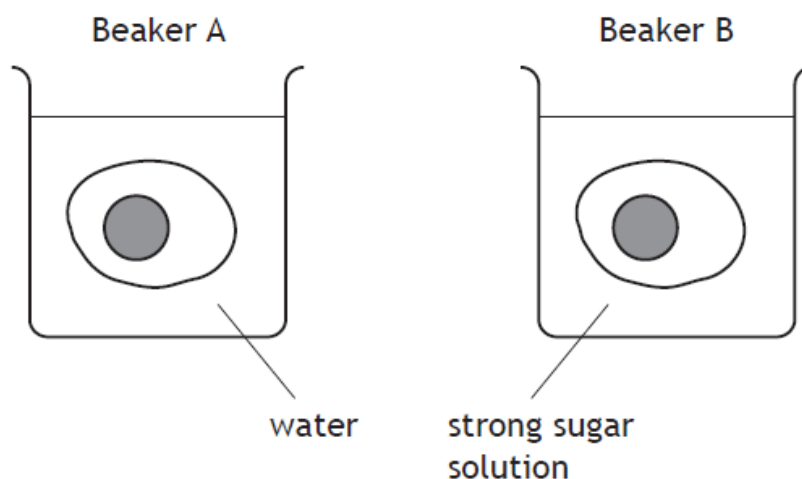
- (ii) One bar of this chocolate contains 630 kilojoules which is 7.5% of the reference intake (RI).

Calculate the total number of kilojoules which should be consumed daily.

1

23. Shells can be removed from eggs by dissolving them in vinegar for 2–3 days. The egg contents remain inside a thin membrane.

In an investigation the shells from two eggs were removed. The eggs were then weighed and placed in beakers as shown below.



After 2 hours the eggs were removed from the beakers, blotted dry and reweighed. The results are shown in the following table.

<i>Beaker</i>	<i>Mass at start (g)</i>	<i>Mass after 2 hours (g)</i>	<i>Percentage change in mass</i>
A	54.0	67.5	
B	52.1	47.8	-8.2

Complete the table by calculating the percentage change in mass for beaker A.



24. Researchers have discovered an advantageous genetic mutation that causes high bone density in humans.

One man in the USA was discovered to possess this mutation after he walked away without injury from a serious car crash. Further studies have found several members of the same extended family with this mutation.



20 members of the family provided blood samples for DNA and biochemical testing. 7 of them were found to have high bone density. The same tests were performed on another group of 20 unrelated individuals with normal bone density.

The location of the gene mutation was able to be identified and it is hoped that the findings will help in developing medications to increase bone density for the treatment of conditions such as osteoporosis.

Calculate the percentage of the family who did not have the mutation for high bone density.



Graphs, relationships & interpreting information

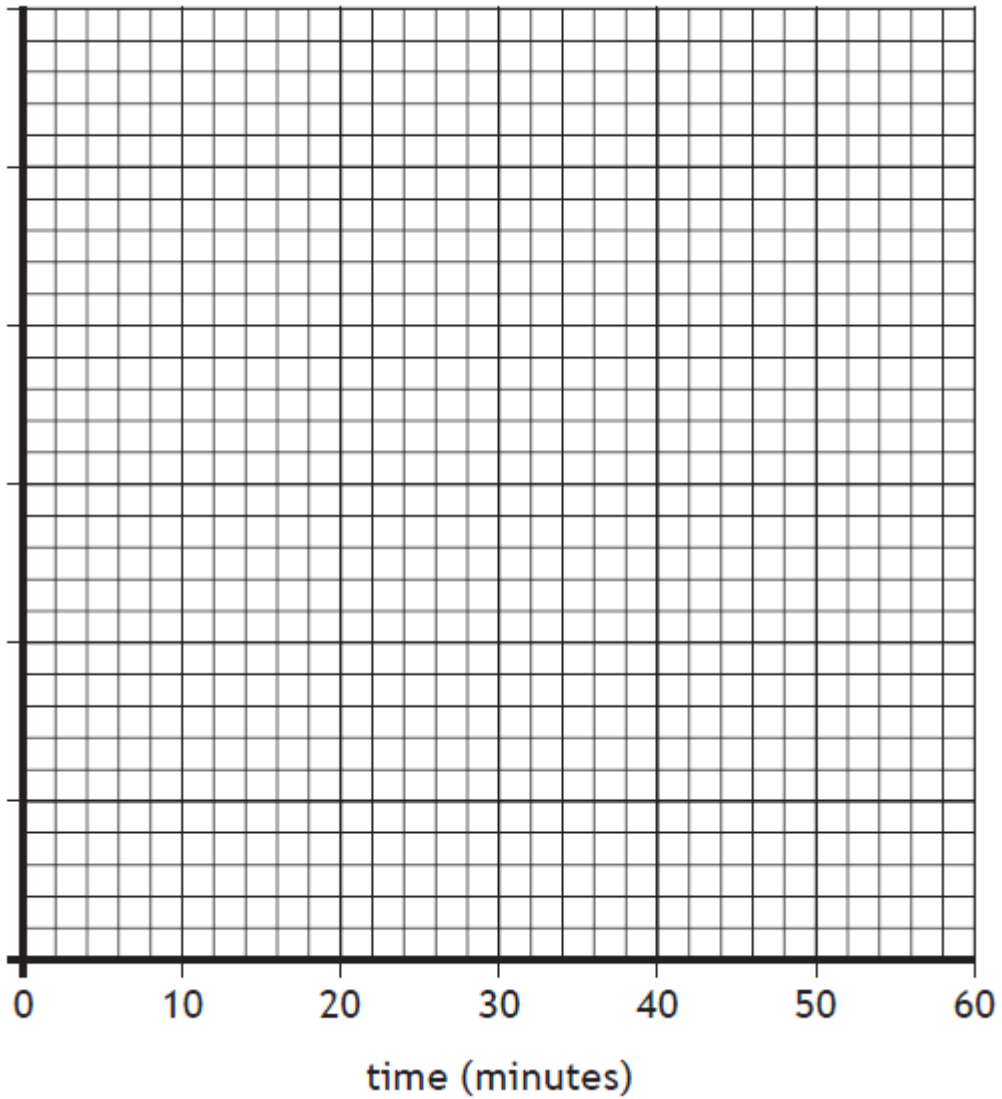
25. An investigation was carried out into the respiration of yeast. A dough was made containing live yeast and left in optimum conditions. As the yeast respired, the carbon dioxide produced caused the dough to rise. The volume of the dough was measured every 10 minutes for 60 minutes. The results are shown in the table.

Time (minutes)	Volume of dough (cm ³)
10	8
20	14
30	22
40	26
50	28
60	28

- (i) On the grid, complete the vertical axis and plot a line graph to show the effect of time on the volume of dough.



25 continued



(ii) Predict the volume of dough at 50 minutes if the experiment was carried out at a lower temperature.

1

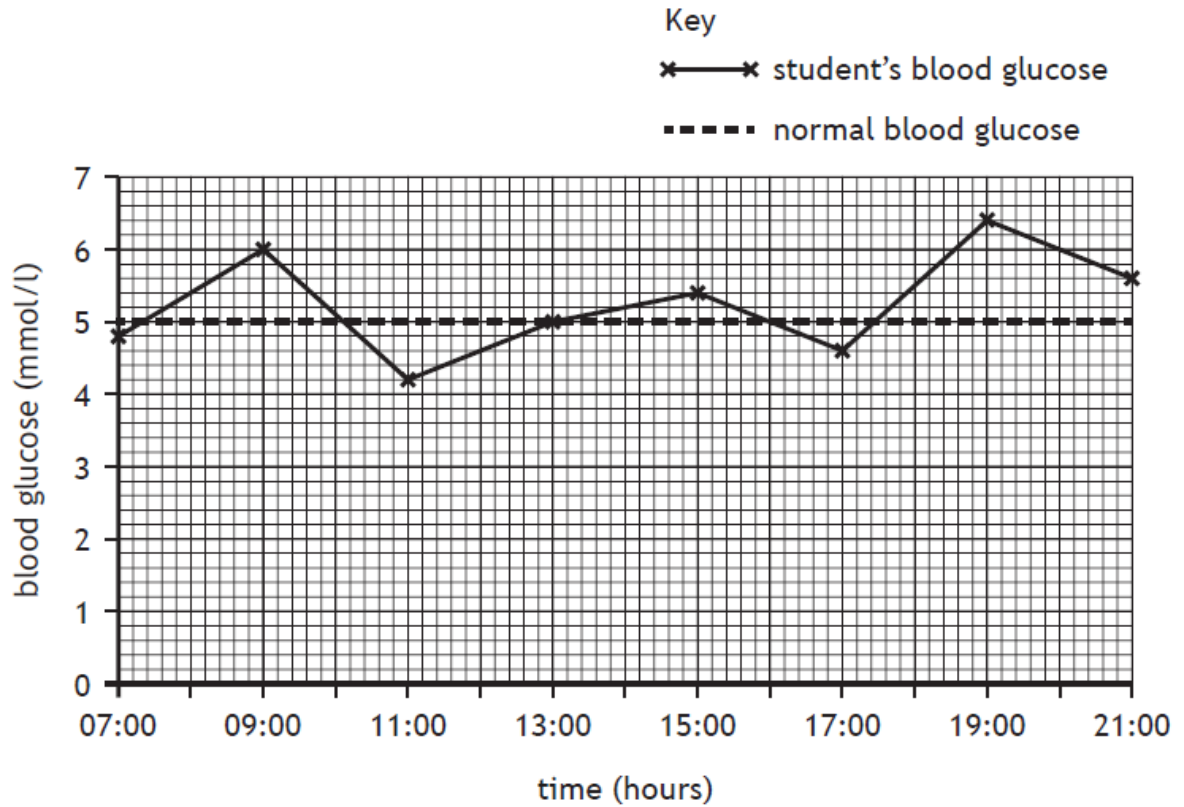
Give a reason for your answer.

1



26. As part of a study into the health of a group of students, blood glucose readings were taken over a period of time.

The graph shows the readings for one of the students.

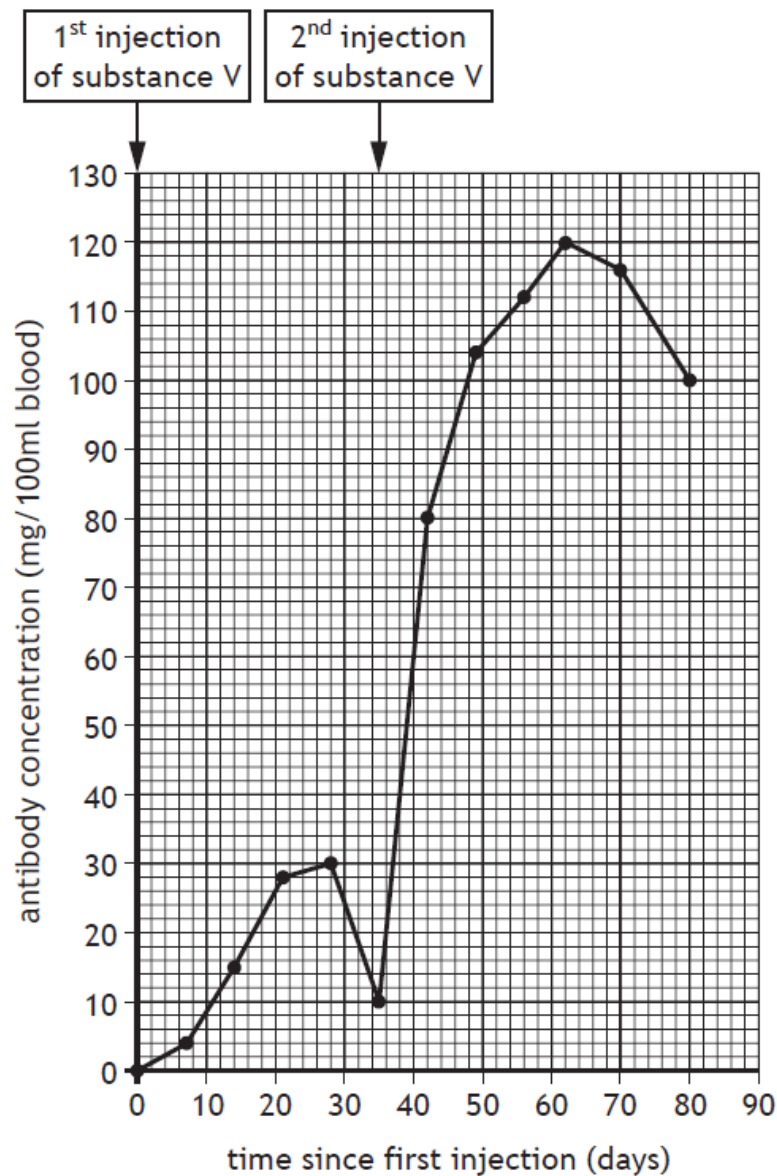


- (a) Identify the time when this student's blood glucose reached its maximum value.



27. In a study, volunteers were injected with substance V on day 0 and again on day 35. Substance V causes antibodies to be produced.

The graph shows the antibody concentration in the blood of one of the volunteers in response to the two injections.



- (a) Identify the maximum antibody concentration following the first injection, but before the second.

1

_____ mg/100 ml

- (b) Calculate the number of days after the second injection that it took for the antibody concentration to reach its maximum value.

1



27 continued

- (c) The second injection caused a higher concentration of antibody to be produced than the first.

Give two other differences in the antibody production in response to the two injections.

2

- (d) If the trend continues as shown in the graph, predict the antibody concentration on day 90.

1

28. A study found that exercise can reduce the risk of developing some types of cancer.

Researchers examined the level of exercise of 1.4 million people over an 11 year period and recorded any diagnosis of cancer and when it occurred.

Participants were asked to keep their own record of the frequency and intensity of their exercise.

Those participants who exercised were found to have a reduced risk of developing some types of cancer. These results are shown in the table.

Type of cancer	Average risk reduction (%)
lung	26
kidney	23
stomach	22
myeloma	17
bladder	13

The study did not take into account factors such as diet and smoking, which may have affected the results. The fact that participants were asked to record their own exercise is another limitation of this study.

The doctor in charge of the research suggested that these results support the promotion of exercise as a means of reducing the risk of cancer.

However, it was suggested by a different researcher that further studies would need to be carried out before the results could be considered valid.



28 continued

- (a) Most research starts off with a question. For example, 'Is enzyme activity affected by pH?'

Suggest a question that could have led to the research described above. 1

- (b) Name the type of graph that should be used to present the results shown in the table. 1

- (c) Suggest one reason why the participants recording their own exercise is described as a limitation. 1

- (d) Three factors that could affect the results are age, duration of exercise and type of exercise.

Choose one of these factors.

Describe how the study would be carried out to take the chosen factor into account and improve the validity of the results. 1



29. Students carried out an investigation into the effect of soil moisture on the percentage ground cover of moss in their school lawn.

A quadrat was used to estimate the percentage ground cover of moss at several sites. Soil moisture was also measured at each of the sites.

The results of the investigation are shown in the table.

Sample site	Average soil moisture (%)	Ground cover of moss (%)
1	18	86
2	14	70
3	15	80
4	11	58
5	13	65
6	12	60
7	22	98
8	30	99
9	35	100

- (a) Describe the relationship between average soil moisture and percentage ground cover of moss.

1

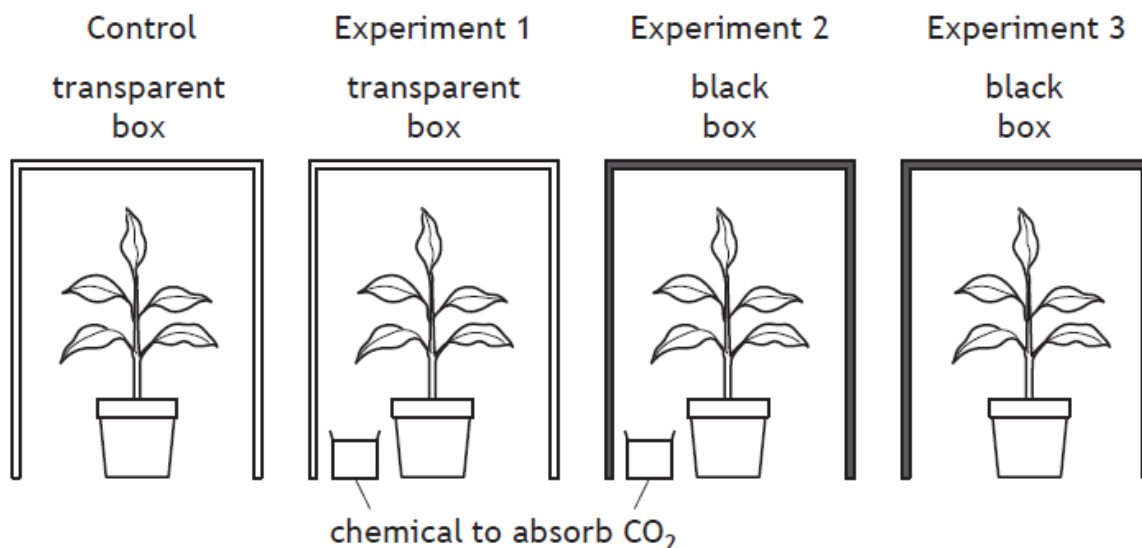
- (b) Describe how the reliability of these results could be increased.

1

30. An investigation was carried out into the conditions needed for photosynthesis.

Before starting the investigation, four plants were de-starched by placing them in the dark for 24 hours.

The plants were then placed in the conditions shown and then left for 48 hours.

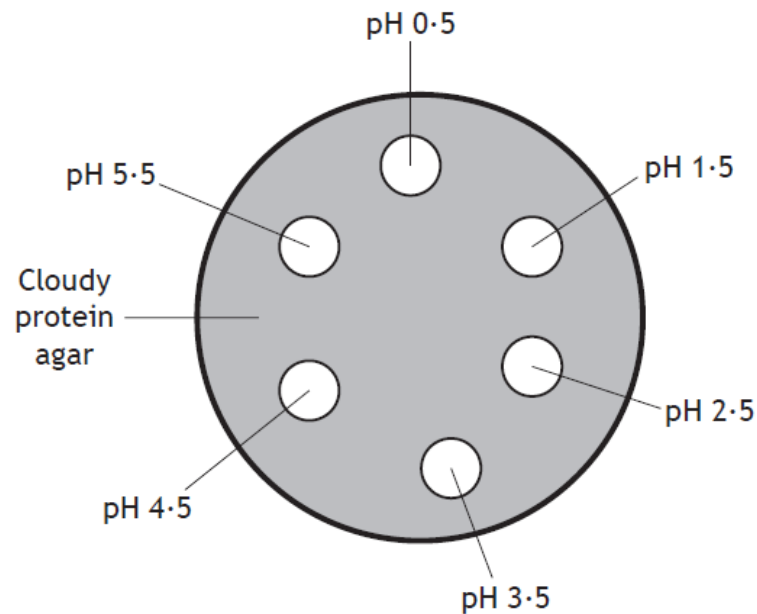


The leaves of each plant were then tested for the presence of starch.

- (a) (i) Tick the box(es) to show in which of the following starch would be present after 48 hours. 1
- | | |
|---------------------------------------|---------------------------------------|
| <input type="checkbox"/> Control | <input type="checkbox"/> Experiment 1 |
| <input type="checkbox"/> Experiment 2 | <input type="checkbox"/> Experiment 3 |
- (ii) Explain the purpose of the control. 1
- (iii) Explain why experiment 2 is invalid. 1
- (iv) State the factor that is being investigated in experiment 3. 1

31. An investigation was carried out into the effect of pH on the activity of the enzyme pepsin.

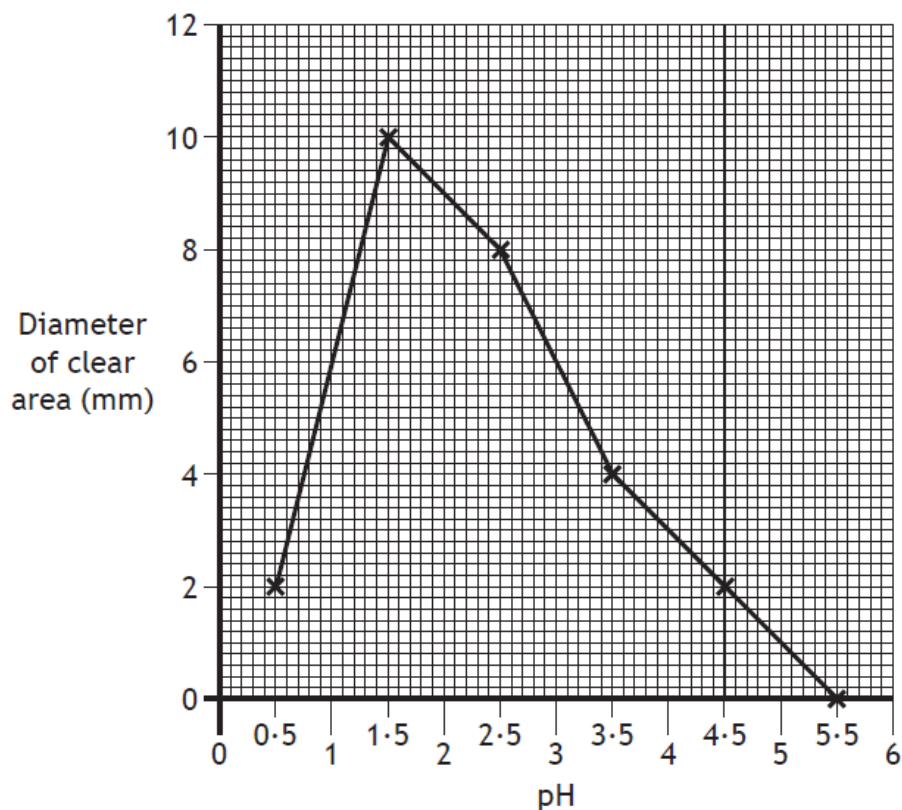
A Petri dish was filled with cloudy protein agar. Six holes were made in the agar and each was filled with pepsin solution at the pH values shown.



When the protein is broken down, cloudy agar becomes clear.

The dish was examined after 24 hours and the diameter of the clear area around each hole was measured. The larger the clear area, the more active the enzyme.

The results are shown in the graph.





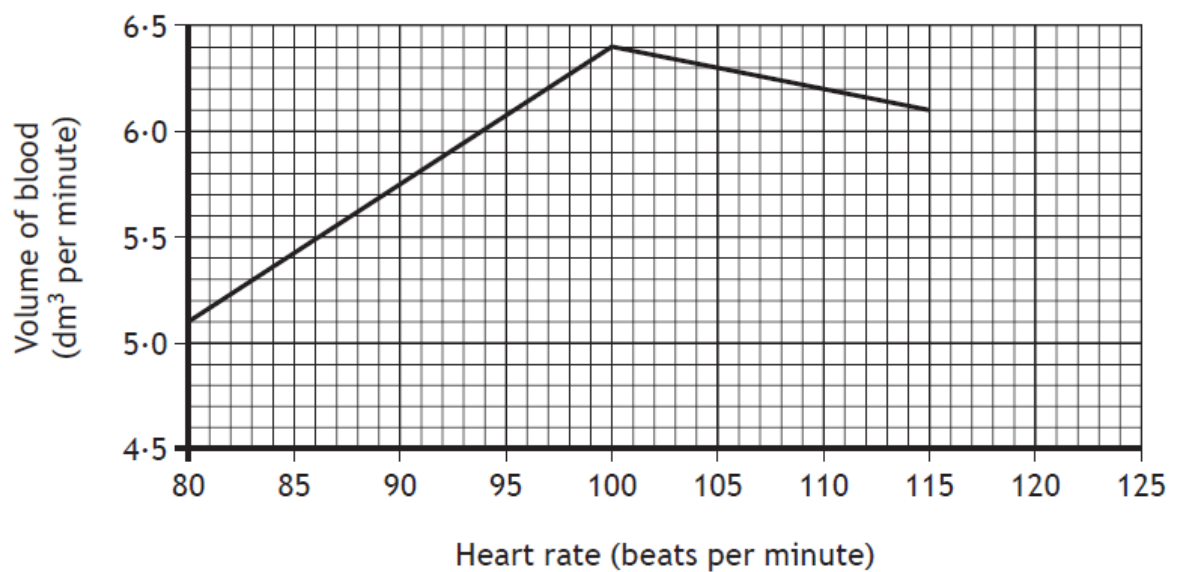
31 continued

- (a) (i) Identify the optimum pH for pepsin in this experiment. 1

pH _____

- (b) State two variables which should be controlled to make this experiment valid. 2

32. The graph shows the effect of changes in heart rate on the volume of blood pumped by the left ventricle.



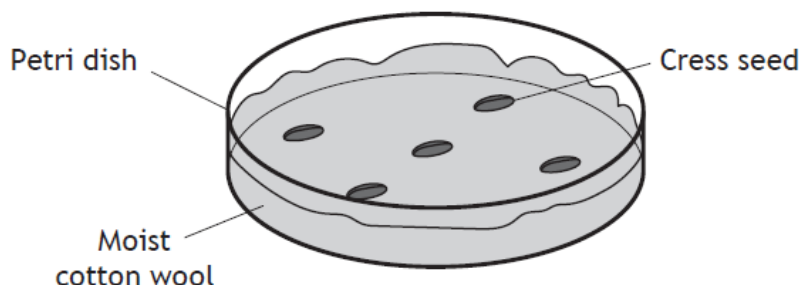
- (i) Describe the relationship between heart rate and volume of blood pumped by the left ventricle. 2

- (ii) Predict the volume of blood pumped by the left ventricle at 120 beats per minute. 1



33. To investigate the effect of competition on the growth of cress seeds, five Petri dishes, labelled A–E, were set up and left for six days. Each dish contained a layer of moist cotton wool with different numbers of cress seeds sown evenly across its surface.

Dish A is shown in the diagram.



The results are shown in the table.

<i>Dish</i>	<i>Number of seeds sown</i>	<i>Number of seedlings surviving after six days</i>	<i>Percentage of seedlings surviving after six days</i>
A	5	5	100
B	10	10	100
C	20		95
D	40	34	85
E	80	60	75

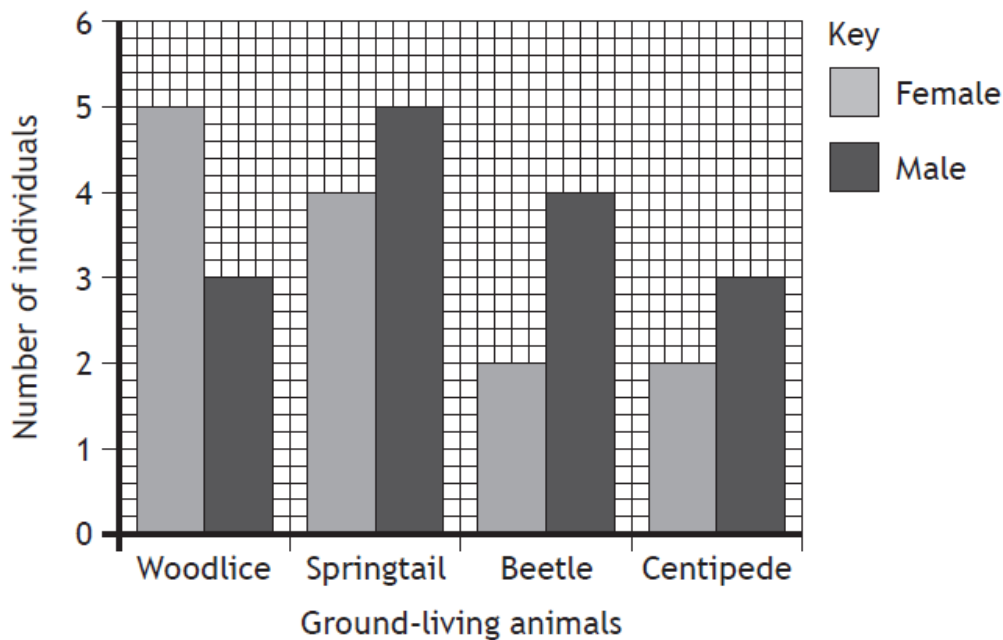
Describe the relationship between the number of seeds sown and the percentage of seedlings surviving after six days.



34.

In an investigation into ground-living animals in a woodland, a group of students collected and counted the animals they found.

The students sorted the animals into male and female, counted them and recorded the results in a bar graph.



(a)

- 1 Identify the animal which had the greatest overall abundance. 1

- 2 The students concluded that males were always more abundant than females.

Identify the animal for which this is not true. 1

- (b) It was decided that the samples were not fully representative of the area.

Suggest how the investigation could be improved. 1



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34 continued

(b) The distribution of organisms may be affected by abiotic factors.

The table shows the results of a study into the effect of soil moisture levels on the distribution of three species of plant.

Sample site	Soil moisture (units)	Number of plants		
		Species E	Species F	Species G
1	20.2	11	15	12
2	23.4	13	14	11
3	22.1	12	16	10
4	24.5	15	17	15
5	26.6	18	13	12
6	28.4	19	15	14

State which species has its distribution most affected by the soil moisture levels.

1

35. A student set up an investigation into the effect of temperature on the rate of photosynthesis in a green plant, by measuring the volume of oxygen released in one hour.

The results are shown in the table.

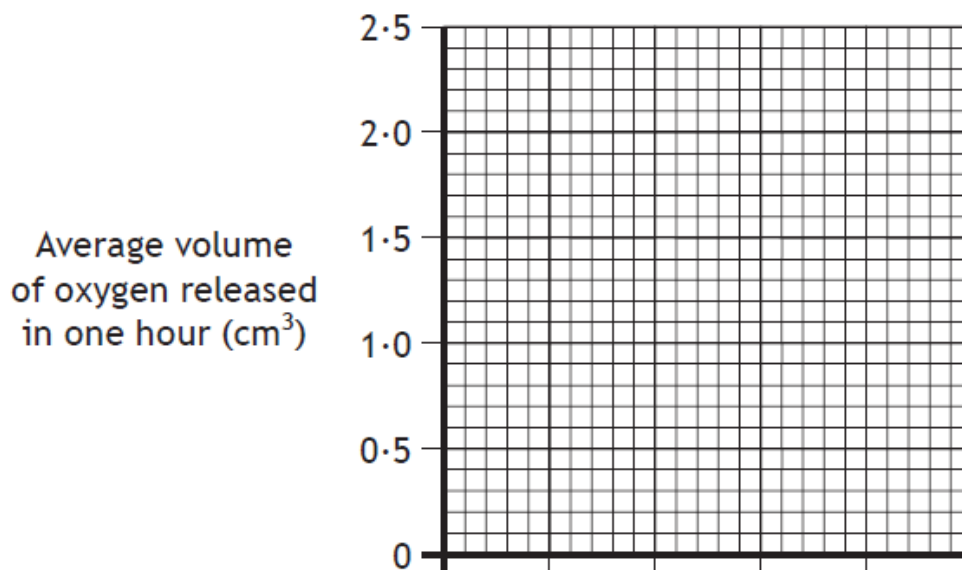
Temperature (°C)	Volume of oxygen released in one hour (cm ³)		
	Experiment 1	Experiment 2	Average
10	0.7	0.5	0.6
20	1.6	1.4	1.5
30	2.7	1.9	2.3
40	2.0	2.6	2.3
50	0.3	0.5	0.4



35 continued

- (a) On the grid, plot a line graph to show the effect of temperature on the average volume of oxygen released in one hour.

2



- (b) Predict the average volume of oxygen released in one hour if the experiment was carried out at a temperature of 60°C .

1

36. Catalase, an enzyme found in living tissues, is involved in the breakdown of hydrogen peroxide into water and oxygen.

In an investigation, catalase was extracted in solution from a variety of tissues and used to soak paper discs. These discs were then dropped into beakers of hydrogen peroxide, as shown in Diagram 1. As the oxygen was released the discs returned to the surface, as shown in Diagram 2.

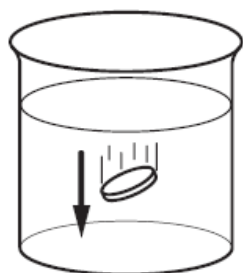


Diagram 1

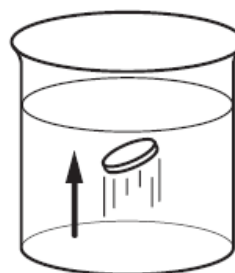


Diagram 2



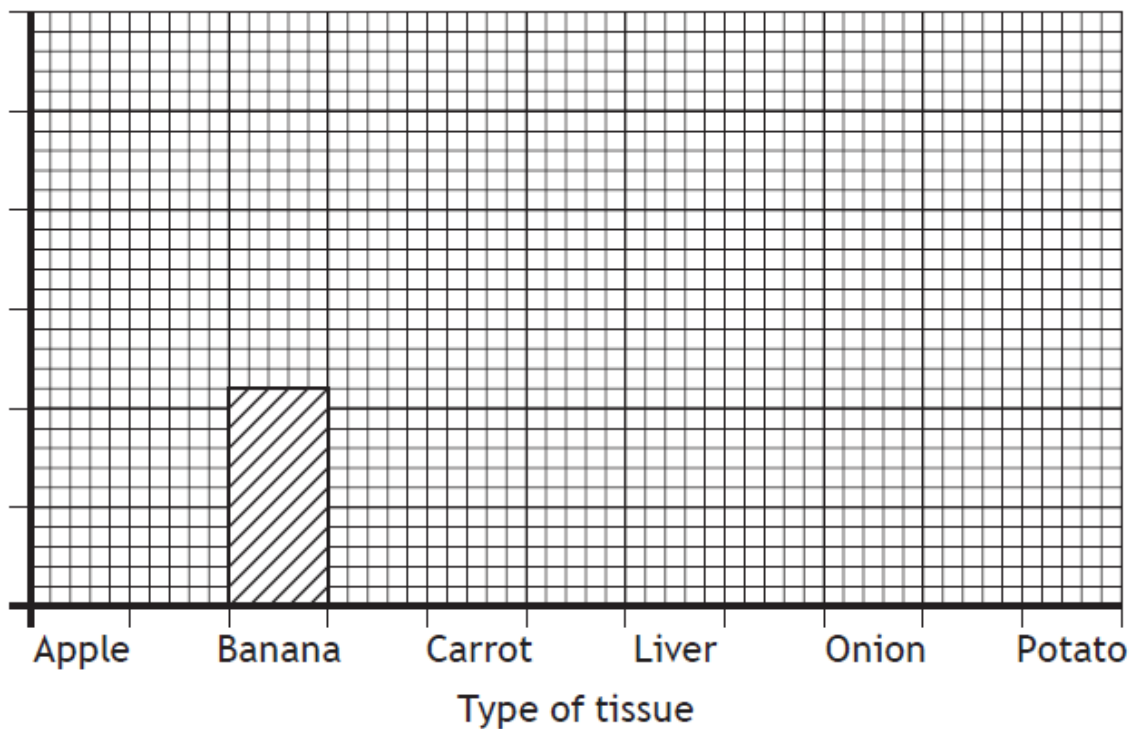
36 continued

The time taken for these discs to return to the surface was recorded and shown in the table.

Type of tissue	Time for disc to return to the surface (s)
Apple	108
Banana	44
Carrot	68
Liver	8
Onion	70
Potato	72

- (a) On the grid below, complete the vertical axis and the remaining bars to show the time taken for the discs to return to the surface, for each tissue.

2



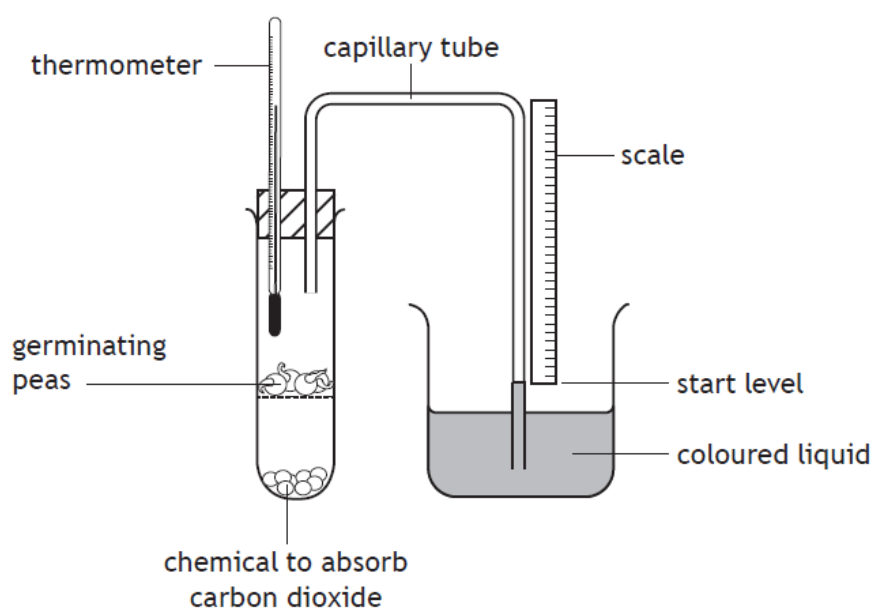
36 continued

- (b) The aim of the experiment was to investigate catalase activity in a variety of tissues.

Using the information given, write an appropriate conclusion for this experiment.

1

37. A student investigated the effect of temperature on the rate of respiration in germinating (growing) peas. Using the arrangement shown, four respirometers labelled A–D were set up at the temperatures shown in the table below.



The level of the coloured liquid was measured on the scale at the start of the investigation and again after 20 minutes. The rise in liquid level was due to oxygen uptake by the germinating peas. The results are shown in the table.

Respirometer	Temperature (°C)	Contents	Rise in liquid level (mm)	Rate of oxygen uptake (mm per minute)
A	15	Germinating peas	14	0.7
B	15	Dead peas	0	0
C	25	Germinating peas	26	
D	25	Dead peas	0	0



37 continued

Respirometers B and D were set up as control experiments.

Describe the purpose of the controls in this investigation.

1

38. Type 1 diabetes occurs if the body does not produce any or enough insulin.

People with Type 1 diabetes need to inject insulin.

The table contains information about some of the different types of insulin available.

<i>Type of insulin</i>	<i>Time for insulin to start working</i>	<i>Time for insulin levels to peak</i>	<i>Duration in blood (hours)</i>
P	1 hour	No peak	20–26
Q	1–3 hours	8 hours	12–16
R	30–60 minutes	2–4 hours	5–8
S	15 minutes	30–90 minutes	3–5

Using information from the table, answer the following questions.

(i) A fast acting type of insulin can be injected just before meals.

Identify the type of insulin that is best suited for this.

1

(ii) Another type of insulin can be injected once a day to provide a steady supply of insulin to the body.

Identify the type of insulin that would be most effective at doing this.

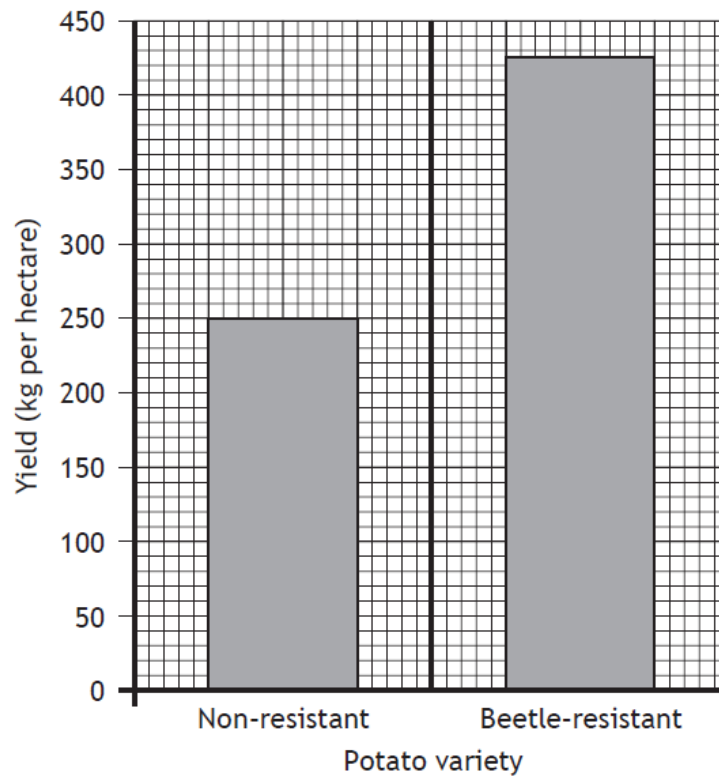
1



39. Certain varieties of potato plant are eaten by beetles, reducing the yield of potatoes. A beetle-resistant variety of potato plant was developed.

In an investigation, the beetle-resistant variety was grown outdoors in one field and the non-resistant variety grown in another.

The yields of both varieties were recorded and the results are shown in the graph below.



- (a) Describe how the reliability of these results could be increased. 1

- (b) Identify a variable that would have to be kept the same between the two fields to ensure the results were valid. 1



40. Levels of air pollution can be estimated by the presence or absence of organisms called lichens.

<i>Air pollution level</i>	<i>Most common type of lichen present</i>
Low	Shrubby
Medium	Leafy
High	Crusty

Environmental scientists carried out a study on lichen species at four different sites and obtained the results shown in the table below.

<i>Site</i>	<i>Number of lichen species present</i>		
	<i>Shrubby</i>	<i>Leafy</i>	<i>Crusty</i>
A	0	5	19
B	3	2	0
C	16	3	0
D	7	14	2

(a) (i) Site A had the highest levels of air pollution.

Using information from both tables, describe the evidence supporting this statement.



41. Nutritional information helps people make an informed choice about the food they eat.

Table 1 – Label from a bar of chocolate

<i>Nutritional information</i>	<i>per 100 g</i>	<i>per bar</i>	<i>% RI*</i>
Energy (kJ)	2251	630	7.5
Sugar	65 g	18 g	15.6
Protein	10 g	2.8 g	3
Total fat	25 g	7 g	10
Saturated fat	20 g	5.6 g	28
Salt	0.4g	0.1 g	1.7

*RI = Reference Intake (formerly “guideline daily amount”)

Table 2 – Guidelines on salt content

<i>Salt category</i>	<i>Salt content (g/100 g)</i>
High	More than 1.5
Medium	0.3 to 1.5
Low	Less than 0.3

- (a) Using information from Table 1 and Table 2, identify the salt category to which this chocolate bar belongs.



42. During the investigation the students found four different species of periwinkles at different positions on the rocky shore.



The highest position that the sea water reaches on the shore is called the high tide level.

The bars in the table below represent the positions on the shore where each species of periwinkle was found.

	<i>Species of periwinkle</i>			
<i>Position on shore</i>	<i>Small</i>	<i>Edible</i>	<i>Rough</i>	<i>Flat</i>
High tide level ↓ Low tide level	█	█	█	█

State which species of periwinkle is least likely to compete with the small periwinkle.

Explain your answer.



43. A group of students carried out a five year investigation into plant growth in an area of abandoned farmland.

They sampled the area using quadrats.

The results are shown in the table below.

Year	Average abundance of each plant		
	Meadow grass	Ragwort	Pink campion
2011	8	15	9
2012	16	14	7
2013	24	12	4
2014	25	8	2
2015	25	5	1

Use information from the table to suggest why the ragwort abundance decreased over the five-year period.

1

44. An investigation into the population of these moths in a woodland was carried out. The moths were captured, marked and released. 24 hours later the moths were recaptured.

The results are shown in the following table.

Variety of moth	Number of moths marked and released	Number of marked moths recaptured	Marked moths recaptured (%)
Light	480	264	55
Dark	520	208	40

Suggest a reason why the number of the marked moths recaptured was worked out as a percentage.

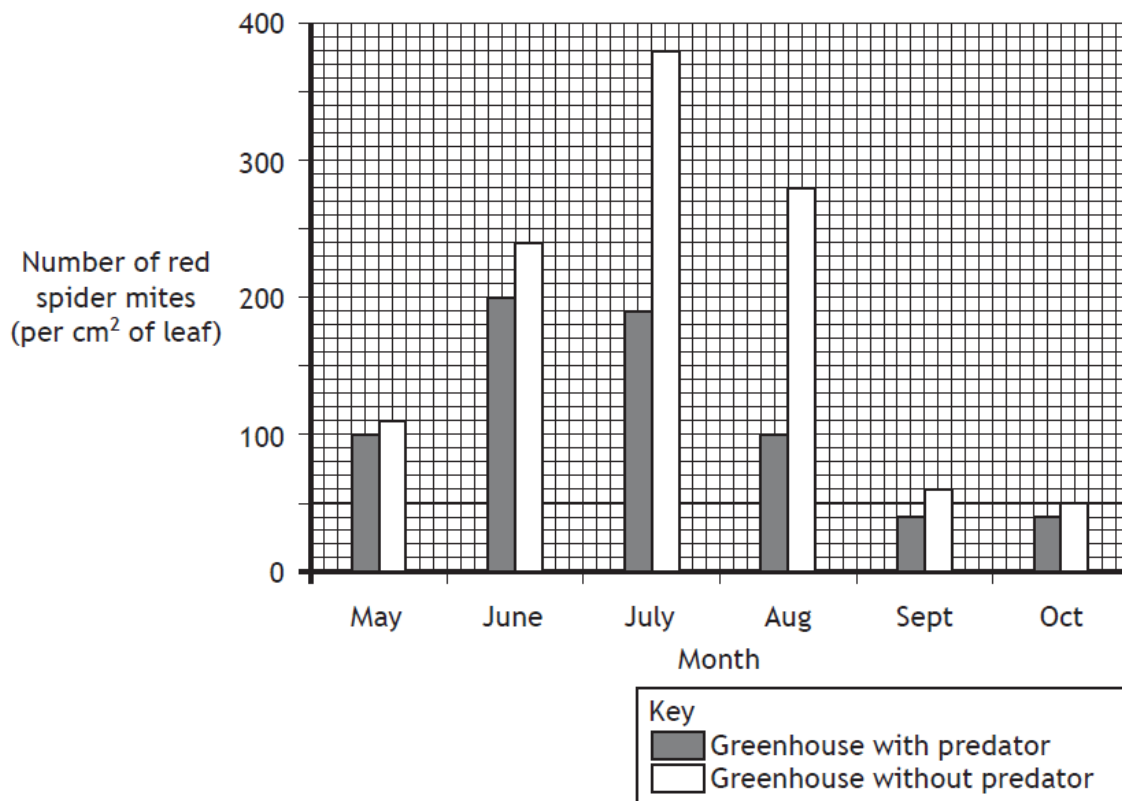
1

45. Red spider mites are a common pest which destroy tomato plants. Some of the mites are resistant to chemical pesticides.



Tomato growers aimed to investigate whether a predator would reduce the spider mite numbers in their greenhouses. Two identical greenhouses were used and the predator was released into only one greenhouse.

The results are shown in the graph below.



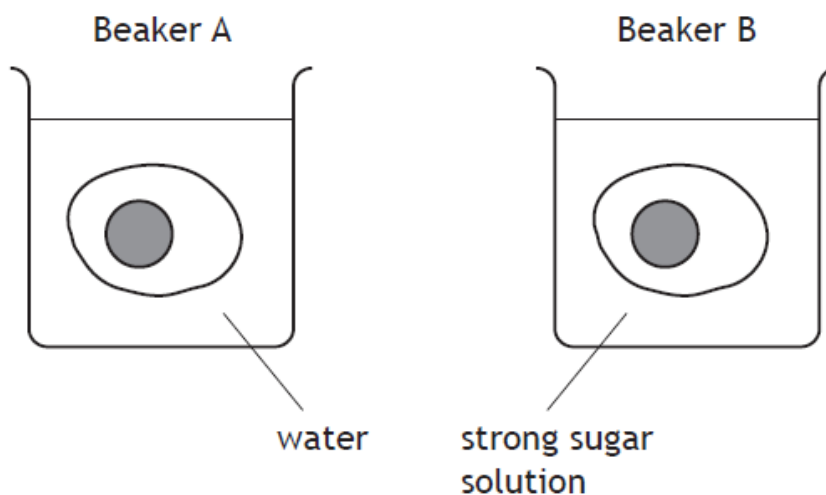
- (i) With reference to the aim of this investigation, give the conclusion that the tomato growers would have drawn from these results. 1

- (ii) The greenhouse containing tomato plants without predators was included as a control experiment.

State the purpose of the control in this investigation. 1

46. Shells can be removed from eggs by dissolving them in vinegar for 2–3 days. The egg contents remain inside a thin membrane.

In an investigation the shells from two eggs were removed. The eggs were then weighed and placed in beakers as shown below.



After 2 hours the eggs were removed from the beakers, blotted dry and reweighed. The results are shown in the following table.

<i>Beaker</i>	<i>Mass at start (g)</i>	<i>Mass after 2 hours (g)</i>	<i>Percentage change in mass</i>
A	54.0	67.5	
B	52.1	47.8	-8.2

Suggest why the eggs were blotted dry before being reweighed.

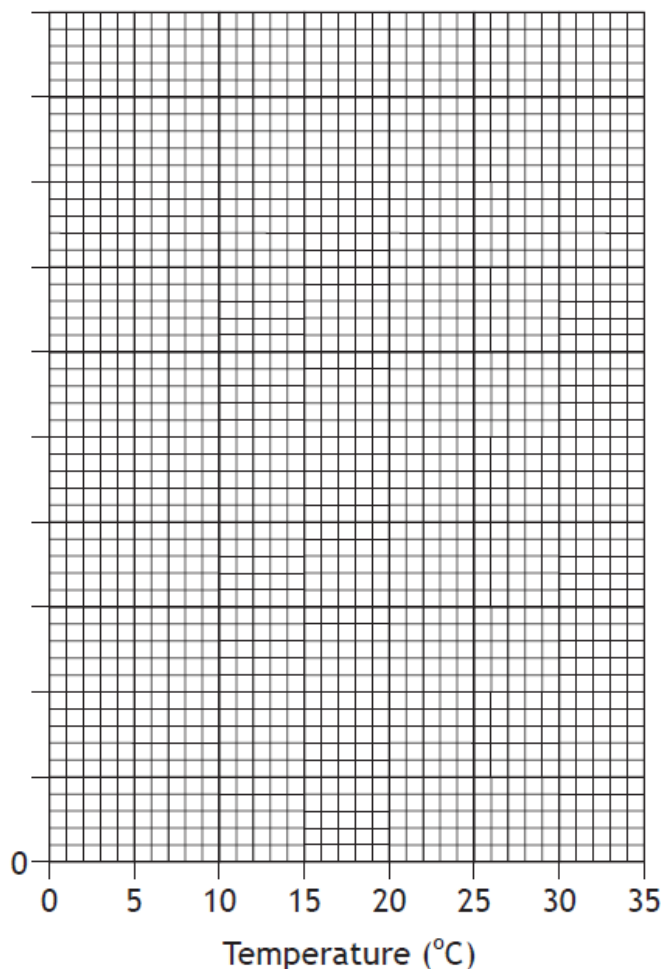
1



47. An experiment was set up to find out the optimum temperature for the growth of tomatoes in a glasshouse. The following table gives the results of this experiment.

Temperature (°C)	Fresh mass of tomatoes (g/plant)	Dry mass of tomatoes (g/plant)
14	1000	50
18	8300	415
22	9000	450
26	2200	110
32	1600	80

(i) On the grid below, complete the vertical axis and plot a line graph to show the effect of temperature on the dry mass of tomatoes. 2



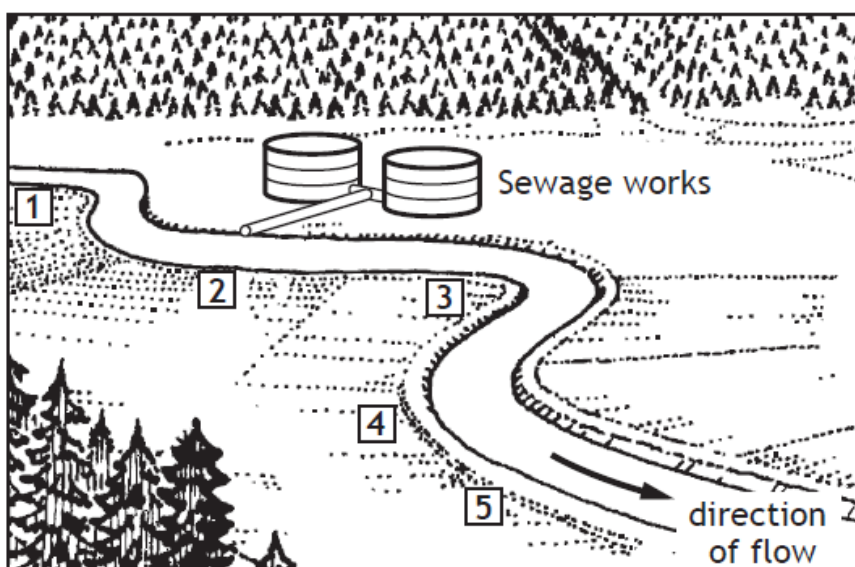
47 continued

- (ii) Above 26 °C the drop in the fresh mass of tomatoes continues at a steady rate.

Using the information in the table, predict the fresh mass of tomatoes which will be produced at 35 °C.

1

48. A river was sampled at five sites as shown in the diagram below.



The following tables show the results of analysing the samples at each site.

Table 1

Site	Oxygen levels (Units)	Number of bacteria per 100ml
1	1.2	500
2	0.04	150 000
3	0.40	12 680
4	0.54	3 400
5	1.12	1 250



48 continued

Table 2

Organism Present	Site 1	Site 2	Site 3	Site 4	Site 5
Mayfly nymphs	23	0	0	0	8
Stonefly nymphs	42	0	0	0	21
Caddis fly larvae	18	0	0	10	15
Fresh water shrimp	2	0	0	1	1
Blood worms	1	5	24	7	1
Sludge worms	1	67	43	9	0

(a) (i) Using data from Table 1, describe the relationship between the number of bacteria and the oxygen level in the water. 1

(ii) Methylene blue is a chemical which can be used to compare oxygen levels in the water. The lower the oxygen level, the faster methylene blue changes from blue to colourless.

A sample of water from each of the five sites was tested.

Predict which sample would lose its blue colour fastest. 1

(b) Use data from Tables 1 and 2 to answer the following questions.

(i) State which of the organisms in the samples would be found in areas of high oxygen content. 1

(ii) Sewage in the river is a form of water pollution.

Describe the effect this pollution has on the number of different types of organisms in this river. 1



49. Five leaves were collected from a horizontal stem and another five from a vertical stem. The widths of the leaves were measured and the results are shown in the table below.

leaf	Leaf width (mm)	
	Horizontal stem	Vertical stem
1	52	32
2	60	34
3	56	35
4	50	44
5	52	35
average	54	

The results show that leaves from a horizontal stem are bigger than leaves from a vertical stem.

Give a reason why these results might not be reliable.

1

50. Researchers have discovered an advantageous genetic mutation that causes high bone density in humans.

One man in the USA was discovered to possess this mutation after he walked away without injury from a serious car crash. Further studies have found several members of the same extended family with this mutation.



20 members of the family provided blood samples for DNA and biochemical testing. 7 of them were found to have high bone density. The same tests were performed on another group of 20 unrelated individuals with normal bone density.

The location of the gene mutation was able to be identified and it is hoped that the findings will help in developing medications to increase bone density for the treatment of conditions such as osteoporosis.

Explain why the biochemical tests were also performed on the 20 individuals with normal bone density.

1



51. A group of students carried out an investigation into the variety of cell types.



The types of cell they examined are shown in the box below.

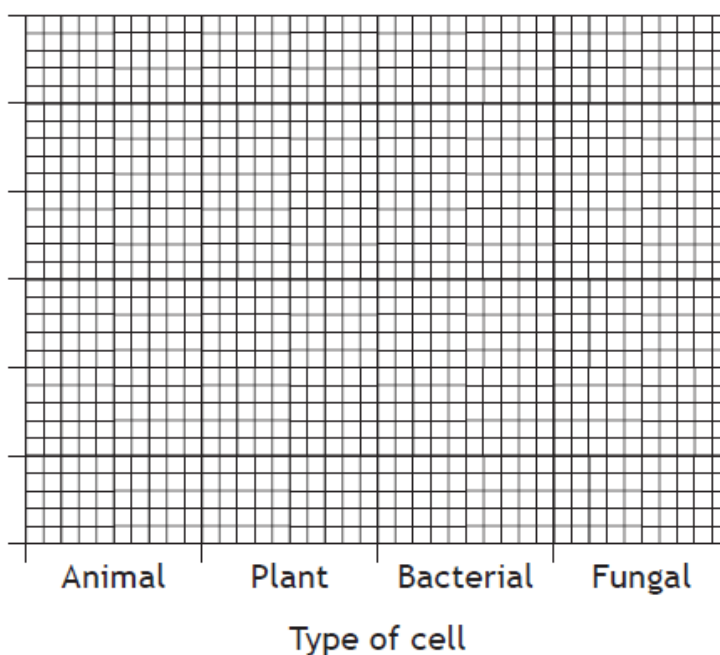
Animal	Plant	Bacterial	Fungal
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The students then measured a number of cells and calculated the average cell sizes. The results are shown in the table below.

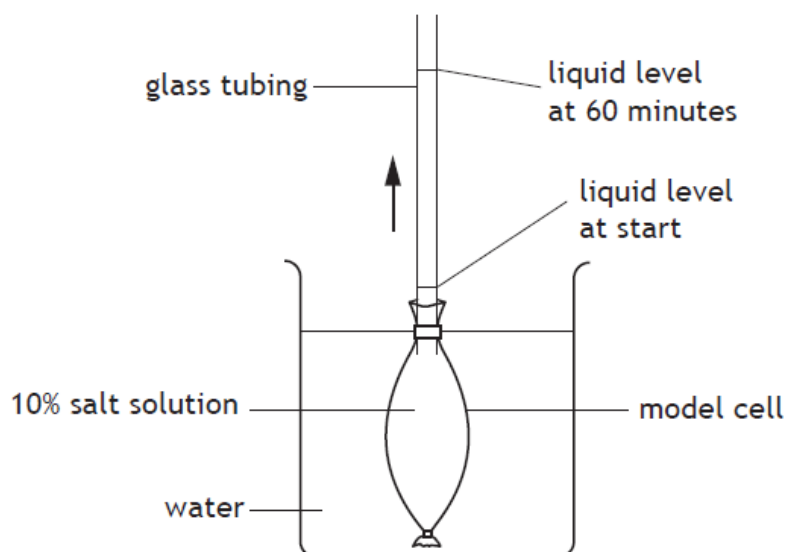
Type of cell	Average size of cell (μm)
Animal	24
Plant	48
Bacterial	3
Fungal	7

On the graph paper below, complete the vertical axis and draw a bar chart to show the average size of the cells shown in the table.

2



52. The apparatus shown below was used to investigate the movement of water into and out of a model cell. The model cell had a selectively permeable membrane.



The liquid level in the glass tubing was measured every 10 minutes for 60 minutes.

The results are shown in the table below.

<i>Time (minutes)</i>	<i>Liquid level (mm)</i>
0	10
10	22
20	32
30	40
40	48
50	56
60	64

When the investigation was repeated, the average rate of movement of liquid was slower.

Suggest one difference in the way that the investigation was set up that could have caused this change in results.



53.(a) Hydrogen peroxide can damage cells and lead to cell death. Catalase is an enzyme which breaks down hydrogen peroxide into oxygen and water.

Scientists in New Zealand investigated the link between the level of catalase in sheep livers and the fat in their meat. The hypothesis was that the higher the level of liver catalase, the greater the fat content of the meat.

In the investigation, they examined 9 sheep with a high percentage of fat and 15 sheep with a low percentage of fat. The sheep with the high percentage of fat had an average catalase level of 4800 K/g and those with the lower percentage of fat had an average catalase level of 3600 K/g.

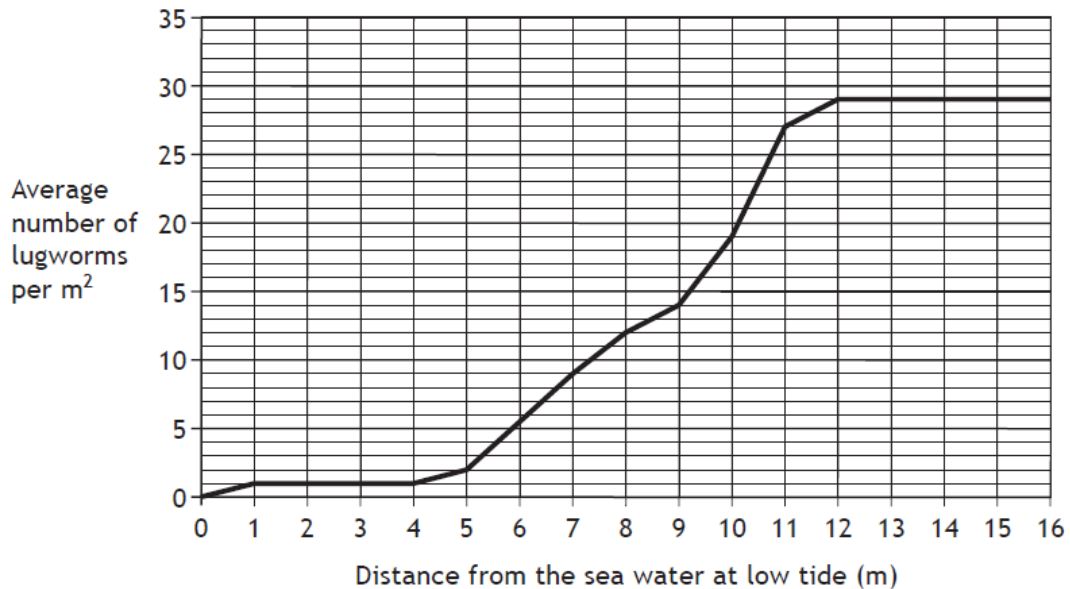
The scientists concluded that their hypothesis was correct.

(a) Identify an aspect in the planning of the investigation that would suggest that the hypothesis might not be proven correct. 1

(b) A further investigation proved that the hypothesis was correct.
Describe how this investigation could help farmers to select only sheep with a low percentage of fat, to provide meat for consumers following a low fat diet. 1



54. Lugworms live on the seashore in dark moist burrows under the sand. The graph below shows the average number of lugworms at different distances from the seawater at low tide.



Describe the relationship between the distance from the seawater at low tide and the average number of lugworms per m².

2

Ratios

55. An experiment was carried out to investigate stem height in pea plants.

The parent plants were both homozygous. When they were crossed the F₁ generation were all tall. These plants were then crossed with each other to produce the F₂ generation.

The results obtained in the F₂ generation differed from the expected results.

The actual results were 90 tall and 36 dwarf plants.

Calculate the simplest whole number ratio for these results.

1

_____ : _____
tall dwarf



56. The table shows some information about causes of adult deaths in Scotland.

<i>Cause of adult deaths</i>	<i>Number of adult deaths (per 100 000 population)</i>	
	<i>Males</i>	<i>Females</i>
Cancer	385	274
Coronary heart disease	165	105
Chronic obstructive pulmonary disease	71	58

Calculate the simple whole number ratio of male deaths to female deaths due to coronary heart disease.

1

_____ : _____
Males *Females*

57. In a survey of 90 students it was found that 25 of them had hitchhiker's thumb.

Calculate the number of students with straight thumb to hitchhiker's thumb as a simple, whole number ratio.

1

_____ : _____
straight hitchhiker's
thumb thumb



58. A study was carried out into the percentage of amino acids present in the blood of people with different diets.

One group tested were meat eaters and the other group were vegetarians.

In both groups, samples were analysed to show the percentage of amino acids in their food and in their blood after digesting the food.

The results are shown in the table.

Amino acid	Amino acid present (%)			
	Meat eaters		Vegetarians	
	In food	In blood	In food	In blood
Arginine	5.5	1.6	6.4	1.4
Leucine	8.0	5.4	7.0	5.0
Lysine	6.4	6.4	4.8	4.8
Serine	4.8	5.4	5.0	5.4
Threonine	4.0	3.8	3.8	3.8
Tyrosine	3.2	2.0	3.0	1.8

Calculate the simple, whole number ratio for tyrosine to serine in the blood of vegetarians.

1

_____ : _____
tyrosine serine

59. When 1000 people were surveyed, 625 people were found to clasp their hands with the left thumb on top.

What is the simple whole number ratio of left to right thumb people?

_____ : _____
left thumb right thumb

1



60. The following table shows the changes in the flow of blood through the capillaries in some body organs at rest and during exercise.

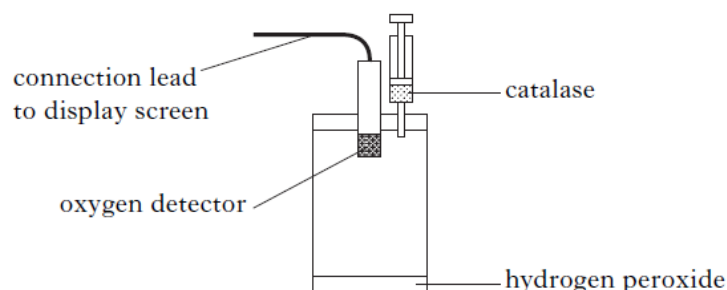
<i>Body organs</i>	<i>Capillary blood flow (cm³/min)</i>	
	<i>At rest</i>	<i>During exercise</i>
heart muscle	260	650
brain	760	760
skin	380	1200
intestine	1160	540

How does the capillary blood flow through the heart muscle at rest compare to that during exercise, expressed as a simple whole number ratio?

_____ : _____
at rest during exercise

1

61. The apparatus shown below was used to study the effect of different temperatures on the activity of the enzyme catalase.



The catalase was added and reacted with the hydrogen peroxide to release oxygen. The increase in oxygen compared to the starting value was recorded as a percentage.

This was carried out at five different temperatures and the results are shown below.

<i>Temperature (°C)</i>	<i>Increase in oxygen (%)</i>
4	0.55
21	0.80
34	1.45
40	1.05
50	0.05



61 continued

Calculate the simple whole number ratio of percentage increase in oxygen at 34 °C, 40 °C and 50 °C.

$$\frac{\quad}{34^\circ\text{C}} : \frac{\quad}{40^\circ\text{C}} : \frac{\quad}{50^\circ\text{C}}$$

1

62. Candytuft is a plant with white or pink flowers. The two forms of the gene responsible for the flower colour are:

P = pink flowers and **p** = white flowers.

The offspring actually consisted of 24 pink flowered and 16 white flowered plants.

What is the simplest whole number ratio of pink to white flowered plants in the offspring?

$$\frac{\quad}{\text{pink}} : \frac{\quad}{\text{white}}$$

1

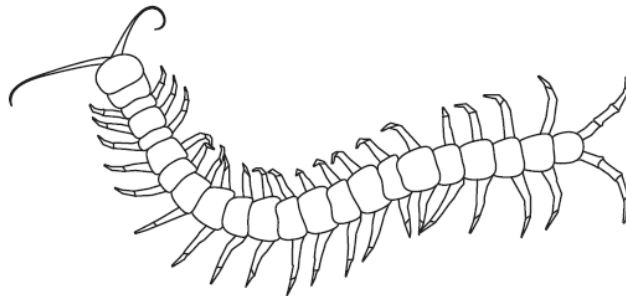


Keys

63. The following paired statement key can be used to identify invertebrate groups.

1. Six legs..... *Hexapoda*
More than six legs..... go to 2
2. 8 legs go to 3
More than 8 legs go to 4
3. Curved sting *Dromopoda*
No curved sting *Arachnida*
4. 1 pair of legs per body segment..... *Chilopoda*
2 pairs of legs per body segment *Diplopoda*

Use the key to identify the invertebrate group to which the following organism belongs.



- A *Dromopoda*
- B *Arachnida*
- C *Chilopoda*
- D *Diplopoda*



64. The following table gives information about some of the flowering plants found in the area.

<i>Plant</i>	<i>Height range (cm)</i>	<i>Flower colour</i>	<i>Flowering period (months)</i>
Pink Campion	30–90	pink	6
Ragwort	30–200	yellow	6
Meadow Grass	30–70	green	3
Buttercup	5–90	yellow	5

Using the information in the table, complete the three boxes in the paired statement key below.

3

- Flower colour is yellow go to 2
Flower colour is not yellow

- Height of plant can be over 100 cm Ragwort
Height of plant is under 100 cm

- Flowering period lasts only 3 months Meadow Grass
Flowering period is longer than 3 months



Pie Charts (collect pie charts from your teacher)

65. Nutritional information helps people make an informed choice about the food they eat.

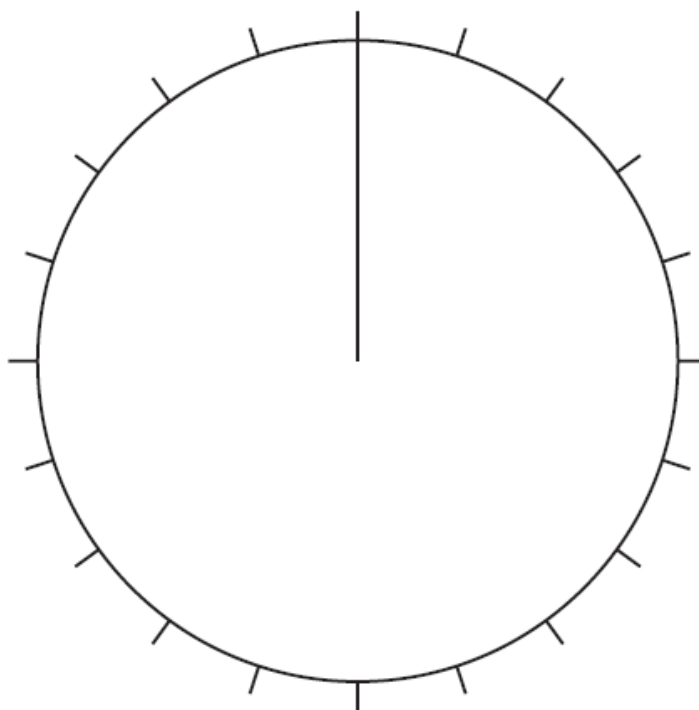
Table 1 – Label from a bar of chocolate

Nutritional information	per 100 g	per bar	% RI*
Energy (kJ)	2251	630	7.5
Sugar	65 g	18 g	15.6
Protein	10 g	2.8 g	3
Total fat	25 g	7 g	10
Saturated fat	20 g	5.6 g	28
Salt	0.4g	0.1 g	1.7

*RI = Reference Intake (formerly “guideline daily amount”)

Use the information in Table 1 to complete the pie chart below to show the composition of protein, sugar and total fat in 100 g of the chocolate.

2





66. During a woodland survey, a group of students measured some abiotic factors. Readings they took included the temperature of the soil and the air.

During the survey, the students sampled the leaf litter in the woodland using pitfall traps.

However, when they checked the pitfall traps four days after setting them up, the students discovered that they were all empty.

The error was corrected and the students set out the pitfall traps once again. The table below shows the types of invertebrates and numbers found.

<i>Invertebrates</i>	<i>Number found</i>
Woodlice	35
Beetles	20
Slugs	0
Spiders	30
Snails	15

Use the information in the table to complete the pie chart below. 2

