

Focus on success: GCSE science

A03

Build on your students' assessment performance using our self-guided, modular training pack

Biology data
source booklet



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Introduction

In this booklet you will find information from the legacy ISAs which you can use in class with students to develop their AO3 skills. As you look at the materials you will see that they are also relevant for developing many aspects of AO2, particularly if you are looking for practicals set in a different context from what the students have properly experienced in class.

Not all of the legacy ISAs are relevant to use with the new specification, so we have listed only those that have links either to the required practicals or to areas of the subject content where the information could be useful in teaching. The full range of legacy ISA materials are available on [e-AQA](#).

The information we have given for each ISA depends on whether it has a link to the current required practicals.

ISAs linked to the required practicals (RPs)

For these ISAs we have supplied the following materials

- Title
- Context: Brief overview explaining the purpose of the investigation and possible context the teacher could use to set the investigation in.
- Method sheet outlining how you could carry out the practical. If you are carrying out one of the **required practicals** you might find the method sheets in the [practical handbook](#) more useful. Detailed guidance can be found for all the required practicals in the free practical handbooks which include technician and teachers notes plus student worksheets.
- The ISA Section 2 questions relate to both to the practical carried out and the case study for the ISA.
- Section 2 Question 1

All parts of Question 1 in Section 2 are the same for each set of ISAs and refer to the method used. The focus of these questions is the same, regardless of the ISA and ISA set (A, B, etc), so we have selected the most common ones to present here (page 7). They can be applied to all the methods. If you would like to see the original questions for each practical these can be found with the full ISA resources on SKM.

If you are using these questions with the practical lessons from the required practicals students have to carry out, then you will be able to use the students' own data. If you are using them for revision then results for each RP are provided in the technician section of the practical handbook.
- Case studies

These will be very useful because, firstly they set the investigation in a different context which reinforces to students that, on the exam paper, questions will be set in unfamiliar context. Secondly they provide data sets that are the appropriate size and complexity to use with students to practice many of the skills needed in the new papers. These include graphing skills, a number of the maths skills and all the AO3 skills discussed in the previous activity. Teachers will be able to amend the data sets to match the ability of their students, for example, altering the numbers to include decimals raises the level of demand.
- Section 2 question 2

The second series of questions in section 2 refer to the data on the **secondary data sheet** which are the **case studies**. These questions are AO3 type questions and are very useful as the context for each case study will be unfamiliar. These questions could be used for

homework or to stimulate a discussion during intervention lessons. This is another opportunity to ensure students understand the command words and really do write explanations rather than descriptions.

ISAs linked to areas of subject content

Some of the ISAs do not have a direct links to a required practical but do contain information that is covered in the specification so could be used in teaching these particular areas of the subject content. For each of these ISAs we have given the following:

- ISA title
- context
- case studies.

When you carry out any practical it is the school's responsibility to carry out a risk assessment and any preparatory work to ensure the practical works.

ISAs linked to the required practicals

ISA title	Brief summary of experiment	Link to RPA (Biology/Trilogy/Synergy)
BU2.2 Photosynthesis	Effect of light intensity on photosynthesis	Biology 6/Trilogy 5/Synergy 10
BU2.6 Factors affecting photosynthesis	Effect of coloured light on rate of photosynthesis	Biology 6/Trilogy 5/Synergy 10
BU3.2b Solutions	Concentration of sucrose solution affecting osmosis	Biology 3/Trilogy 2/Synergy 4
BU1.5 Plant extracts	Plant extracts having antibiotic-like properties	Biology 2
BU1.6 Human coordination	Practice improves human coordination	Biology 7/Trilogy 6/Synergy 8
BU3.6b Surface area	Effect of surface area on water uptake (osmosis)	Biology 3/Trilogy 2/Synergy 4
BU2.7 Enzymes	Factor affecting an enzyme-controlled reaction	Biology 5/Trilogy 4/Synergy 20

Section 2 Question 1:

Possible questions to use with the method sheets

- 1 (a) (i)** Do your results support the hypothesis that you investigated?

You should use any pattern that you can see in your results to support your answer.

You should include examples from your results.

- 1 (a) (ii)** Did you get any anomalous results?

Explain your answer.

Your explanation should include examples from your results.

- 1 (b)** Describe in detail how you could use repeated readings to obtain more accurate results.

- 1 (c)** What was the independent variable in the investigation that you did?

.....

What was the range of the independent variable?

The range was from to

Explain why this was or was not a suitable range.

What was the dependent variable ?

One control variable was?

- 1 (d)** Most investigations contain errors or uncertainties.

What do you think was the cause of the largest error or uncertainty in your investigation?

.....

.....

What could you do to reduce the size of this error or uncertainty if you were to repeat the investigation?

Explain your answer.

BU2.2 Photosynthesis

Context:

Investigating factors that affect the rate of photosynthesis. This was covered by two ISAs one investigating light intensity and the other how the wavelength of light effects the rate. The method below is investigating the effect of light intensity. Students could develop their own hypotheses and identify which variables to control and what the dependent variable and independent variables are. These ideas could be set in the context of the importance of lighting in an aquarium, or the effect of increasing carbon dioxide concentrations on the growth of terrestrial or marine plants

Additional Science / Biology Controlled Assessment

BU2.2 Photosynthesis

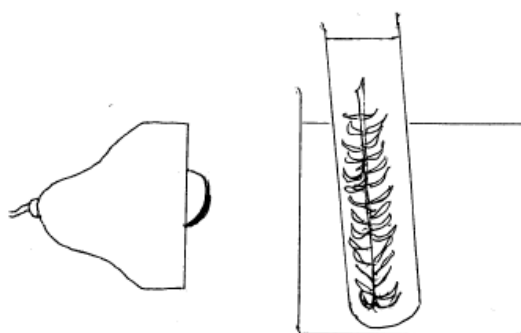
This method could be used to investigate the following hypothesis:

'The rate of photosynthesis depends on light intensity.'

You will need to prepare a table for the results.

Equipment:

Large glass beaker (250 – 400cm³)
Boiling tube
Pondweed
Bench lamp
0.2% sodium hydrogen carbonate solution
Metre or half metre rule
Stop clock
Scissors



Method:

1. Pour sodium hydrogen carbonate solution into the boiling tube so that it is nearly full.
2. Using scissors, cut the stem of the pondweed at an angle, so that you have a piece about three-quarters of the length of the boiling tube.
3. Put the pondweed into the boiling tube, cut end upwards, so that the cut end is about 1 – 2 cm below the surface of the solution.
4. Put the boiling tube into the beaker, three-quarters fill the beaker with tap water. (See diagram above.)
5. Turn on the bench lamp and place it very close to the beaker.
6. Measure the distance between the pondweed and the bulb.
7. Leave the apparatus for three minutes. (If bubbles do not appear from the cut end of the pondweed by the end of one minute, speak to your teacher.)
8. Count and record the number of bubbles emerging from the pondweed in one minute.
9. Move the bench lamp 10cm further away from the pondweed.
10. Repeat steps 6, 7, 8 and 9 until you have five sets of results.

Case studies

Case Study 1

A student investigated the effect of changing the temperature on photosynthesis by a piece of pondweed. The student counted the number of bubbles produced by the pondweed in one minute at each temperature.

The student kept all other conditions the same in each case.

The table shows the results.

Temperature in °C	Number of bubbles produced in one minute
5	7
10	15
15	21
20	24
25	24

Case Study 2

A group of students investigated the effect of changing the temperature on the volume of oxygen produced by a pond plant.

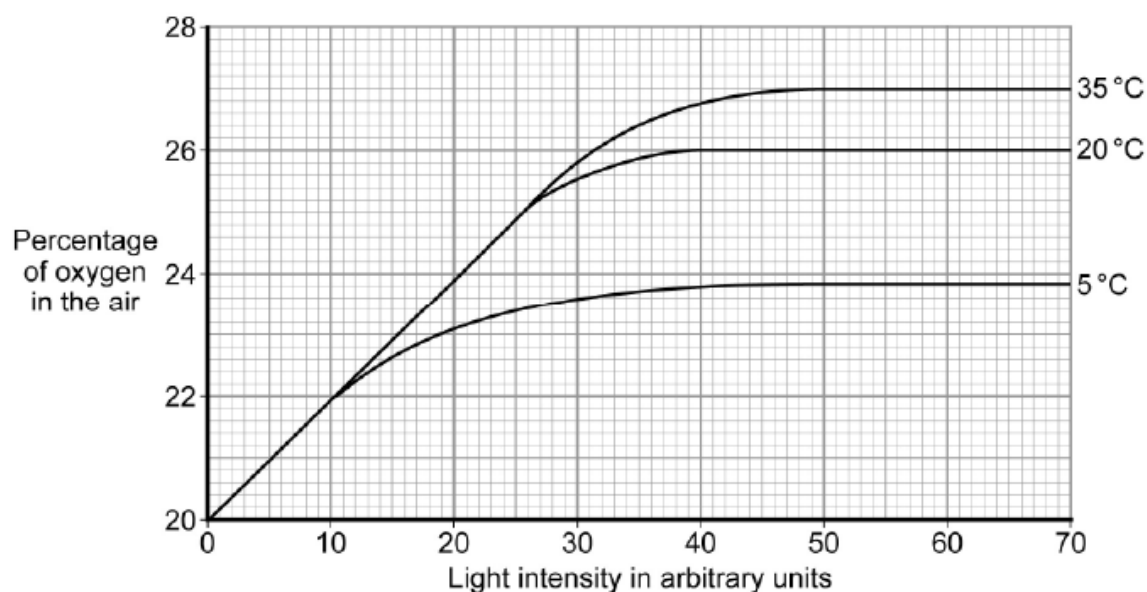
The table shows the results.

Temperature in °C	Volume of oxygen produced in mm ³ per minute			
	Trial 1	Trial 2	Trial 3	Mean
15	3	5	2	3
20	5	6	8	6
25	10	11	14	12
30	18	20	19	19
35	25	23	26	25

Case Study 3

Scientists investigated the effect of changing the temperature on the percentage of oxygen in the air around a plant at different light intensities.

Their results are shown in the graph.



Case Study 4

A gardener wanted to heat his greenhouses. The gardener investigated using an electric heater and a paraffin-burning heater.

The gardener controlled the temperature in different greenhouses using the two types of heater. He recorded the time taken between planting tomato seeds and the tomato plants growing to full size.

The tables show his results.

Using an electric heater

Temperature in °C	Time for tomato plants to grow to full size in days
16	139
18	128
20	117
22	106
24	99
26	95

Using a paraffin-burning heater

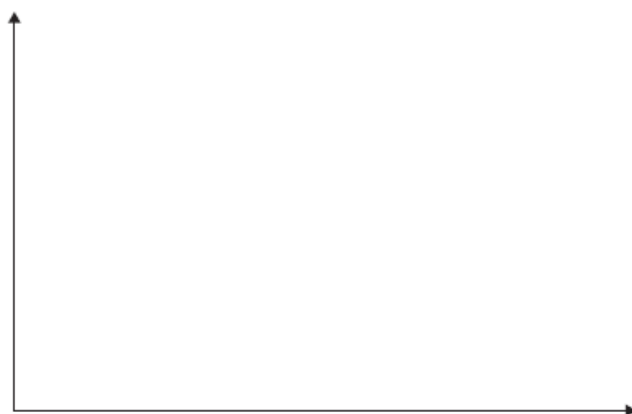
Temperature in °C	Time for tomato plants to grow to full size in days
16	138
18	127
20	116
22	105
24	94
26	83

Section 2 questions

2 You have been given a Secondary Data Sheet that provides results from similar investigations.

2 (a) Draw a sketch graph of the results in Case Study 1.

The graph should show how the number of bubbles produced by the pondweed in one minute varies with temperature.



2 (b) A gardener makes this hypothesis:

‘The higher the temperature, the faster photosynthesis will be.’

Look at Case Studies 1, 2 and 3.

Explain whether or not the results in Case Studies 1, 2 and 3 support this hypothesis.

To gain full marks, your explanation should include appropriate examples from the results in Case Studies 1, 2 and 3.

2 (c) Look at Case Study 4.

To what extent do the results support the gardener’s hypothesis? Explain your answer.

BU2.6 Factors affecting Photosynthesis

Case Study 1

A student investigated the effect of the wavelength of light on the rate of photosynthesis. The student measured the rate of photosynthesis by counting the number of bubbles of oxygen the plant produced in two minutes.

The table shows the results.

Wavelength of light in nanometres (and colour of light)	Number of bubbles of oxygen produced in two minutes
500 (blue)	80
550 (green)	30
600 (yellow)	40
650 (orange)	60
700 (red)	75

1 nanometre = 0.000 000 001 metres

Case Study 2

A group of students did a similar investigation to the student in Case Study 1. They measured the total volume of oxygen produced in two minutes.

The table shows the results.

Wavelength of light in nanometres (and colour of light)	Volume of oxygen produced in two minutes in mm ³			
	Trial 1	Trial 2	Trial 3	Mean
400 (violet)	14	17	18	16
450 (indigo)	39	32	34	34
500 (blue)	36	26	23	25
550 (green)	6	7	7	7
600 (yellow)	14	11	14	13
650 (orange)	23	21	25	23
700 (red)	27	25	25	26

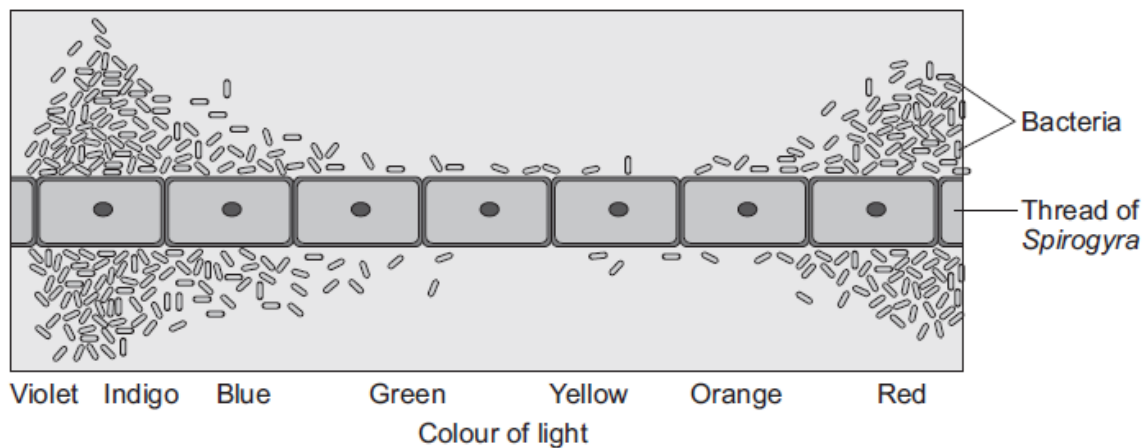
Case Study 3

Spirogyra is a simple pond plant growing in long threads.

A scientist shone light of different colours along the length of a thread of *Spirogyra*.

The scientist added bacteria to the water. The bacteria move to where there is the most oxygen.

The diagram shows the results.

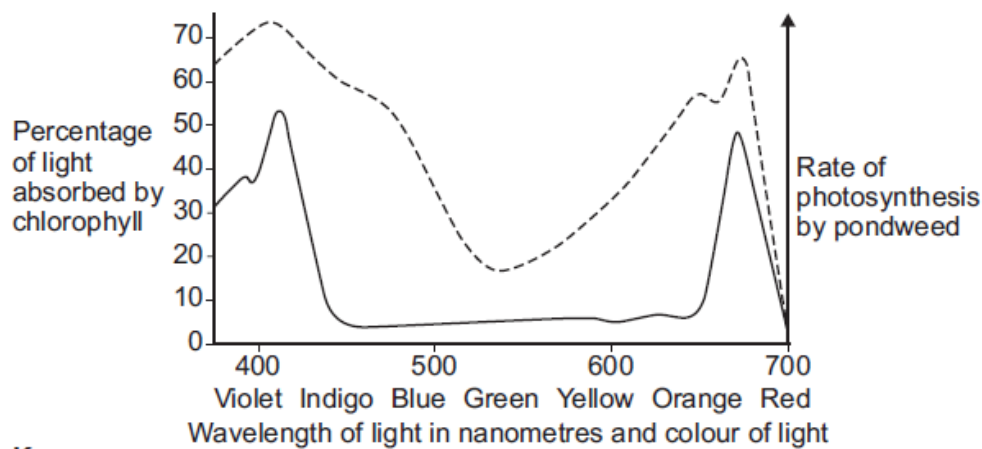


Case Study 4

Scientists collected a sample of pure chlorophyll from pondweed. They measured the percentage of light absorbed at different wavelengths by the chlorophyll sample.

The scientists also investigated the rate of photosynthesis by the pondweed at different wavelengths of light.

The graph shows the results.



Key

- Rate of photosynthesis by pondweed
- Percentage of light absorbed by chlorophyll

Questions for effect of wavelength on rate of photosynthesis

2 You have been given a Secondary Data Sheet with results from similar investigations.

2 (a) Draw a sketch graph of the results in Case Study 1.

The graph should show how the number of bubbles of oxygen produced in two minutes varies with the wavelength of light.

[2 marks]



2 (b) A student makes a hypothesis:

‘The wavelength of the light received by a plant affects the rate of photosynthesis.’

Look at Case Studies 1, 2 and 3.

Explain whether or not the results in Case Studies 1, 2 and 3 support this hypothesis.

To gain full marks, your explanation should include appropriate examples from the results in Case Studies 1, 2 and 3.

2 (c) The students who did the investigations in Case Studies 1 and 2 used the same method.

Explain why the students who did the investigation in Case Study 2 could be more confident of their conclusion than the students who did the investigation in Case Study 1.

2 (d) Look at Case Study 4.

A student says:

‘The rate of photosynthesis depends on the percentage of light absorbed by chlorophyll.’

To what extent does the information in Case Study 4 support the student’s statement?

Give reasons for your answer using information from Case Study 4.

BU3.2b Solutions

Context:

Investigate a factor that affects osmosis.

Students could develop their own hypotheses and identify which variables to control and what the dependent and independent variables are.

This method could be used to investigate the following hypothesis:

'The change in mass of plant tissue depends on the concentration of the solution it is placed in.'

You will need to prepare a table for the results.

Equipment:

Large potato

Knife and chopping board or tile

5 boiling tubes in a rack or beaker

Balance

Paper towels

Sucrose solutions (0.0, 0.5, 1.0, 1.5, 2.0 moles per dm³)

Measuring cylinder

Marker pen or sticky labels

Stoppers for boiling tubes or aluminium foil or cling film

Method:

1. Pour 30cm³ of each sucrose solution into separate boiling tubes, label the tubes.
2. Cut the potato into slices about 6 or 7 mm thick. Cut the slices into 'chips'.
3. From these chips of potato cut five of equal length, as long as possible, such that if they were put into the boiling tubes they would be submerged.
4. Gently blot the chips on paper towel to remove surface moisture.
5. Measure and record the mass of each potato chip.
6. Place the potato chips, one in each tube of solution, noting the mass of each chip in each solution.
7. Cover the tubes and leave them for as long as possible, between 30 minutes and four hours.
8. Remove each chip from the solution, one at a time; gently blot its surface on paper towel.
9. Measure and record the mass of each potato chip.

Case studies

Case Study 1

A student put 5 g slices of sweet potato into sugar solution of different concentrations. The student recorded the mass of the pieces of sweet potato at the start and then after 30 minutes. The student calculated the change in mass of each piece of sweet potato.

These are the results.

Concentration of sugar solution in moles per dm ³	Change of mass in grams
0.0	+ 0.5
0.5	+ 0.1
1.0	– 0.1
1.5	– 0.3
2.0	– 0.5

Case Study 2

A group of students did an investigation with slices of carrot. The students dried the surfaces of five slices of carrot, weighed them, and then put them into different concentrations of sucrose (sugar) solution. Three hours later, the students dried the surfaces of the carrot slices and reweighed them. The students repeated the investigation three more times.

These are their results.

Concentration of sucrose solution in moles per dm ³	Mean mass at the start in grams	Mean mass after 3 hours in grams	Mean percentage change of mass
0.2	4.15	4.26	+ 2.65
0.4	4.16	4.12	– 0.96
0.6	4.08	4.01	– 1.72
0.8	4.04	3.92	– 2.97
1.0	3.98	3.86	– 3.02

Case Study 3

When plant cells are put into a sucrose solution, the cell contents may swell up or shrink.



Students investigated the effect of different concentrations of sucrose solution on cells from a red onion. The students counted 100 cells and recorded how many had shrunken cell contents for each solution.

The table shows their results.

Concentration of sucrose solution in moles per dm ³	0.00	0.10	0.20	0.40	0.60	0.80	1.00
Number of cells, out of 100, with shrunken cell contents	1	1	5	35	76	95	98

Case Study 4

Scientists put pieces of potato into six different concentrations of salt solution. Each solution contained equal concentrations of a coloured protein. The large protein molecules had no effect on the concentration of the solution.

After four hours the scientists measured the colour intensity of each solution. They repeated their investigation two more times and calculated mean values.

The table shows their results.

The original colour intensity of the solution was 100.

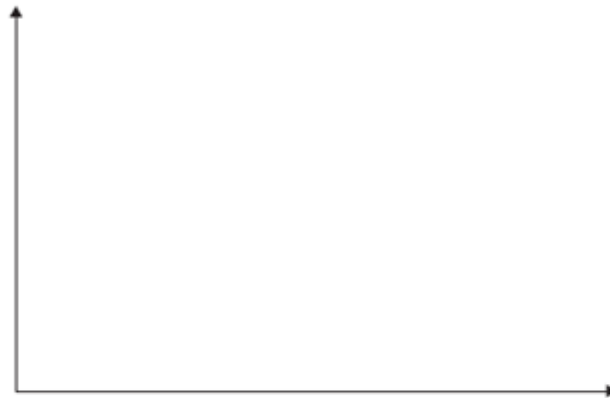
Concentration of salt solution in moles per dm ³	Colour intensity of solution after 4 hours			
	Trial 1	Trial 2	Trial 3	Mean
0.00	123	117	118	119
0.20	114	109	112	112
0.40	101	100	100	100
0.60	87	84	83	85
0.80	65	59	61	62
1.00	47	52	49	49

Section 2 questions

2 You have been given a Secondary Data Sheet that provides results from similar investigations.

2 (a) Draw a sketch graph of the results in Case Study 1.

The graph should show how the loss of mass by a plant varies with the wind speed.



2 (b) A farmer wanted to make his fields bigger. The farmer removed hedges from around his fields. The farmer then found he needed to water his crops more often to keep them healthy.

The farmer made this hypothesis:

'Increasing the wind speed on crops increases the amount of water the crops lose.'

2 (b) (i) Look at Case Studies 1, 2 and 3.

Explain whether or not the results in Case Studies 1, 2 and 3 support this hypothesis.

To gain full marks your explanations should include appropriate examples from the results in Case Studies 1, 2 and 3.

2 (b) (ii) Look at Case Study 4.

Do the results support the farmer's hypothesis? Explain your answer.

BU1.5 Plant extracts

Context:

Antibiotics are medicines that help to cure bacterial disease. Students have been given the hypotheses that extracts from some plants have properties similar to those of medical antibiotics. This idea can be set in the context of herbal cures and traditional remedies for infections.

This method could be used to investigate the following hypothesis:

‘Extracts from some plants have properties similar to those of medical antibiotics.’

Equipment

- | | | |
|--|--|--------------------------------------|
| • Test tubes containing plant extracts | • Disc containing a medical antibiotic | • Sticky tape |
| • Nutrient agar in Petri dish with ‘safe’ bacteria | • Forceps | • Scissors |
| • Filter paper discs | • Bunsen burner | • Marker pen or labels |
| | • Incubator set at 25°C or below | • Ruler or graph paper (for results) |

Method

- 1 Sterilise a pair of forceps for a few seconds in a Bunsen flame. Allow them to cool.
- 2 Use the forceps to pick up one of the filter paper discs and put it into a test tube containing a plant extract. Shake gently for 30 seconds.
- 3 Use the forceps to place the disc onto the agar jelly in the Petri dish, using sterile techniques. Use the marker pen or labels to label the base of the dish with the name of the plant extract.
- 4 Repeat steps 1 to 3, as necessary, using different plant material. Use the same Petri dish each time and space the discs around it.
- 5 Add a disc containing a medical antibiotic to the agar in the Petri dish.
- 6 Tape the dish and incubate it.
- 7 After incubation collect the Petri dish. Do **not** remove the tape or the lid at any time.
- 8 Measure the space where no bacteria are growing, around each disc.
- 9 Return the unopened Petri dish to the teacher.

Case studies

Case Study 1

Students investigated the effect of different concentrations of garlic extract on bacteria.

The students soaked small discs of filter paper in the extracts and then placed them onto *E. coli* bacteria growing on agar in a petri dish. The students incubated the petri dish for three days. They measured the diameter of the circle around each filter paper disc where no bacteria were growing.

The table shows their results.

Concentration of garlic extract in arbitrary units	Diameter of the circle where no bacteria were growing in cm
0	0.0
10	0.5
20	1.0
30	1.5
40	2.0

Case Study 2

A second group of students did a similar investigation to the group in Case Study 1.

These are their results.

Concentration of garlic extract in arbitrary units	Diameter of the circle where no bacteria were growing in cm			
	Trial 1	Trial 2	Trial 3	Mean
0	0.0	0.9	0.0	0.3
20	0.8	1.0	0.8	0.87
40	2.1	2.0	1.9	2
80	4.0	4.2	3.8	4
160	3.8	4.0	3.9	3.9

Case Study 3

Some scientists made different concentrations of garlic extracts in sterile nutrient solution. They added *B. subtilis* bacteria to the nutrient solution and incubated for two days. They measured the cloudiness of each mixture.

The more bacteria present, the cloudier the mixture becomes.

The table shows their results.

Concentration of garlic extract in arbitrary units	Percentage cloudiness of mixture after two days			
	Trial 1	Trial 2	Trial 3	Mean
0	100	98	99	99
10	88	84	85	86
20	45	40	41	42
40	22	23	20	22
80	9	12	12	11

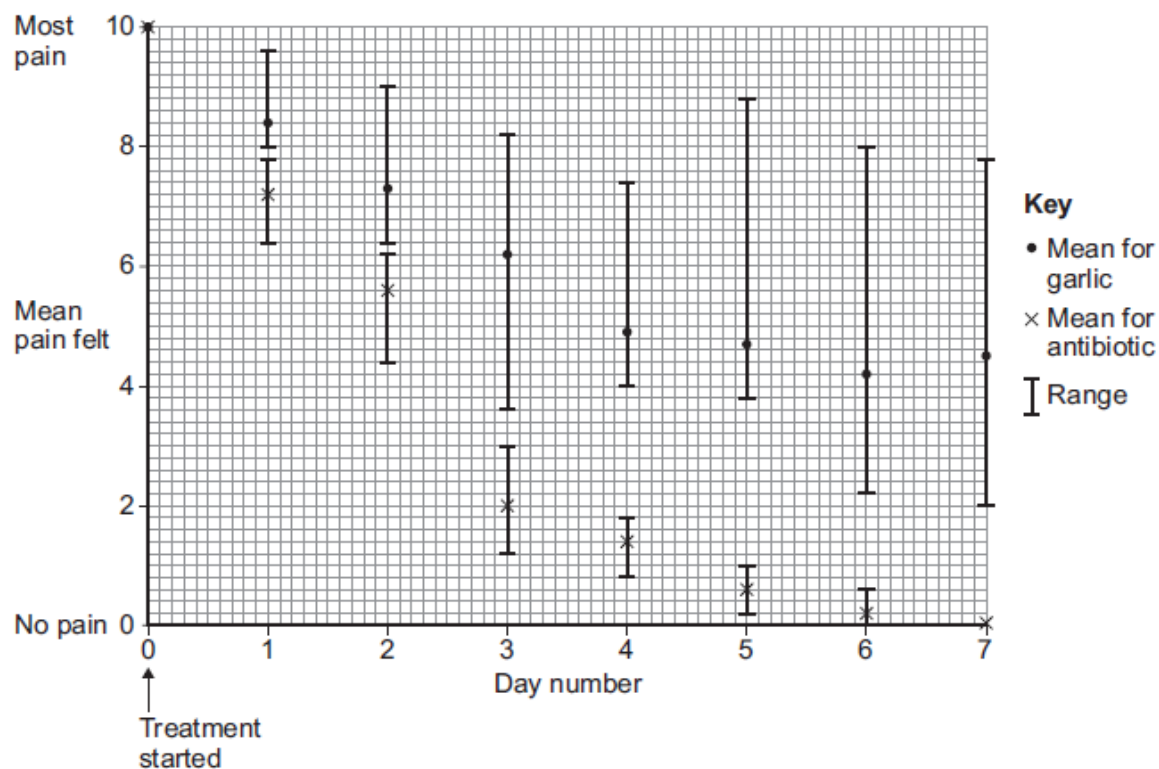
Case Study 4

In an investigation, doctors used 10 volunteers who had sore throats caused by a bacterium called *Streptococcus*.

The volunteers were divided into two similar groups. One group was given a course of garlic extract. The other group was given a course of an antibiotic.

The volunteers estimated the pain they felt from the sore throat each day for seven days, using a scale of 0 (no pain) to 10 (most pain).

The graph shows the results.



Section 2 questions

2 You have been given a Secondary Data Sheet with results from similar investigations.

2 (a) Draw a sketch graph of the results in Case Study 1.

The graph should show how the diameter of the circle where no bacteria were growing varied with the concentration of garlic extract.



2 (b) Look at Case Study 2.

The students have recorded the mean values of the diameter of the circle where no bacteria were growing.

What mistakes did the students make in calculating and recording the mean values?

Explain your answer.

2 (c) Look at Case Studies 1, 2 and 3.

A student suggested a hypothesis:

'The greater the concentration of garlic extract, the greater the number of bacteria that will be killed.'

Explain whether or not the results in Case Studies 1, 2 and 3, support this hypothesis.

To gain full marks, your explanation should include appropriate examples from the results in Case Studies 1, 2 and 3.

2 (d) Look at Case Study 4.

Sore throats may be caused by a bacterium called *Streptococcus*.

Doctors compared garlic extract with an antibiotic on their ability to relieve the pain caused by *Streptococcus*.

Use the graph in Case Study 4 to compare the effectiveness of the two treatments on *Streptococcus*.

You should also consider the limitations of the evidence.

BU1.6 Human coordination

Context:

The nervous system enables humans to react to their surroundings and coordinate their behaviour. Students are given the hypothesis that human - coordination improves as the amount of practice increases. This idea could be set in the context of driving a car and the need to react quickly to changing conditions or the need for fast reactions when playing sports.

This method could be used to investigate the following hypothesis:

'Human co-ordination improves as the amount of practice increases.'

Equipment

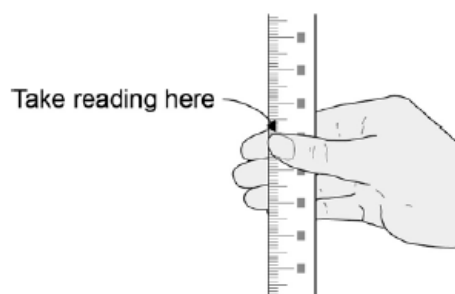
Metre rule

A conversion table

Figure 1



Figure 2



Method

- 1 You should use your 'weaker' hand for this investigation (eg if you are right handed, use your left hand).
- 2 Rest your arm on the table with your hand projecting over the edge.
- 3 Your partner should hold the metre rule vertically above your hand with the zero mark level with the top of your thumb, as shown in **Figure 1**.
- 4 Without warning, your partner should drop the ruler. You should catch the ruler as quickly as possible.
- 5 Record the reading from the ruler for the 'catch' reaction, as shown in **Figure 2**.
- 6 Convert the reading from the ruler to reaction time, using the conversion table.
- 7 Repeat as necessary to test the hypothesis.

Case studies

Case Study 1

A right-handed student investigated co-ordination.

The student threw four hundred darts at the centre of a target using his left hand. He recorded the distance from the centre of the target for each dart thrown.

The table shows some of the results.

Dart number	Distance from the centre of the target to the dart in cm
1	6.3
100	4.0
200	2.3
300	1.2
400	0.7

Case Study 2

Three other right-handed students did a similar investigation to the student in Case Study 1. Each student threw a total of 500 darts.

The table shows some of the results.

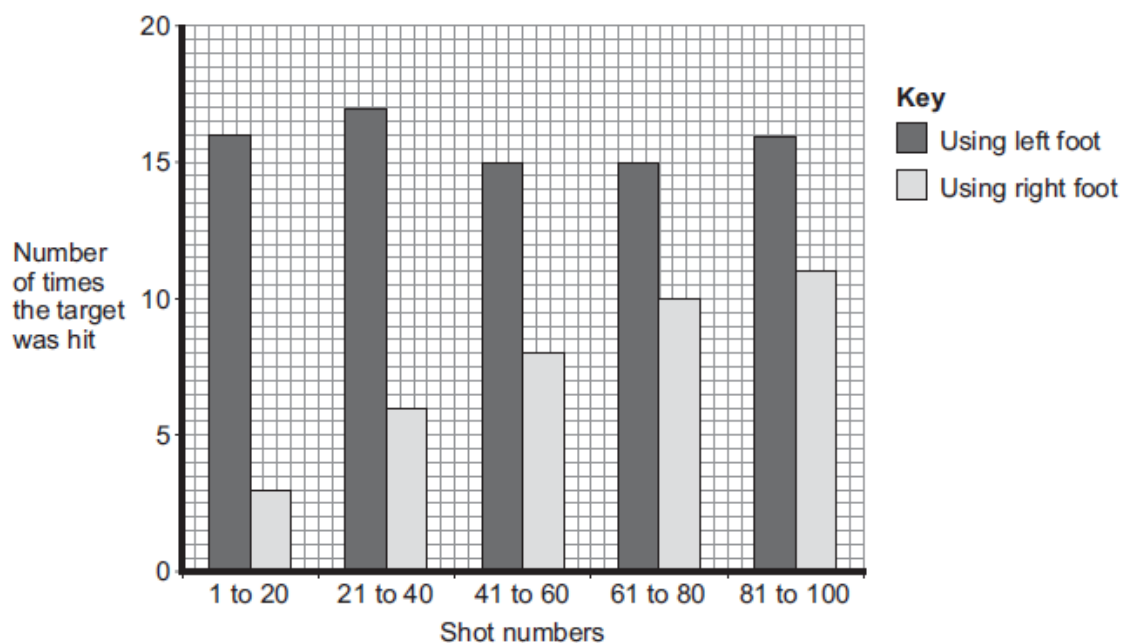
Dart number	Distance from the centre of the target to the dart in cm		
	Student 1	Student 2	Student 3
1	7.9	5.7	12.4
100	7.5	4.5	10.7
200	8.2	3.6	9.6
300	5.8	2.2	8.4
400	5.2	1.8	7.8
500	4.6	0.0	7.4

Case Study 3

A left-footed footballer practiced kicking a football at a small target. She kicked the football 100 times with her left foot, and then she kicked the football 100 times with her right foot.

The number of times she hit the target from a 10 metre distance was recorded after each 20 shots.

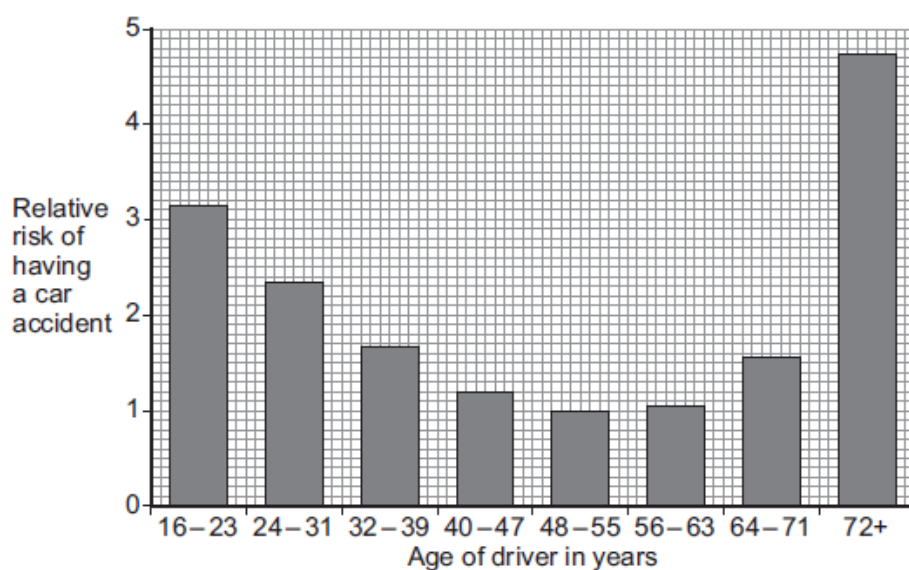
The chart shows the results.



Case Study 4

The bar chart shows the relative risk of drivers of different ages having a car accident.

The table shows the reaction times for people of different ages.



Age in years	Reaction time in seconds
20	0.28
30	0.24
40	0.30
50	0.32
60	0.41
70	0.48
80	0.52

Section 2 questions

2 You have been given a Secondary Data Sheet with results from similar investigations.

2 (a) Draw a sketch graph of the results in Case Study 1.

The graph should show how the distance from the centre of the target varies with the dart number.



2 (b) Look at Case Studies 1, 2 and 3.

A student states:

'The more often you repeat a task, the better you will become at doing it.'

Explain whether or not the results in Case Studies 1, 2 and 3 support this hypothesis.

To gain full marks, your explanation should include appropriate examples from the results in Case Studies 1, 2 and 3.

2 (c) A student looked at the information in Case Study 4.

The student concluded:

'The shorter a driver's reaction time, the lower the relative risk of having a car accident.'

To what extent does the information in Case Study 4 support this conclusion?

BU3.6b Surface area

Context:

Many organ systems are specialised for exchanging materials. The effectiveness of an exchange system is increased by having a large surface area. In humans the surface area of the lungs is increased by alveoli and the surface area of the small intestines is increased by Villi. The surface area of the roots is increased by root hairs and the surface area of leaf is increased by having a flattened shape and internal air spaces.

The students will investigate the effect of surface area on the uptake of water by plant or animal tissue. Suitable context include the consequence of partial intestine removal or gastrectomy on absorption of food or the effect of smoking on the lungs surface area available for gas exchange

This method could be used to investigate the following hypothesis:

'The surface area available for uptake affects the rate of uptake of water.'

Equipment

Pieces of potato (cubes of 2 cm sides)
Ruler
Knife & chopping board
Balance
100 cm³ beakers
Paper towels
Teaspoon
Stop clock

Method

- 1 Carefully dry off any surplus moisture from the surfaces of one of the 2 cm potato cubes by dabbing lightly with a paper towel.
- 2 Record the mass of the potato cube.
- 3 Put the potato cube into a beaker.
- 4 Cut a second potato cube into two equal halves and dab lightly with a paper towel.
- 5 Record the mass of both pieces together. Put them together into a different beaker.
- 6 Repeat this process, cutting other 2 cm potato cubes into even smaller pieces.
- 7 Add water to cover all the pieces of potato in each beaker, use a teaspoon to gently separate the pieces of potato as much as possible.
- 8 After ten minutes, pour away the water in each beaker, remove the pieces of potato and dab lightly with a paper towel.
- 9 Record the mass of potato from each beaker.
- 10 Calculate the total surface area of the potato in each beaker.
- 11 Calculate the percentage change in mass of the potato for each beaker. Use the formula:

$$\text{Percentage change in mass} = \frac{(\text{final mass} - \text{original mass}) \times 100}{\text{original mass}}$$

Case studies

Case Study 1

A student cut five 2 cm cubes of potato into different numbers of pieces to give different surface areas. The student put the potato pieces into water for 10 minutes, and then recorded the increase in mass of each original cube of potato.

The student kept all other conditions the same in each case.

The table shows the results.

Surface area of potato in cm ²	Increase in mass in g
24	1.2
32	1.6
40	2.0
48	2.4
56	2.8

Case Study 2

A group of students did a similar investigation to the student in Case Study 1, using apple not potato.

The students calculated the percentage increase in mass of the pieces of apple after 10 minutes.

The table shows the results.

Surface area of apple in cm ²	Percentage increase in mass			
	Trial 1	Trial 2	Trial 3	Mean
16	1.46	1.50	1.42	1.46
24	2.88	3.04	2.95	2.96
32	4.22	4.36	4.14	4.24
40	5.86	5.58	5.49	5.64
48	6.88	7.22	6.96	7.02
56	7.98	8.42	8.64	8.35

Case Study 3

A group of students investigated the effect of putting pieces of different plant material into a sugar solution for 20 minutes. The students calculated the percentage change in mass of the plant material after 20 minutes.

The table shows the results.

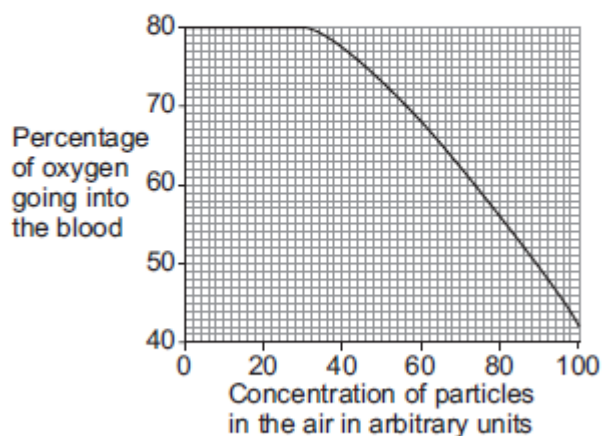
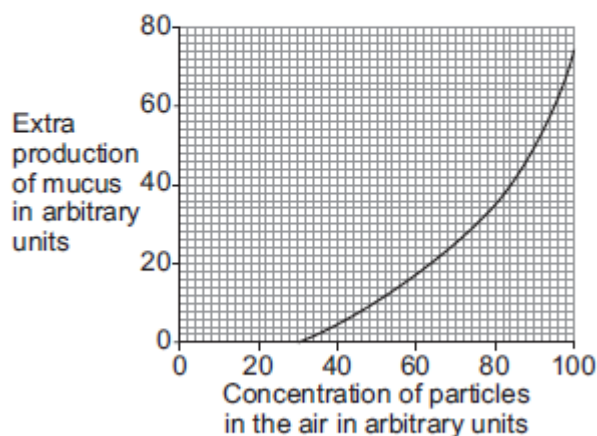
Type of plant	Surface area in cm ²	Percentage change of mass
Potato	50	Loss 12.6
	20	Loss 8.4
Carrot	28	Loss 9.6
	16	Loss 6.2
Sugar cane	22	Gain 4.8
	14	Gain 2.9

Case Study 4

We can breathe in tiny particles from the air. The tiny particles can make the cells at the surface of the lung produce extra mucus. The extra mucus reduces the amount of oxygen going into the blood.

Scientists investigated how smoke particles in the air affect mucus production and the amount of oxygen going into the blood.

The graphs show the results.



Section 2 questions

2 You have been given a Secondary Data Sheet with results from similar investigations.

2 (a) Draw a sketch graph of the results in Case Study 1.

The graph should show how the increase in mass varies with the surface area of potato.



2 (b) (i) A student makes this hypothesis:

'The greater the surface area the faster substances can move through the surface.'

Look at Case Studies 1, 2 and 3.

Explain whether or not the results in Case Studies 1, 2 and 3 support this hypothesis.

To gain full marks, your explanation should include appropriate examples from the results in Case Studies 1, 2 and 3.

2 (b) (ii) The students who did the investigations in Case Studies 1 and 2 used the same method.

Explain why the students who did the investigation in Case Study 2 could be more confident of their conclusion than the students who did the investigation in Case Study 1.

2 (c) People who live or work in smoky environments may have difficulty breathing.

Do the results in Case Study 4 support this idea?

Explain your answer using information from Case Study 4.

What other information might be needed in order for you to be sure of your conclusion?

BU2.7 Enzymes

Context:

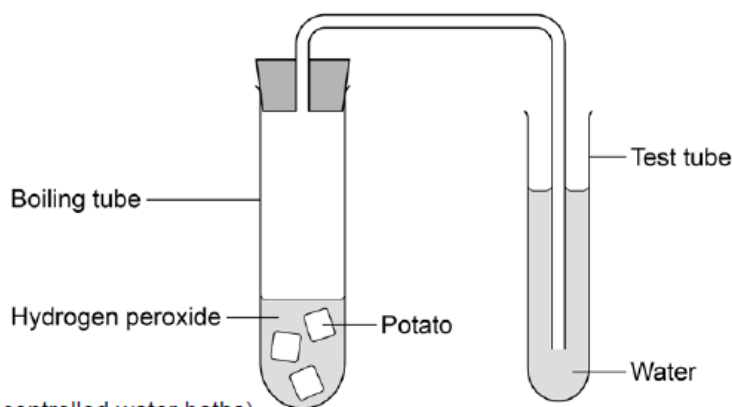
Protein molecules are made up of long chains of amino acids. These long chains are folded to produce a specific shape that enables other molecules to fit into the protein. Catalysts increase the rate of chemical reactions. Biological catalysts are called enzymes. Enzymes are proteins. The shape of an enzyme is vital for enzymes function. High temperatures change the shape. Different enzymes work best at different pH values. Suitable contexts include the design of low temperature washing powders or the need to manipulate the pH of a reaction for industrial uses of enzymes.

This method could be used to investigate the following hypothesis:

'The rate of an enzyme-controlled reaction depends on the temperature.'

Equipment:

Boiling tube with delivery tube
Test tube
Potato
Small plastic bag
Kitchen knife or scalpel
Cutting board or tile
Stop watch
Thermometer
Measuring cylinder or syringe to measure 10 cm^3
Hydrogen peroxide solution
Means of controlling temperature
(eg beakers + kettle **or** thermostatically controlled water baths)



Method:

- 1 Cut three cubes of potato. Each cube should be 0.5 cm by 0.5 cm by 0.5 cm.
- 2 Place these cubes into a small plastic bag.
- 3 Measure 10 cm^3 of hydrogen peroxide into a boiling tube.
- 4 Put the boiling tube and the plastic bag containing the potato into a water bath at $20\text{ }^{\circ}\text{C}$ for three minutes. Measure and record the temperature of the water bath.
- 5 Put the cubes of potato into the hydrogen peroxide and quickly set up the apparatus shown in the diagram. Keep the boiling tube in the water bath.
- 6 Count and record the number of bubbles passing out of the delivery tube into the water in one minute.
- 7 Repeat steps 1–6 for other temperatures. Use fresh hydrogen peroxide and potato each time.

Case studies

Case Study 1

A student investigated the effect of temperature on the rate of a reaction controlled by an enzyme. The student measured the rate of reaction by counting the number of bubbles of oxygen produced in one minute when hydrogen peroxide was broken down by the enzyme catalase.

The table shows the results.

Temperature in °C	Number of bubbles of oxygen produced in one minute
5	2
15	4
25	8
35	16
45	32

Case Study 2

A group of students did a similar investigation to the student in Case Study 1. They measured the total volume of oxygen produced in one minute.

The table shows the results.

Temperature in °C	Volume of oxygen produced in one minute in mm ³			
	Trial 1	Trial 2	Trial 3	Mean
5	4	3	3	3
15	7	9	8	8
25	12	16	15	14
35	25	29	26	27
45	15	54	58	56
55	14	18	15	16
65	2	3	0	2

Case Study 3

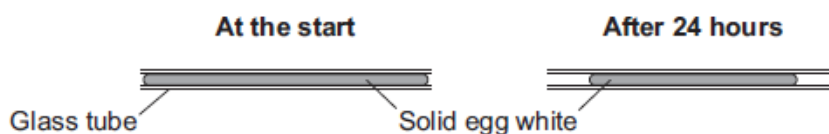
Egg white is made of protein.

Students investigated the digestion of egg white.

The students:

- filled six narrow glass tubes with fresh egg white
- boiled the tubes so the egg white became solid
- placed each tube into a different beaker containing protease enzyme at different pH values and different temperatures for 24 hours
- measured the length of solid egg white in each tube after the 24 hours.

The diagram shows the investigation.



pH	Temperature in °C	Original length of solid egg white in cm	Final length of solid egg white in cm
5	15	6.0	5.6
7	35	6.0	3.8
9	55	6.0	5.8

Case Study 4

Biological detergents contain enzymes; non-biological detergents do not contain enzymes.

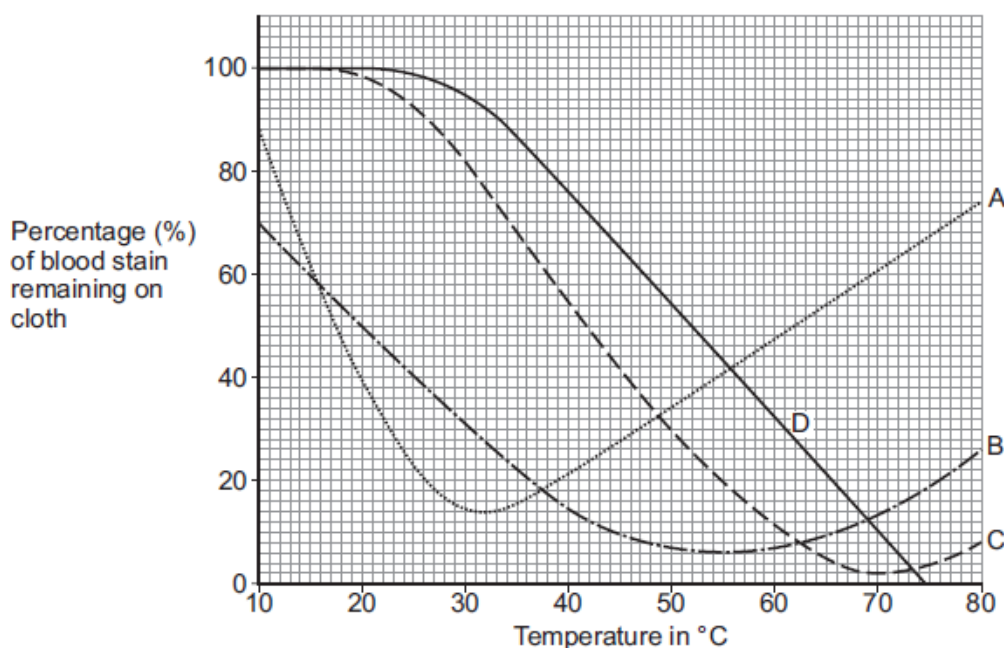
Scientists investigated the action of four detergents, A, B, C and D, in removing blood stains.

The scientists stained pieces of cloth with blood.

They washed the cloth in the different detergents, at different temperatures.

After drying the pieces of cloth, they estimated the percentage of blood stain remaining on the cloth.

The graph shows the results.

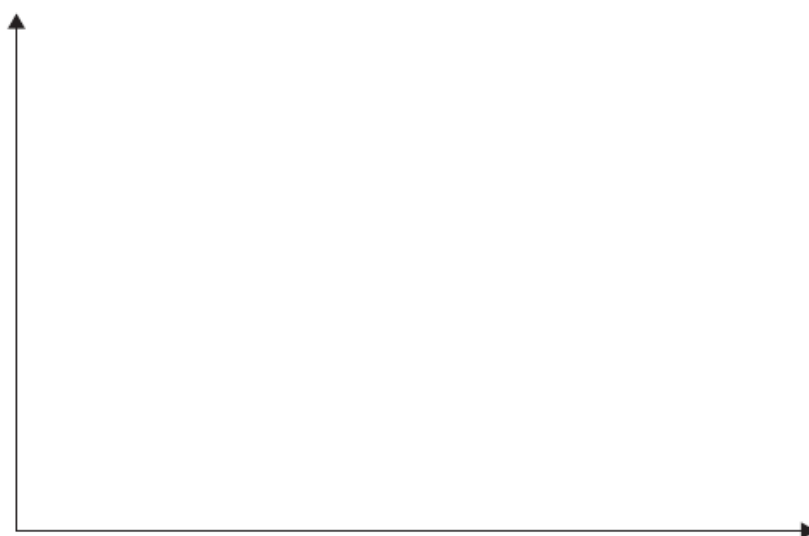


Section 2 questions

2 You have been given a Secondary Data Sheet with results from similar investigations.

2 (a) Draw a sketch graph of the results in Case Study 1.

The graph should show how the number of bubbles of oxygen produced in one minute varies with the temperature.



2 (b) A student makes a hypothesis:

'The temperature of a reaction controlled by an enzyme affects the rate of the reaction.'

Look at Case Studies 1, 2 and 3.

Explain whether or not the results in Case Studies 1, 2 and 3 support this hypothesis.

To gain full marks, your explanation should include appropriate examples from the results in Case Studies 1, 2 and 3.

2 (c) The students who did the investigations in Case Studies 1 and 2 used the same method.

Suggest **two** reasons why the students who did Case Study 2 could be more confident of their conclusion than the students who did Case Study 1.

Explain your answer.

2 (d) Look at Case Study 4.

Which detergent, **A**, **B**, **C** or **D**, would you suggest should be used in the home?

Give reasons for your answer using information about the effectiveness of the different detergents at different temperatures from Case Study 4.

What other information might be needed in order for you to be sure of your conclusion?

Further ISAs linked to areas of subject content

Context and case studies given

ISA title	Brief summary of experiment
BU1.1 Choices	Effect of light intensity on distribution of invertebrates
BU3.2a Water loss	Factor affecting water loss in plants
BU2.3 Field work	Light intensity affecting growth of plants
BU3.3a Stomata	Factor affecting number of stomata on leaf surfaces
BU1.4 Planting density	Growth depends on planting density
BU2.4 Diffusion	Factor affecting rate of diffusion
BU3.4b Biogas	Factor affecting production of biogas
BU2.5 Fatigue	Factor affecting speed of fatigue of muscles
BU3.5a Acid rain	Effect of acid concentration on germination or growth of seedlings
BU3.5b Lungs	Factor affecting volume of air breathed out
BU3.6a Body temperature	Factor affecting body temperature

BU1.1 Choices

Context:

Organisms, including microorganisms, have features (adaptations) that enable them to survive in the conditions in which they normally live. Students investigate the distribution of invertebrates in a habitat depends on the light intensity using a Choice chamber with four sectors and a transparent lid.

Case studies

Case study 1

Scientists discovered a new species of insect on a remote island. The scientists set up an investigation similar to yours to find the best conditions to keep some of the insects. The scientists recorded the position of 100 of the insects after 1 hour.

These are the scientists' results.

Light intensity in arbitrary units	0	25	50	75	100
Number of insects	60	23	12	3	2

Case study 2

Students collected some woodlice from a garden.

The students counted the number of woodlice they found in different places in the garden.

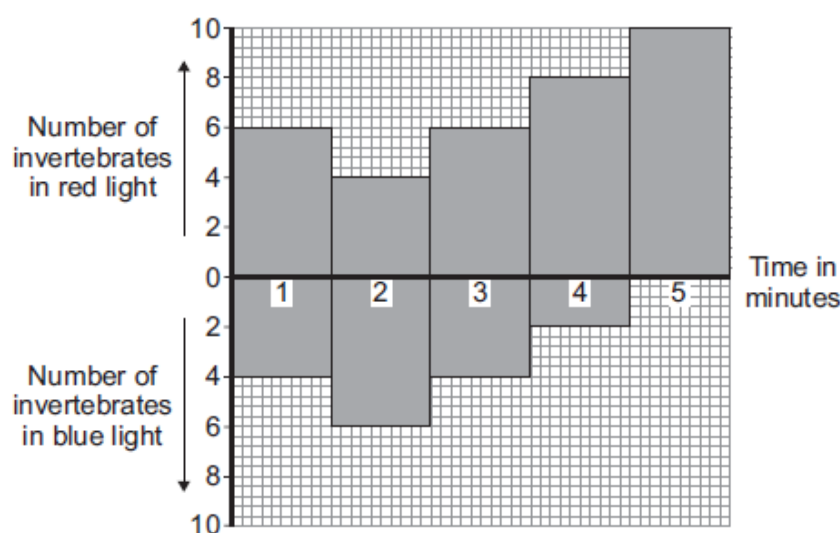
These are the students' results.

Part of the garden	Number of woodlice found
Under an old log	73
On the lawn	2
On the soil	5
In a pile of bricks	46
In a compost heap	53

Case study 3

Students completed an investigation to find out how an invertebrate responds to differences in the colour of light. The students set up a choice chamber giving ten of the invertebrates a choice of red or blue light for five minutes.

The chart shows the students' results.



Case study 4

Students investigated the distance a maggot moved in different light intensities.

The students shone light from a lamp at an angle across some black paper. The students placed the maggot on the paper close to the lamp.

Every 10 seconds the students marked the paper to show how far the maggot had moved away from the lamp. The students measured these distances. The students repeated the experiment using lamps with different light intensities.



The table shows the students' results.

Time in seconds	Total distance of maggot from starting point in mm		
	High intensity light	Medium intensity light	Low intensity light
10	9	5	3
20	16	10	4
30	22	14	5
40	27	17	6
50	31	19	7
60	34	21	7

BU3.2a Water loss

Context:

Plants mainly lose water vapour from their leaves. Most of the loss of water vapour takes place through the stomata. Evaporation is more rapid in hot, dry and windy conditions. Students investigate a factor that affects the rate of water loss from a plant or the rate of water uptake by a plant. This can be done using a length of capillary tube with rubber tubing at the end to allow attachment of leafy plant stem and a hairdryer to act as the wind. (see ISA teachers notes for further guidance)

Case studies

Case Study 1

A student recorded the mass of five potted plants. The student directed wind from a fan onto each plant. Each fan was set to give a different wind speed.

Twenty-four hours later, the student reweighed the potted plants. The student found that the plants had lost mass because they had lost water.

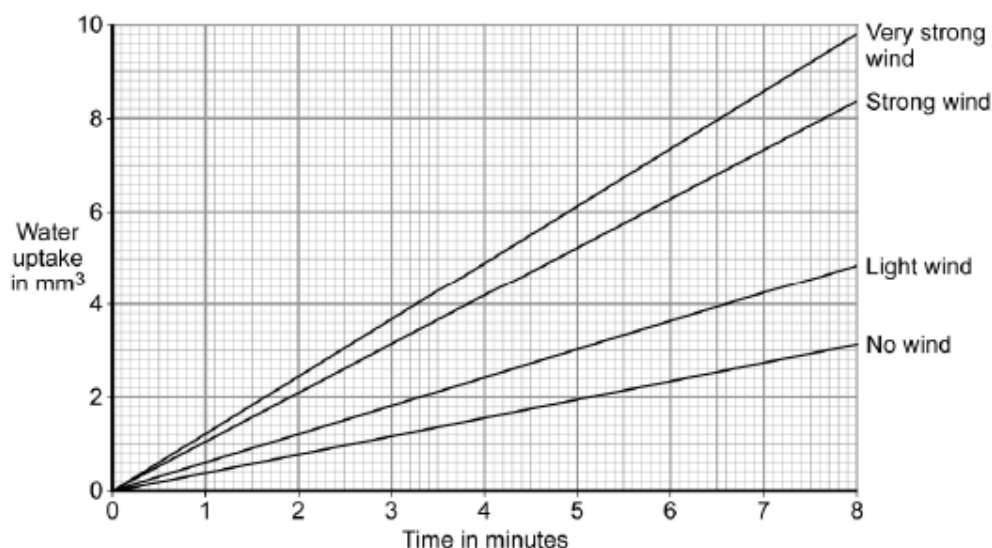
The table shows the results.

Wind speed in cm per second	Loss of mass in 24 hours in grams
0	10
10	18
20	26
30	29
40	30

Case Study 2

Some students recorded the water uptake by a leafy twig when it was exposed to four different wind speeds.

The results are shown in the graph.



Case Study 3

Plants lose most of their water through pores, called stomata, on the leaf surfaces. The stomata can open to release more water vapour and close to release less water vapour.

Scientists looked at the surface of leaves from plants that had been exposed to different wind speeds.

The scientists counted the number of stomata that were fully open and the number that were fully closed and calculated percentages.

The table shows the results.

Wind speed in cm per second	Percentage of stomata that were ...	
	fully open	fully closed
0	97	1
10	45	35
20	27	58
30	4	93
40	2	97

Case Study 4

Scientists investigated the effect of hedges on the need to water crops at different distances from the edge of a field.

The scientists set up two similar fields, one with a hedge that was 2 m high and one with a hedge that was 4 m high. They planted the same crop in each field.

The scientists measured the volume of water that they needed to add to each crop to keep the crop healthy.

The table shows the results.

Distance of crop from hedge in metres	Volume of water needed to keep crop healthy in arbitrary units	
	With a 2 m high hedge	With a 4 m high hedge
0.5	35	70
2	20	42
4	18	24
6	30	26
10	66	32
15	90	47
30	98	50

BU2.3 Field work

Context:

Physical factors that may affect organisms are: temperature, availability of nutrients, amount of light, availability of water and availability of oxygen and carbon dioxide.

Students investigated the effect of a physical factor that may affect the growth of plants in their natural environment. The method sheet investigated how light intensity effects the size of leaves in the place where the plant is growing. This was done by measuring the light intensity just above the plant then finding the fourth leaf down from the top of the stem and measuring the width of the leaf at its widest point and repeating the measurements for plants of the same species, growing in different places with different light levels.

Case studies

Case Study 1

A student grew bean plants in different parts of the garden. When the bean plants were 20 cm tall, the student measured the light intensity at mid-day in each part of the garden.

The student then measured the width of the largest leaf on each plant.

The table shows the results.

Light intensity, in arbitrary units	Width of largest leaf, in cm
0	No leaves
20	2.2
40	4.3
60	4.9
80	4.2
100	3.8

Case Study 2

A group of students investigated the effect of light intensity on the total leaf area of runner bean plants.

All other variables were kept the same. The table shows the results.

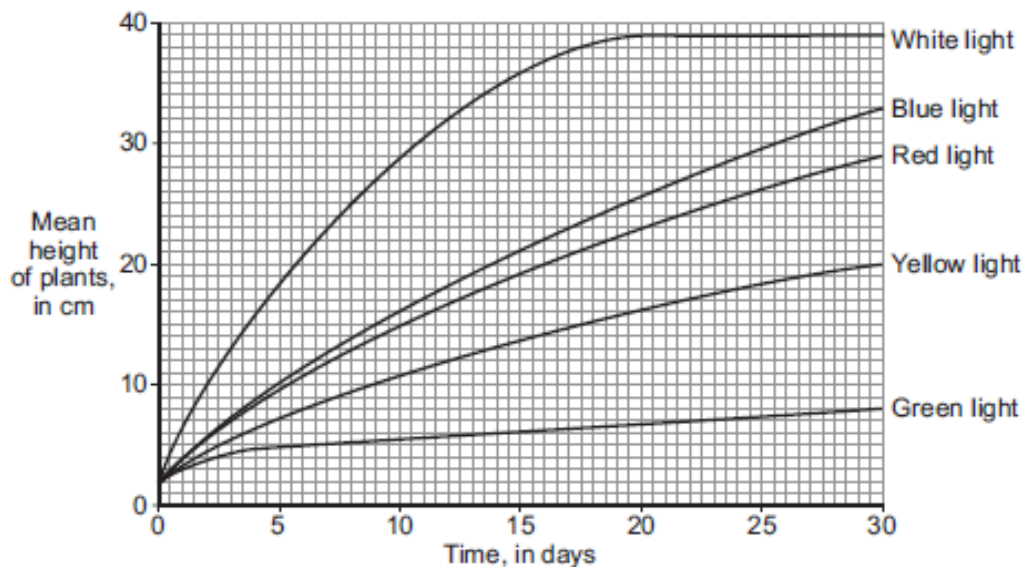
Light intensity, in thousands of lux	Total leaf area, in cm ²			
	Trial 1	Trial 2	Trial 3	Mean
2	477	523	489	496
4	536	567	545	549
6	658	662	623	648
8	636	617	618	624
10	524	499	532	518

Case Study 3

A scientist investigated the height of bean plants grown in different colours of light.

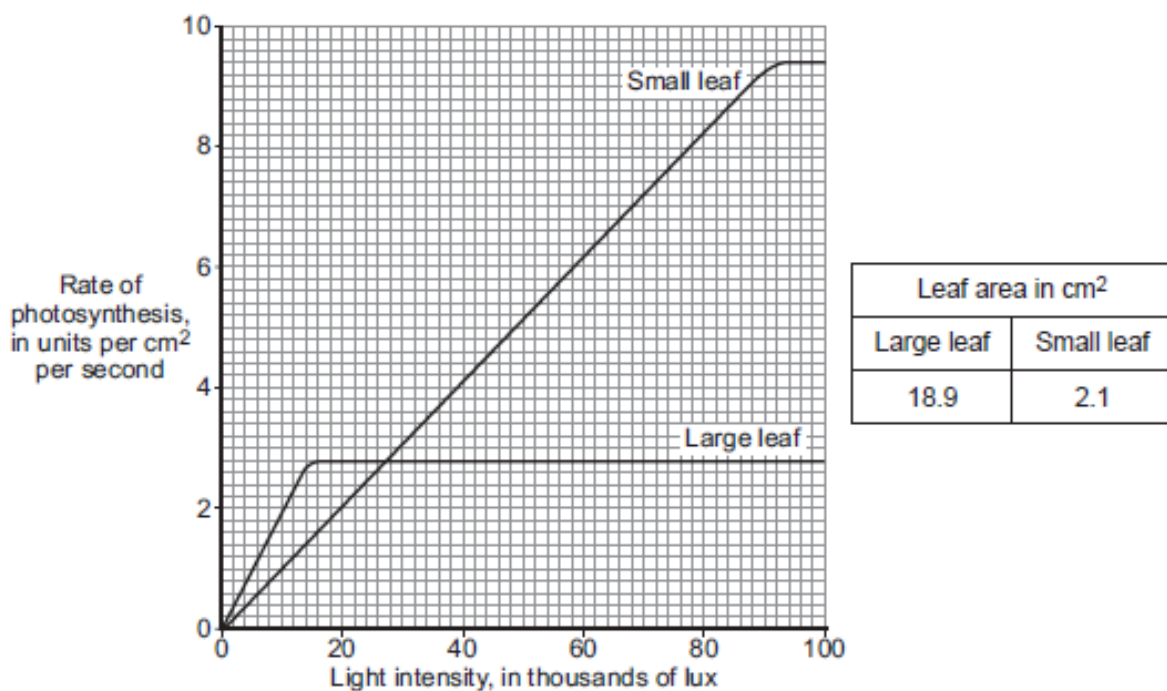
The scientist measured the height from soil level to the top of the plants for 30 days.

All other variables were kept the same for each plant. The graph shows the results.



Case Study 4

Scientists investigated the effect of light intensity on the rate of photosynthesis by two leaves of different size of the same species. The graph shows the results.



BU3.3a Stomata

Context:

Plants have stomata to obtain carbon dioxide from the atmosphere and to remove oxygen produced in photosynthesis. Students investigate a factor that may affect the number of stomata on leaf surfaces. Suitable contexts could include why plants normally found in aquatic/marsh conditions do not survive in arid conditions or why roses do not grow well in sandy soil.

The method sheet investigated the hypothesis that the number of stomata per mm² on the upper surface of a leaf is always different from the number of stomata on the lower surface of that leaf.

Case studies

Case Study 1

A student collected plants that grew in habitats with different soil moisture content.

The student measured the moisture content of the soil in each habitat, with a soil moisture probe.

The student then looked at the lower surface of a leaf from a plant growing in each habitat, using a microscope. The student counted the number of stomata he could see in one field of view of the microscope.

The student used the same magnification each time. The table shows the results.

Moisture content of soil in arbitrary units	Number of stomata in one field of view
2 (very dry)	30
4	41
6	46
8	48
10 (very wet)	49

Case Study 2

Scientists grew one plant of each of two species, A and B, from seed, in soil with different water contents.

After six months the scientists counted the numbers of stomata on the lower surfaces of leaves from each plant.

All other conditions the plants were grown in were kept the same. The table shows the results.

Water content as a percentage of the amount of water the soil can hold	Mean number of stomata on 1 mm ² of lower leaf surface	
	Species A	Species B
20	13	28
30	22	28
40	26	29
50	32	27
60	32	29

Case Study 3

Students recorded the number of stomata on the upper surface of leaves of different species of plant.

The table shows the results.

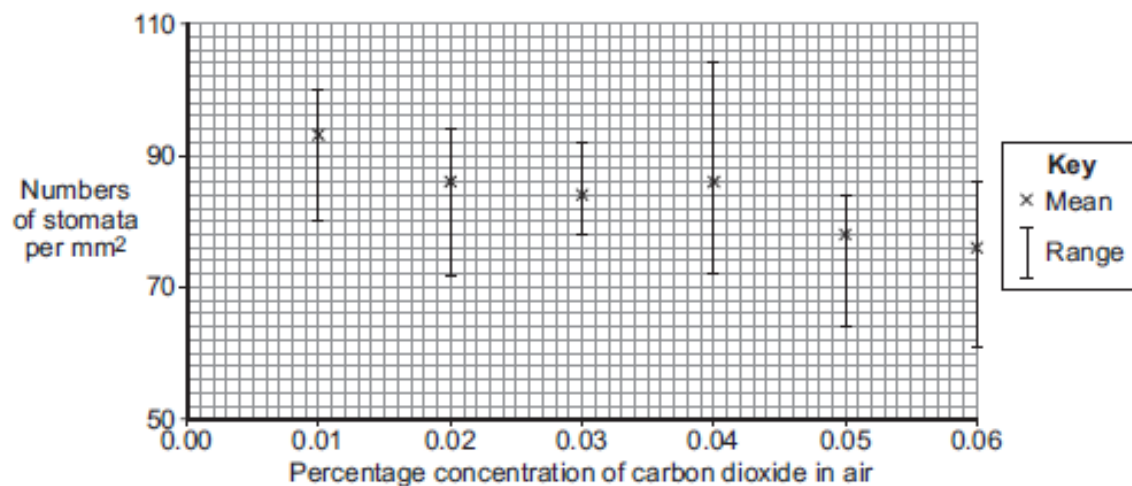
Plant species	Mean number of stomata on upper surface per mm ²
Maize	75
Holly	0
Sycamore	1
Dandelion	2
Wheat	63

Case Study 4

Scientists investigated the effect of different concentrations of carbon dioxide in the air surrounding ginkgo plants on the numbers of stomata.

The scientists plotted their results on a graph. The graph shows the mean value and the range of values for four leaves from ginkgo plants at each concentration of carbon dioxide.

The graph shows the results.



BU1.4 Planting density

Context:

Plants often compete with each other for light and space, and for water and nutrients from the soil. Suitable contexts could include advice to gardeners or commercial growers regarding the spacing of seeds when planting or the importance of correct spacing of plants to maximise yield or appearance. The method sheet investigated the hypothesis that the height of plants depends on how densely the seeds are planted.

Case studies

Case Study 1

A student investigated the effect of planting density on the height of radish plants. The student measured the height of the plants six weeks after planting the seeds.

The table shows the results.

Number of seeds planted per cm ²	Mean height of radish plants after six weeks in cm
1	15
10	15
20	12
30	6
40	3

Case Study 2

A group of students planted beans at different distances apart. After four weeks the students measured the total leaf area of three plants at each distance apart. All other variables were controlled.

The table shows the results.

Distance between bean plants in cm	Total leaf area in cm ²			
	Plant 1	Plant 2	Plant 3	Mean
5	56	63	58	59
10	82	49	88	73
15	104	110	112	109
20	112	128	124	121
25	118	126	130	125

Case Study 3

Scientists measured the girth (the distance around the trunk) of rubber trees for 5 years. The rubber trees were planted at different densities, in different parts of the same rubber tree plantation. The rubber trees all had a girth of 5 cm when planted.

The table shows the results.

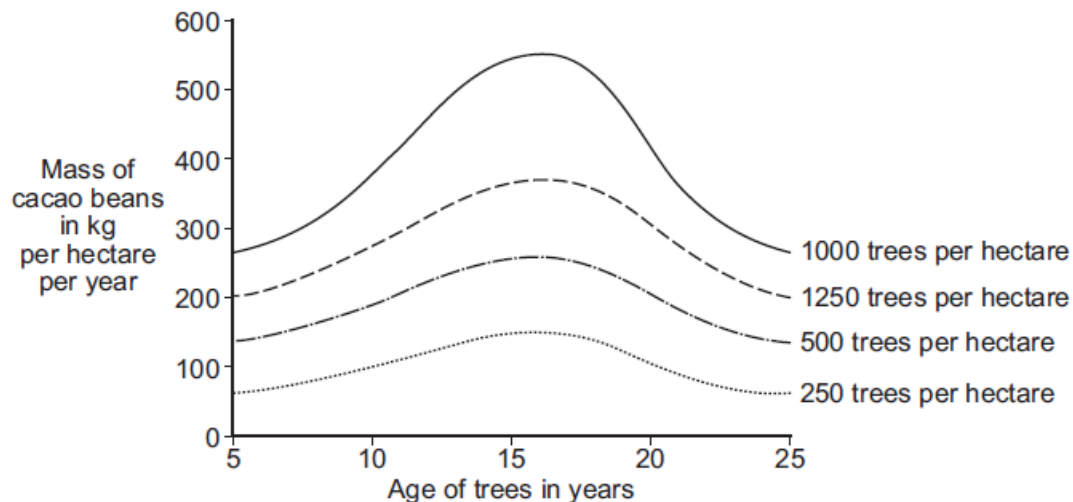
Number of trees per hectare	Time in years			
	2	3	4	5
	Mean girth of trees in cm			
500	15.7	28.6	38.7	48.6
700	23.1	38.0	47.0	60.1
1000	17.8	29.3	39.5	46.2

Note: 1 hectare = 10 000m²

Case Study 4

Scientists investigated the mass of cacao beans produced by cacao trees in different plantations in Sri Lanka. The plantations had trees of different ages and the cacao trees had been planted different distances apart.

The graph shows the results.



BU2.4 Diffusion

Context:

Diffusion is the spreading of the particles of a gas, or of any substance in solution, resulting in a net movement from a region where they are of a higher concentration to a region with a lower concentration. The greater the difference in concentration, the faster the rate of diffusion.

Examples of suitable contexts could include the need to ensure efficient exchange across artificial membranes in hospitals or the design of artificial membranes for delivering drugs in different parts of the body (eg in patches).

The method sheet investigated the hypothesis that the rate of diffusion depends upon the concentration of the substance that is diffusing. This was done by timing how long it took agar cubes containing alkali and cresol red indicator to become yellow, when Hydrochloric acid of various concentrations was added.

Case studies:

Case Study 1

A student investigated the effect of concentration on diffusion. The student took five identical blocks of agar jelly containing an indicator and an alkali. The indicator turns from pink in alkali to colourless in acid. The student put each block into a beaker of acid. The acids were of different concentrations. The student recorded the time taken for all of the indicator in each jelly block to change from pink to colourless.

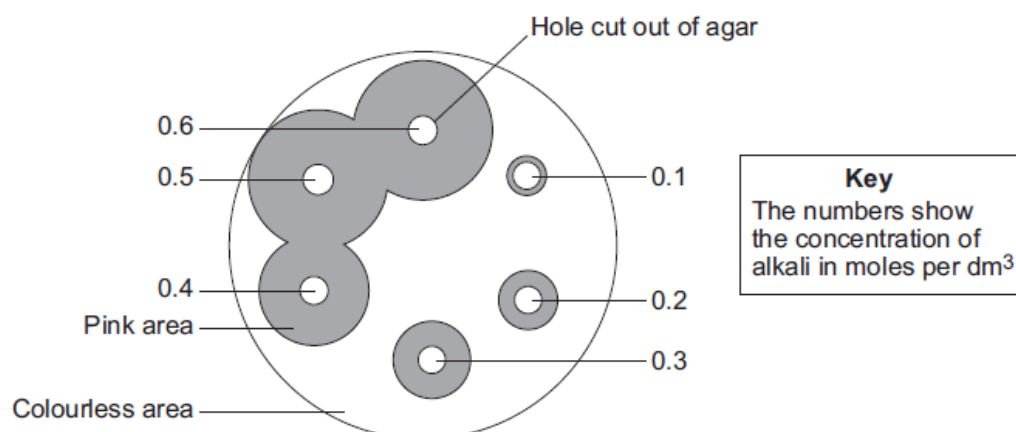
The table shows the results.

Concentration of acid in moles per dm^3	Time for all the indicator to change from pink to colourless in seconds
0.2	180
0.4	88
0.6	45
0.8	22
1.0	11

Case Study 2

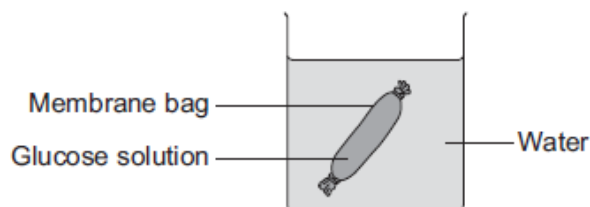
A student cut six small holes in a layer of agar jelly in a dish. The agar jelly contained acid and the same indicator as in Case Study 1. The student added alkali of a different concentration to each hole.

The diagram shows the results after one hour.



Case Study 3

Students investigated the diffusion of glucose through a membrane. The students put membrane bags containing different concentrations of glucose solution into beakers of water. After 10 minutes the students recorded the concentration of glucose in the water. All other variables were controlled. The diagram shows how the investigation was set up.



The table shows the results.

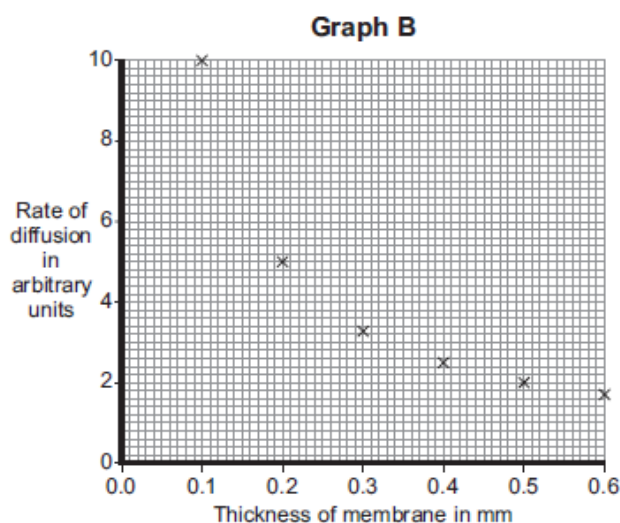
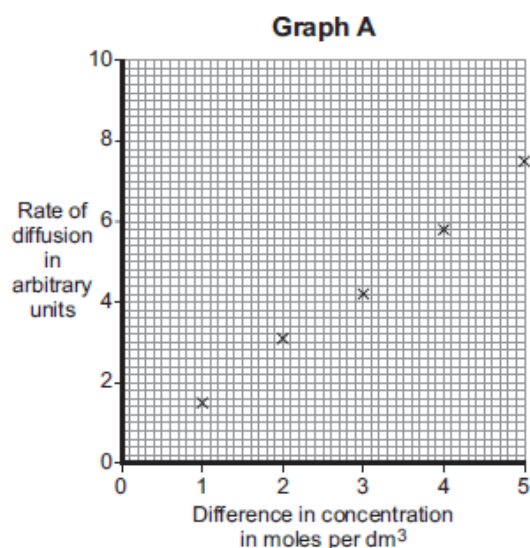
Concentration of glucose in membrane bag in moles per dm ³	Concentration of glucose in the water after 10 minutes in moles per dm ³			
	Trial 1	Trial 2	Trial 3	Mean
0.5	0.1	0.2	0.5	0.2
1.0	0.3	0.4	0.3	0.3
1.5	0.5	0.5	0.5	0.5
2.0	0.7	0.6	0.6	0.6
2.5	0.8	0.8	0.7	0.8

Case Study 4

Scientists investigated how the rate of diffusion is affected by:

- the difference in concentration of two solutions separated by a membrane
- the thickness of the membrane.

The scientists used their results to plot two graphs, A and B.



BU3.4b Biogas

Context:

Biofuels can be made from natural products by fermentation. Biogas, mainly methane, can be produced by anaerobic fermentation of a wide range of plant products or waste material containing carbohydrates. Suitable contexts could include the need to produce alternative sources of energy or the need to deal with large amounts of waste from human activities. The method sheet investigated how the amount of gas produced from yeast and glucose solution depends on the temperature of fermentation

Case studies:

Case Study 1

Students set up four biogas generators, kept at different temperatures. Each biogas generator contained the same amount and type of waste material. The students collected and measured the volume of biogas each generator produced.

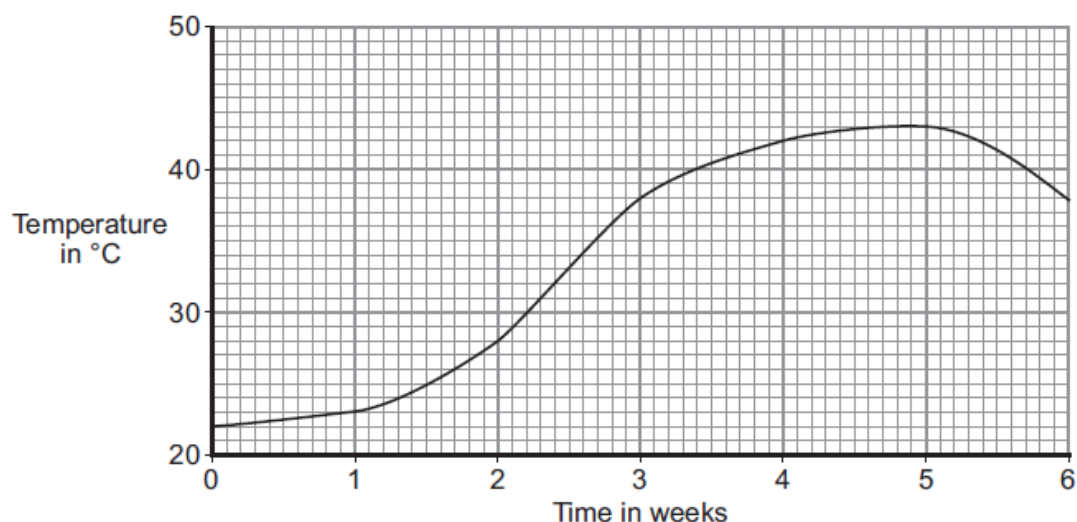
The table shows the results.

Temperature in °C	Volume of biogas produced in dm ³
10	8
20	16
30	32
40	64

Case Study 2

Scientists investigated how the temperature in a biogas generator changed for six weeks after the generator was started.

The graph shows the results.



Case Study 3

Scientists investigated the effect of temperature on the production of biogas, using cow manure. The scientists recorded the volume of biogas produced at each temperature. The scientists did their investigation three times and calculated mean values. All other conditions were controlled.

The table shows the results.

Temperature in °C	Volume of biogas in dm ³			
	Trial 1	Trial 2	Trial 3	Mean
25	38	48	52	50
30	56	56	55	56
35	62	63	60	62
40	68	64	69	67
45	61	59	57	59

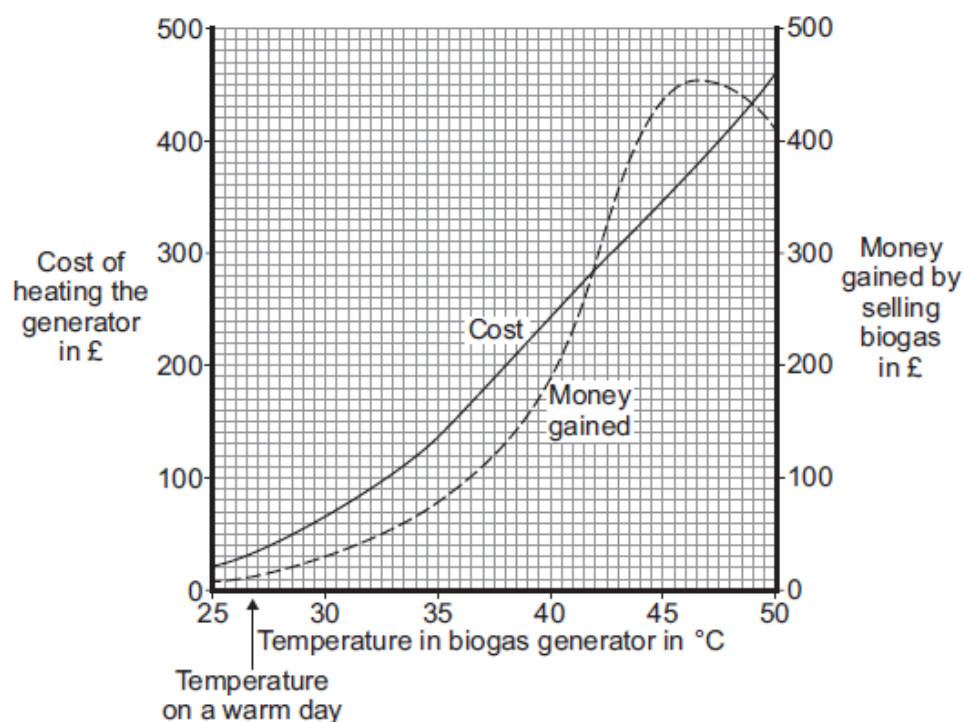
Case Study 4

Scientists investigated a small-scale biogas generator.

The scientists calculated:

- the annual cost of producing the biogas at different temperatures
- the money that could be gained by selling the biogas.

The graph shows the information.



BU2.5 Fatigue

Context: During exercise, if insufficient oxygen is reaching the muscles they use anaerobic respiration to obtain energy. Anaerobic respiration is the incomplete breakdown of glucose and produces lactic acid. If muscles are subjected to long periods of vigorous activity they become fatigued, ie they stop contracting efficiently. Suitable contexts could include how athletic training can reduce the likelihood of fatigue (eg by increasing oxygen supply or developing tolerance to lactic acid). The method sheet investigated the hypothesis that the harder muscles work, the sooner the muscles become fatigued.

Case studies:

Case Study 1

A student lifted masses up and down as shown in the photograph. He lifted different masses at the same rate. He investigated the time it took for his arm muscles to become too painful to continue.

The table shows the results.

Mass lifted in kg	Time taken for arm muscle to become too painful to continue in seconds
2.5	78
5.0	72
7.5	62
10.0	43
12.5	13

Case Study 2

Three students did the same exercise as the student in Case Study 1. Each student lifted a 10 kg mass at five different speeds. For each speed, they counted the number of lifts they could do until it became too painful to continue.

The table shows the results. The faster the speed, the shorter the time for each lift and therefore the harder the exercise.

Time for each lift in seconds	Number of lifts until it became too painful to continue		
	Student 1	Student 2	Student 3
1	3	9	6
2	8	17	14
3	24	32	28
4	38	44	24
5	45	65	53

Case Study 3

Four different students investigated the time it took for different muscles in the body to become painful when the students did different exercises. Each time, the students lifted the same mass at the same rate, using their stronger arm or leg.

The table shows the results.

Position of muscle (and muscle name)	Time taken for the muscle to become painful in seconds			
	Student 4	Student 5	Student 6	Student 7
Front of arm (biceps)	27	28	42	19
Back of arm (triceps)	20	17	35	12
Front of thigh (quadriceps)	42	36	52	21
Back of thigh (hamstring)	47	39	63	23

Case Study 4

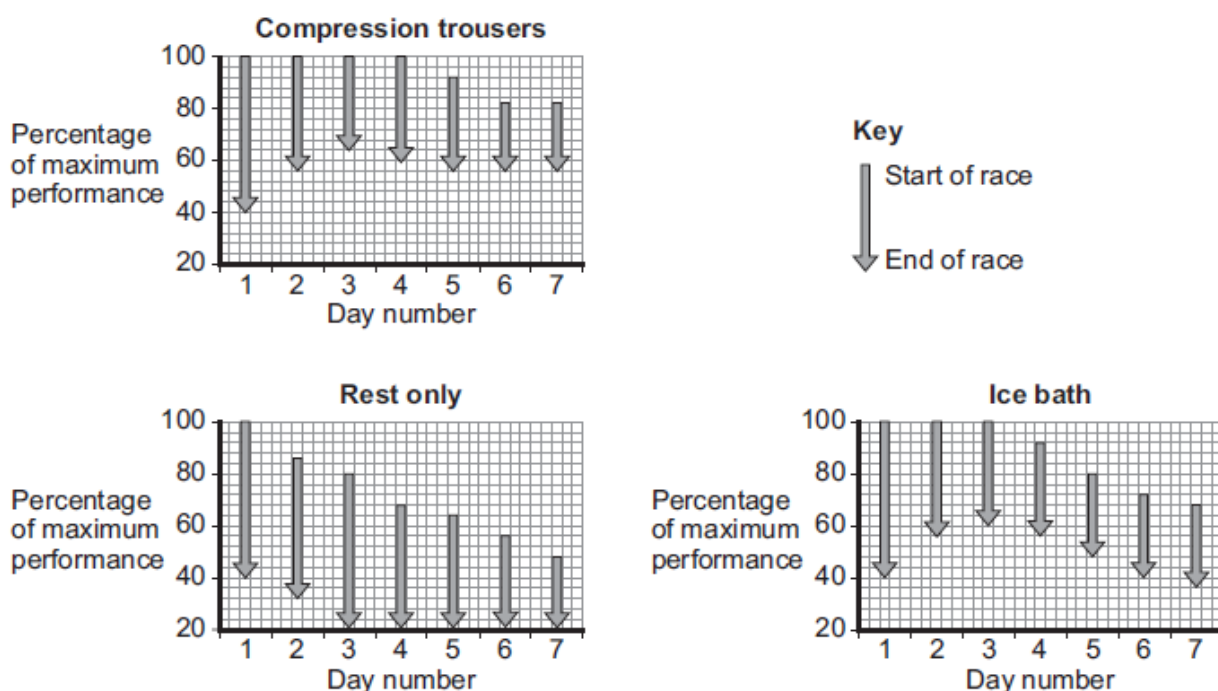
Scientists studied the performance of long-distance cyclists each day for a week. Three groups of cyclists used different recovery programmes after each day's race.

The programmes were:

- wearing special compression trousers for 30 minutes
- rest only
- sitting in an ice bath for 30 minutes.

The cyclists' performances were measured each day.

The arrows show the performance at the start of each day's race and at the end of each day's race.



BU3.5 Acid rain

Context:

Waste may pollute air with smoke and gases such as sulfur dioxide, which contributes to acid rain. Suitable contexts could include: why some crops in areas affected by fall-out from coal-fired power stations grow poorly or the choice of suitable crops in such areas. The method sheet investigated the hypothesis that the growth of seeds depends on the concentration of acid in the solution used to water the seeds.

Case studies

Case Study 1

A student made different concentrations of sulfuric acid. The student used these solutions to water pea seeds. The student measured the length of the roots after seven days.

The student kept all other conditions the same.

The table shows the results.

Concentration of the acid in mol per dm ³	Length of root after seven days in mm
0.00	14
0.02	14
0.04	10
0.06	4
0.08	0 (no roots)

Case Study 2

A group of scientists investigated the effect of different concentrations of sulfur dioxide in the air on the percentage of oil-seed rape seeds that germinated.

The table shows the results.

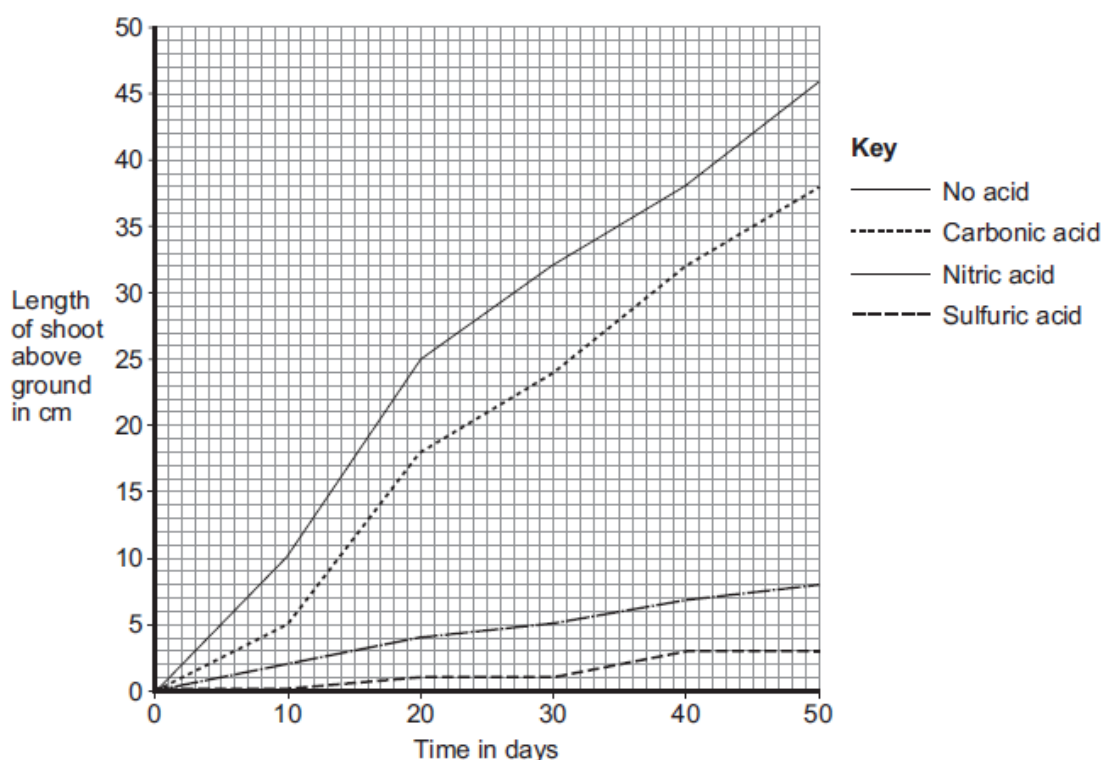
Concentration of sulfur dioxide in the air in arbitrary units	Percentage of seeds that germinated			
	Trial 1	Trial 2	Trial 3	Mean
0	96	100	97	98
20	98	96	94	96
40	73	75	78	75
60	21	43	39	34
80	3	7	4	5

Case Study 3

Acid rain is a mixture of different acids, such as nitric acid, sulfuric acid and carbonic acid. Students investigated the effect of these different acids on the growth of bean plant shoots. The concentration of each acid used was the same as in typical acid rain.

All other conditions were kept the same.

The results are shown in the graph.



Case Study 4

Scientists measured the masses of four different crops growing in soils that had different pH values. In each case, the soil was well-fertilised and pesticides were used when needed. All the crops had similar light and temperature conditions and the crops were fully watered.

The scientists' results are shown in the table.

pH of soil	Mean mass of crop grown in kg per m ² of land			
	Beans	Potatoes	Cabbages	Onions
5.0	1.4	11.6	4.4	0.6
6.0	2.2	16.2	5.4	2.4
6.5	4.5	15.0	6.2	3.7
7.0	3.9	13.4	6.3	4.3
8.0	3.4	11.2	5.3	4.1

BU3.5b Lungs

Context:

Waste products that have to be removed from your body include carbon dioxide produced by respiration and removed via the lungs when we breathe out.

Suitable context could include the effect of lung volume of playing a wind instrument or singing

The method sheet investigated the hypothesis that the maximum volume of air that can be breathed out of a person's lungs in one breath depends on the height of the person.

Case studies

Case Study 1

Some students investigated their lung capacity.

Each student measured their body mass and the total volume of air they could breathe out in a single breath.

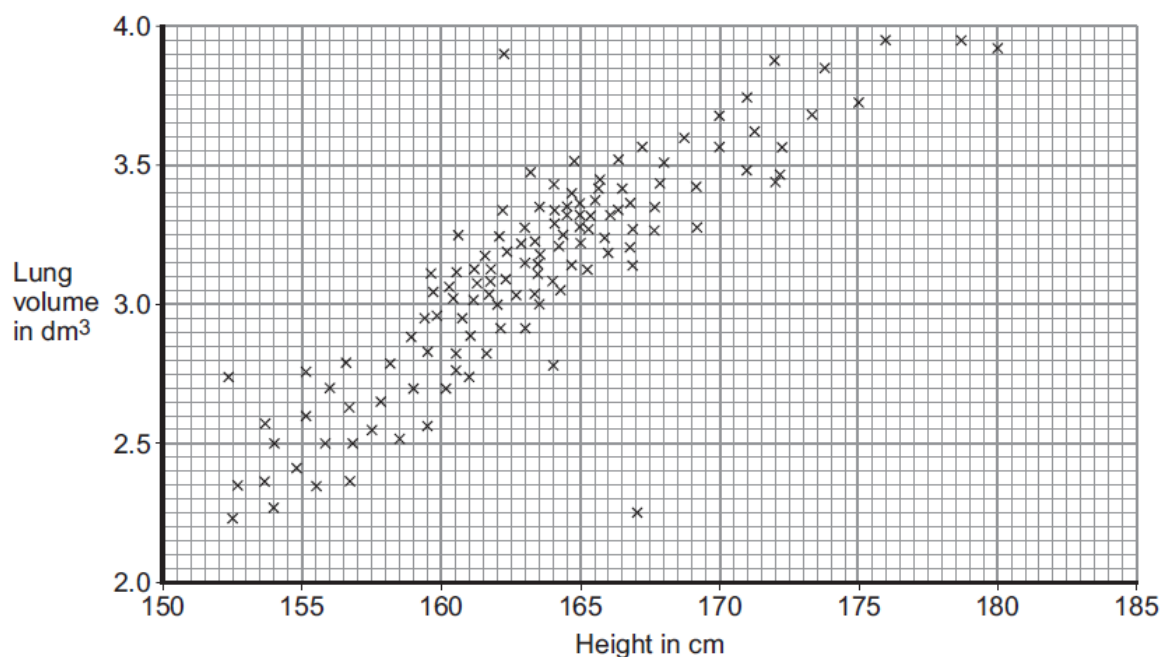
The table shows the results.

Body mass in kg	Total volume of air that could be breathed out in dm ³
45	3.3
50	3.7
55	4.1
60	4.5
65	4.9

Case Study 2

A second group of students measured the height of each girl in their year group. They also measured the lung volume of each girl.

The graph shows the results.



Case Study 3

A third group of students investigated what effect the age of males and females had on the maximum volume of air that could be breathed out in one breath.

The table shows the results.

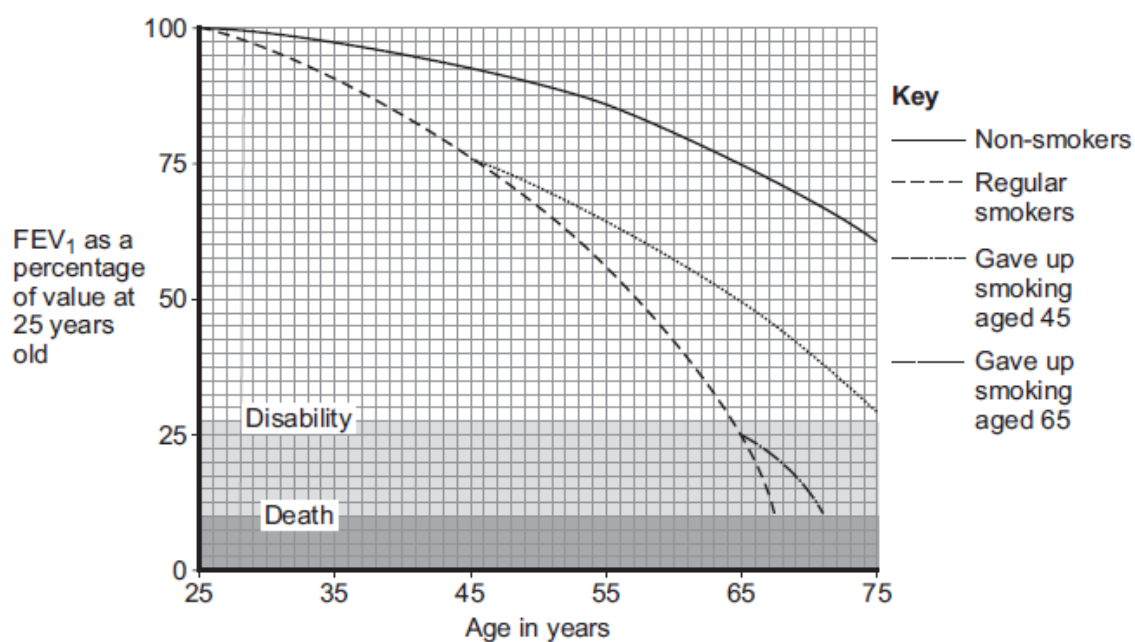
Age in years	Mean maximum volume of air that can be breathed out in one breath in dm ³	
	Male	Female
5	1.2	1.2
10	2.3	2.3
15	4.0	3.5
20	5.3	4.1
30	5.3	4.2
40	5.2	4.0
50	5.0	3.9

Case Study 4

The volume of air that can be forced out of the lungs in one second is called FEV₁. Doctors use FEV₁ to measure the health of the lungs.

The graph shows the FEV₁ of non-smokers, regular smokers and people who have given up smoking.

A large number of measurements were collected over many years.



BU3.6 Body temperature

Context:

Sweating helps to cool the body. Body temperature is monitored and controlled by the thermoregulatory centre in the brain. This centre has receptors sensitive to the temperature of the blood flowing through the brain. Temperature receptors in the skin send impulses to the thermoregulatory. Suitable contexts could include: the effect on body temperature of exercise or of chilling; the need to keep cool during hard or prolonged exercise and to prevent excessive heat loss once the exercise finishes; why older people need to be kept warm.

The method sheet investigated the hypothesis that the longer someone exercises for, the higher their body temperature becomes.

Case studies:

Case Study 1

A student ran on a running machine in a gym at 12 km/h. The student's body temperature was recorded at different times during the run.

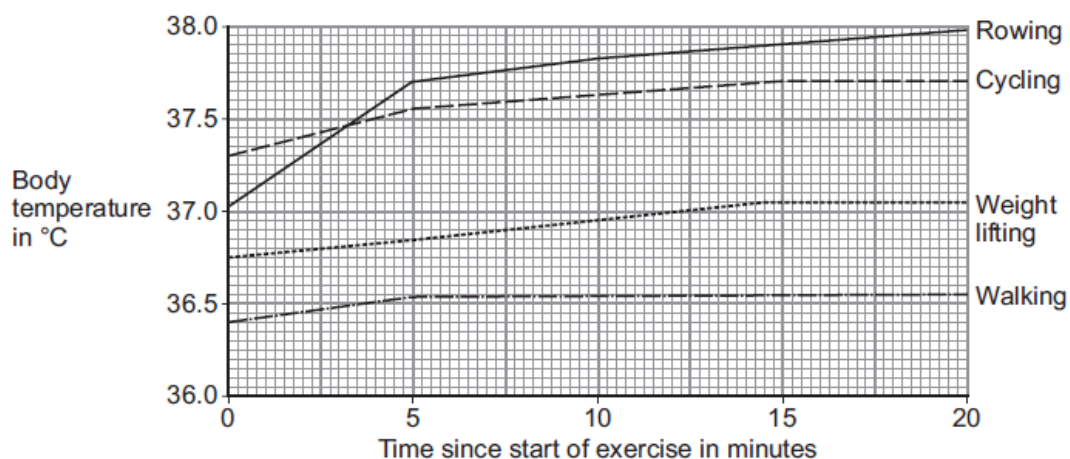
The table shows the results.

Time since start of run in minutes	Body temperature in °C
0	36.8
5	37.2
10	37.6
15	37.6
20	37.6

Case Study 2

Four students had their body temperatures recorded as they each did a different exercise.

The graph shows the results.



Case Study 3

Athletes training for the Olympic Games had their body temperatures recorded as soon as possible after completing races.

The table shows the results.

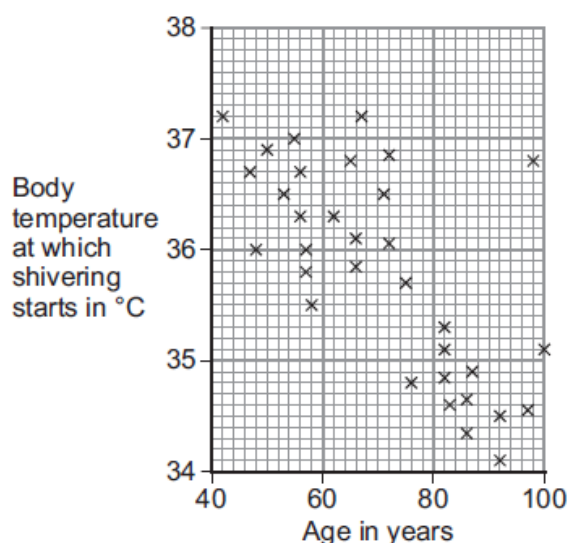
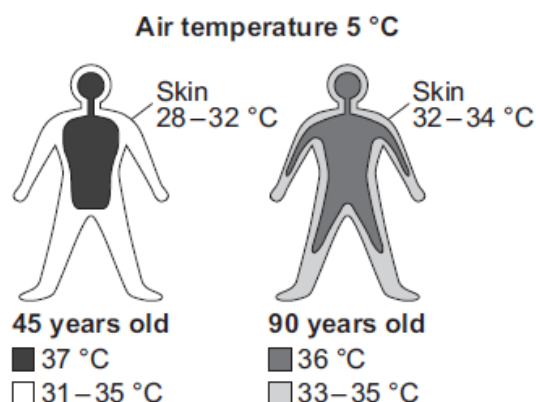
Athlete	Male or female	Distance run in m	Body temperature at end of race in °C
A	Male	100	37.2
B	Male	200	37.1
C	Female	200	37.6
D	Male	400	37.2
E	Female	800	37.6
F	Female	1500	37.8
G	Male	5000	38.0

Case Study 4

The diagram shows the temperature of different parts of the body in two people of different ages on a cold day.

The scattergram shows the body temperature at which individual people of different ages start to shiver.

Each cross represents one person.



Notes

Notes

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