Accredited

OCR
Oxford Cambridge and RSA

GCSE (9–1) Combined Science B (Twenty First Century Science)
J260/08 Combined Science (Higher Tier)
Sample Question Paper

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Date – Morning/Afternoon
Time allowed: 1 hour 45 minutes

You must have:
- a ruler (cm/mm)
- the Data Sheet

You may use:
- a scientific or graphical calculator

SPECIMEN

First name	
Last name	

Centre number						Candidate number				

INSTRUCTIONS
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided.
- Additional paper may be used if required but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the bar codes.

INFORMATION
- The total mark for this paper is **75**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in the question marked with an asterisk (*).
- This document consists of **24** pages.

2

Answer **all** the questions.

1   Solar cells generate electricity using energy from the Sun.

A class of students is investigating factors that affect the output of solar cells.

(a)   Eve wants to investigate the effect of the area of the solar panel on voltage output.

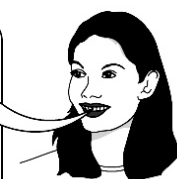She connects a voltmeter to a solar cell. She shines a bench lamp on the solar cell.
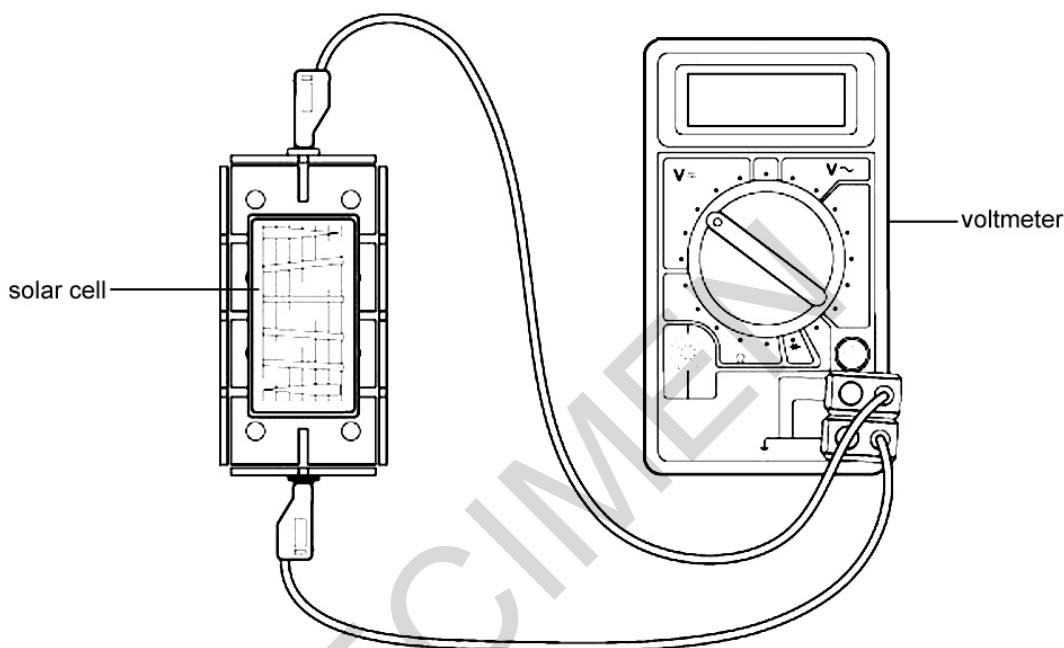
(i)   Eve needs to choose solar panels to use.

I could either use solar cells of different sizes...

...or use the same solar cell, which I gradually cover up

Give **one** reason why she should choose to use one panel, which she covers up, to control this variable.

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(ii)   Name **one** other variable that Eve should control.

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....   **[1]**

(b) Eve's results are shown below.

Area of solar cell exposed to light (mm^2)	Output voltage (V)
6000	0.335
5000	0.330
4200	0.320
3300	0.300
2500	0.275
1600	0.235
800	0.180

(i) Plot a graph of Eve's results. Three have been done for you. **[2]**
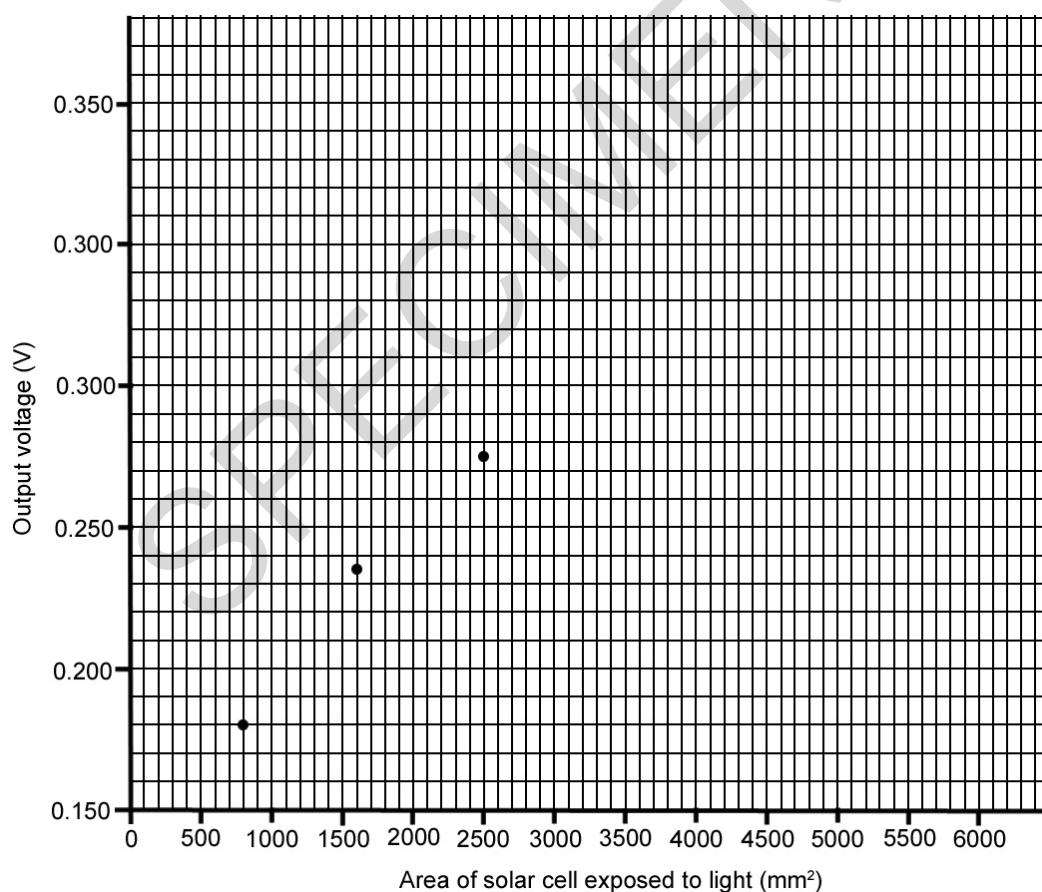
(ii) Connect the points with a smooth curve. **[1]**

4

(iii) Describe the trend in the graph.

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.... **[2]**

(c) Eve also wants to measure the power output of a solar cell.

Describe the circuit she would use. You must draw a circuit diagram as part of your answer.

Include how Eve would use these measurements to calculate the power output of the solar cell.

SPECIMEN

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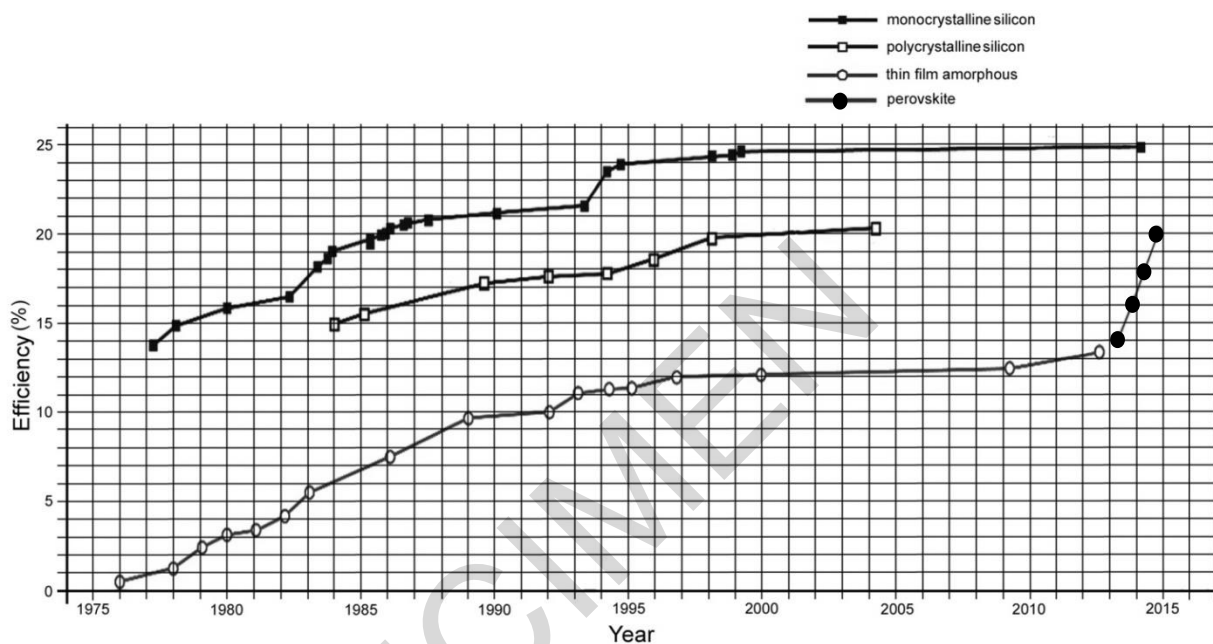.. **[4]**

(d) Eve used solar cells made from polycrystalline silicon.

She sees a newspaper article.

"One of the most exciting developments is with the development of new solar cells produced from chemicals called perovskites."

The graph below shows recent data on the efficiency of different types of solar cells tested in the laboratory.

Discuss the newspaper's claims for perovskites.

Use data from the graph to support your answer.

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2 (a) Autism is a condition that makes it difficult for an affected person to communicate with and relate to other people.

In 1998, following their research, some scientists suggested that autism was linked with children having received the MMR vaccination.

The MMR vaccine is a combined vaccine, giving protection against measles, mumps and rubella.

These are all communicable diseases and to prevent epidemics, a high percentage of the population needs to be vaccinated.

The more easily passed on a communicable disease is, the greater percentage of the population that needs to be vaccinated.

Explain why.

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.... **[2]**

SPECIMEN

J260/08

(b) The table below gives some information about the scientific paper in which the scientists' research was reported.

Year of publication	1998
Research	At The Royal Free Hospital, London, by doctors and researchers.
Authors	Twelve authors. The lead author had a contract with solicitors who were suing the vaccine manufacturers.
Children involved in study	Twelve children.
Publication	In the medical journal, The Lancet.
Other studies	No follow-up studies showed the same correlation.

The study had been accepted for publication in 1998.

In 2010, The Lancet withdrew the paper from the scientific literature.

Two of the statements below are possible reasons for The Lancet withdrawing the paper.

Put a tick (✓) in the box after the **two** correct statements.

Use the information in the table.

Possible reason

The sample size was too small.

All the authors of the study were biased.

The authors were not professionals in their field.

The paper was not peer-reviewed before publication.

The results could not be repeated by other scientists.

[2]

(c) **(i)** Several follow-up studies were made.

A group of students is looking at the results of a Californian study.

The graph below shows the number of people in California who have autism in 1991 in relation to when they were born. The start of vaccination with MMR is also identified.
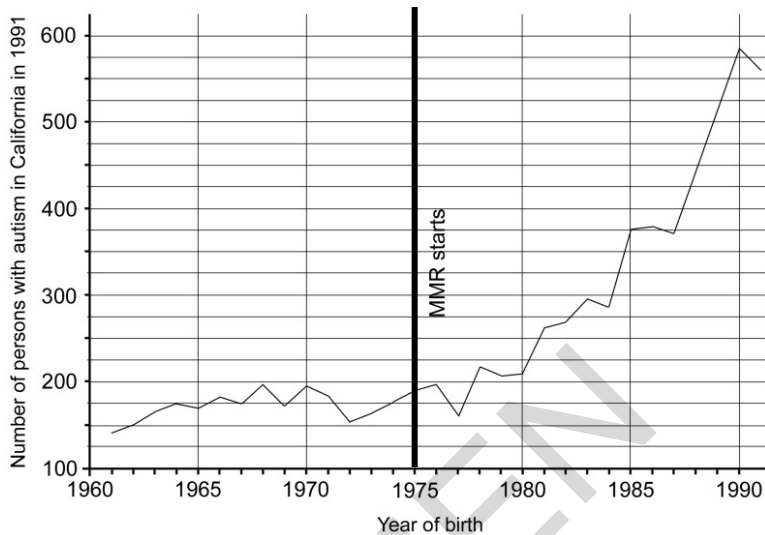
There's a clear correlation between when the vaccination starts and autism cases begin to increase — Abdul

Becky — But we can't tell from the graph how many new cases of autism there are each year

Discuss the students' comments on the study.

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(ii) Here are some suggestions as to how this type of study could be improved.

Some are not suitable.

Put a tick (✓) in the correct box after each statement.

	Suitable	Not suitable
Select a sample from the population to monitor.		
Ensure that all the children have had the MMR vaccination.		
Ensure that there is no record of autism in the family.		

[3]

(d) More recent studies have identified other factors that might be involved in autism.

Some results of these studies are shown below.

Year of publication of study	Country	Number involved in study	Additional information	Conclusion
2014	USA	970	Studied autism cases at different distances from farmland and during different stages of pregnancy	Exposure to several common pesticides during pregnancy increases the risk of autism
2014	Sweden	3000 including control group	Study based on analysis of human genome	52% of autism cases are linked with variations in DNA. New mutations accounted for 3% of cases
2015	UK	258	Based on a study of autism in twins	Genetic influence on autism is 74-98%

How have these studies increased our understanding of autism?

Explain your answer.

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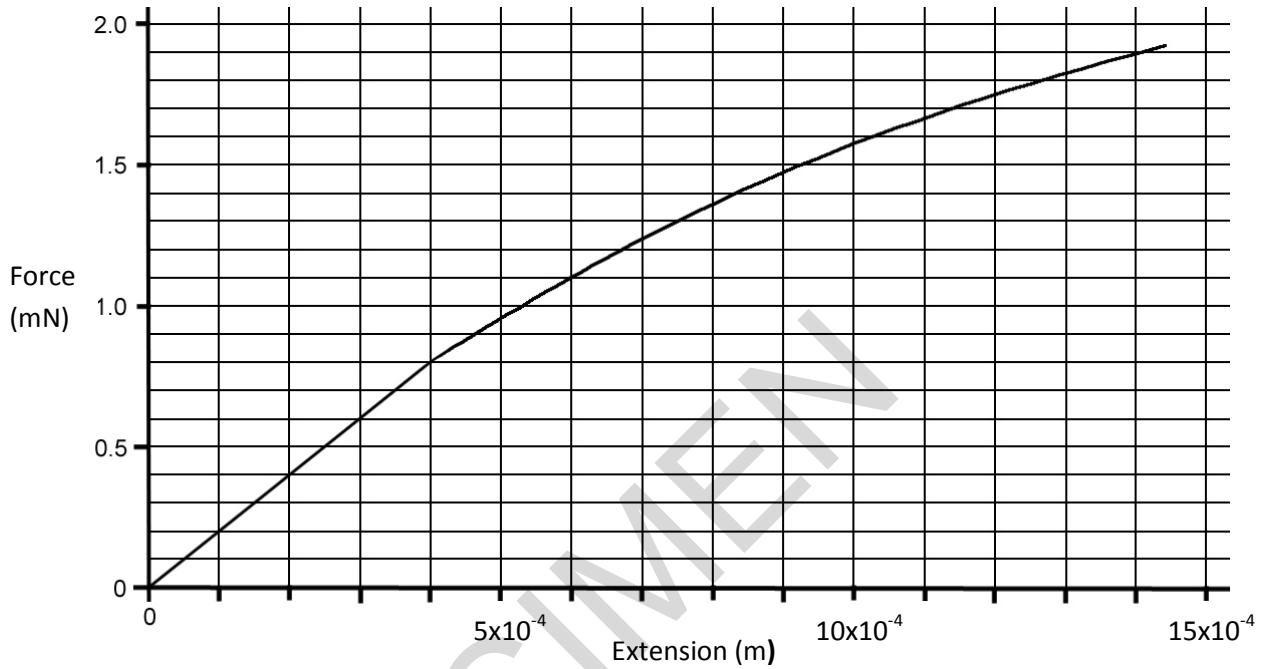
3 **(a)** Scientists are studying the properties of spider silk.

Types of silk, under certain conditions, will obey Hooke's law.

The graph below shows the relationship between extension and force when investigating spider silk.

(i) Up to a force of 0.8 mN, the extension of a sample of silk is linear.

Using the information from the graph, calculate the spring constant for the sample.

Show your working.

....N/m **[5]**

(ii) Calculate the energy stored in the silk thread when the force is 0.8 mN.

In your answer use the formula:

Energy stored (J) = 0.5 x spring constant (N / m) x (extension (m))^2

……………………………………J   **[2]**

(b) A spider spins different types of silk when making its web.

spiral capture silk –
for trapping insects

web frame silk –
for supporting the web
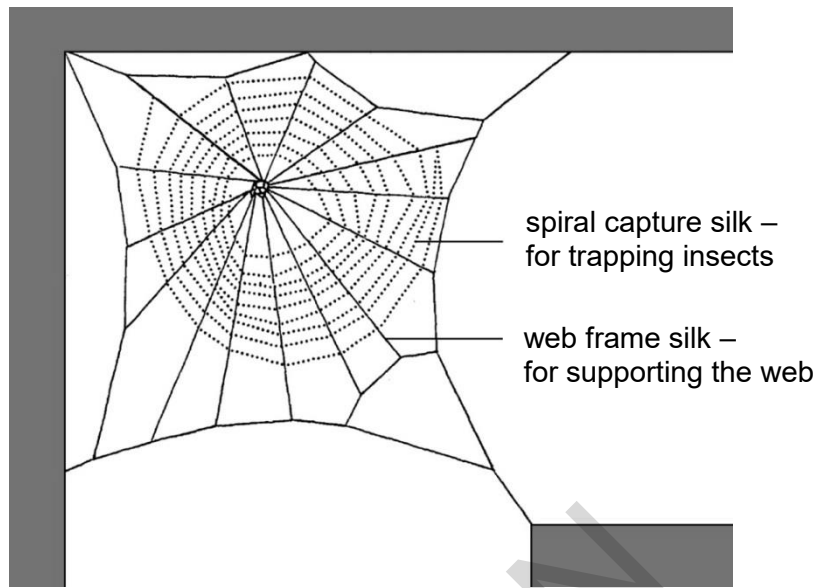
Silk is a protein. A silk fibre is made up of many chains of protein molecules.

The diagram shows the structure of spiral capture silk.

intermolecular forces

tangled protein chains

regular region of protein chain
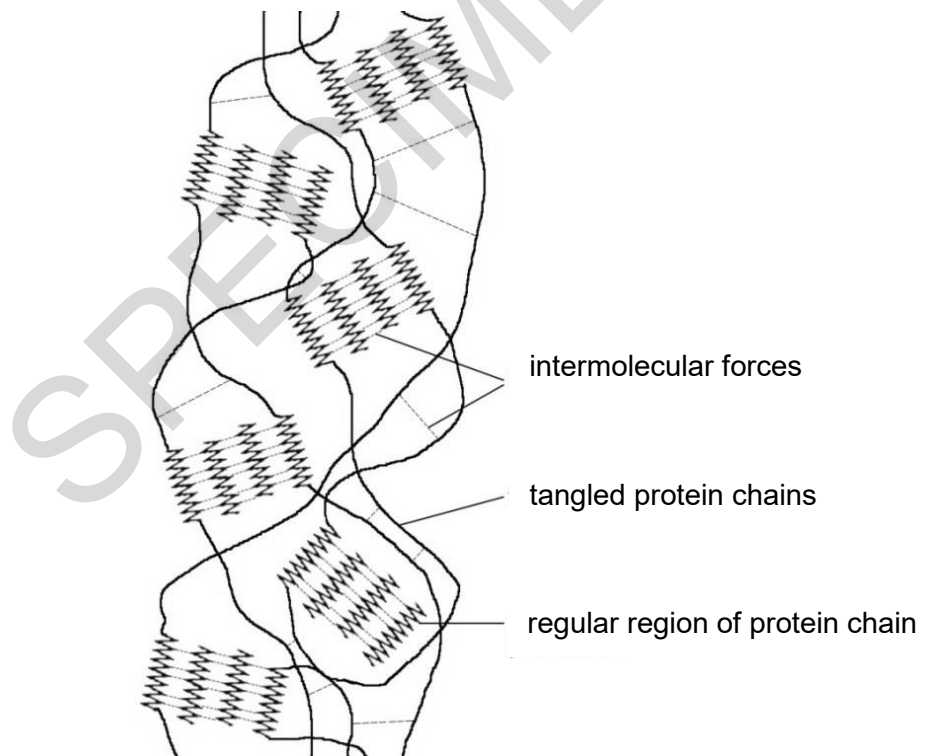
Describe and explain how high temperatures could affect the properties of silk.

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(c) Scientists studied the extension of spiral capture silk fibres.

The relationship between load and extension is shown in the graph below.
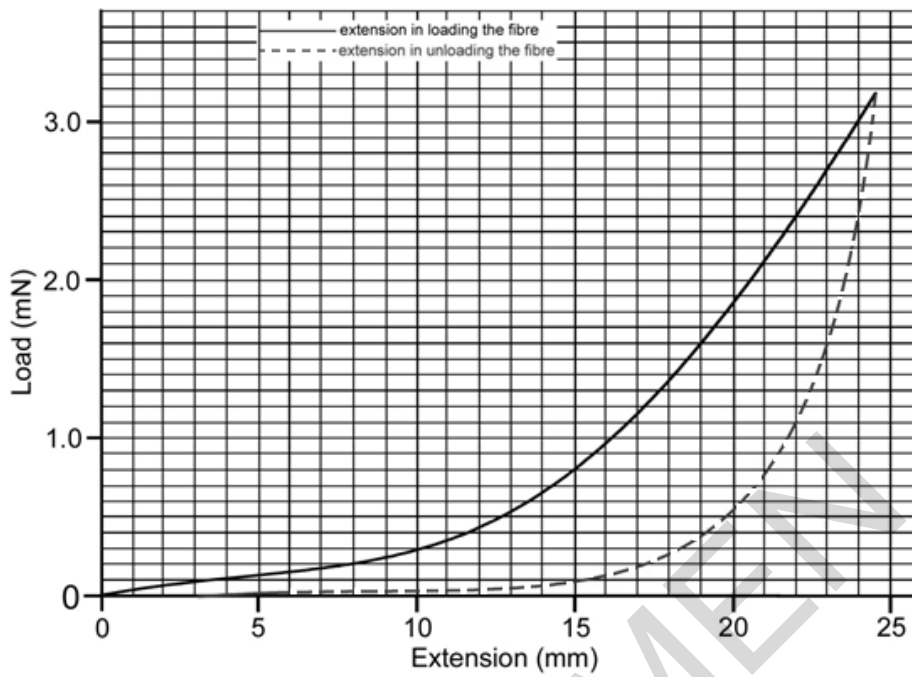

Describe the extension of the fibre as it is:

- loaded
- unloaded.

Explain the behaviour of the silk by referring to its molecular structure.

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(d) This type of silk forms the spiral of the web that traps flying insects.

Suggest how the properties of this type of silk are ideal for it to trap an insect.

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SPECIMEN

4 Lactic acid is an important industrial chemical.

The global market for lactic acid is currently growing at 19% per year.

One use of lactic acid is in the removal of limescale.

Limescale can form on heating elements. Limescale contains calcium carbonate.

Lactic acid reacts with limescale and removes it from a heating element.

The chemical reaction is:

calcium carbonate   +   lactic acid   →   calcium lactate   +   carbon dioxide   +   water

(a)* Some limescale removers contain lactic acid.

Claire is investigating one of these limescale removers.

She notices that the speed of limescale removal from the kettle varies with how much water she adds to the concentrated limescale remover.

She suggests, "this is because the concentration of lactic acid in the limescale remover will affect the rate at which it reacts with the calcium carbonate in the limescale."

Write a prediction **and** plan an investigation to test your prediction in the laboratory.

Include details of how you plan to process your results.

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(b) One of the fastest growing uses of lactic acid is in the production of a polymer, polylactic acid (PLA).

PLA is widely used in food packaging and is biodegradable.

Recently, silver nanoparticles have been added to PLA packaging.

This new packaging prevents the growth of three species of bacteria that cause the most serious forms of food poisoning.

Discuss the benefits and risks of the using the new nanoparticle food packaging.

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5 (a) (i) Scientists at Kew Gardens are searching for new antibiotics from rainforest plants.

What is an antibiotic?

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.... **[1]**

(ii) New antibiotics are needed because of the increase of antibiotic resistance in bacteria.

A number of steps take place to produce resistance bacteria.

Explain how the bacteria become resistant.

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(b) The scientists at Kew Gardens extract chemical substances from the plants using ethanol as a solvent.

The extracts are tested as possible new antibiotics.

They are being tested on the bacterium, methicillin-resistant *Staphylococcus aureus* (MRSA) in the laboratory.

The scientists set up a series of agar plates. Each has been inoculated with the bacterium.

Discs of filter paper, soaked in each of the different extracts, **A**, **B**, **C** and **D**, are placed on an agar plate.
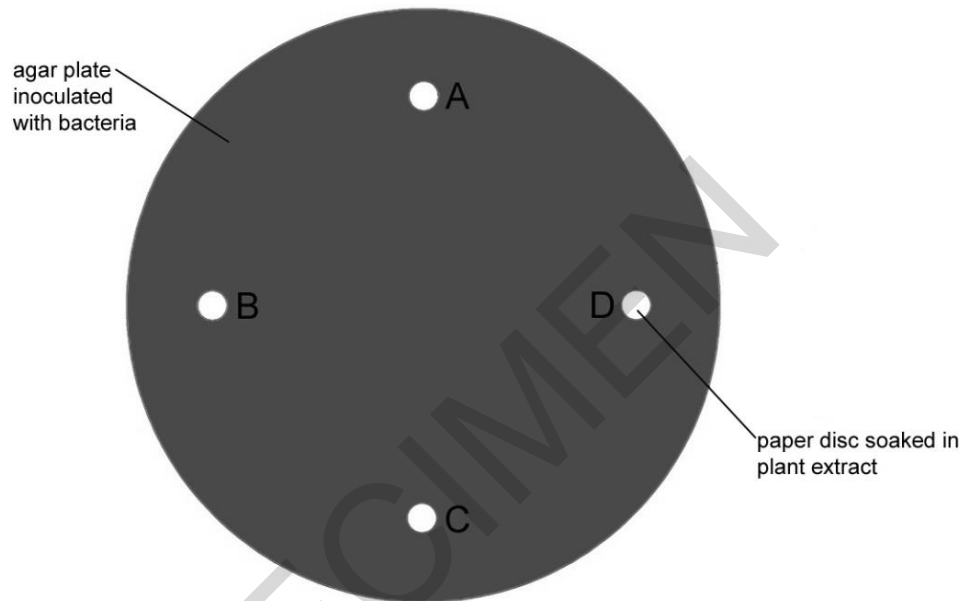
They incubate the agar plate at 37°C and measure the diameter of the clear zones, where no bacteria grow. They do this ten times.
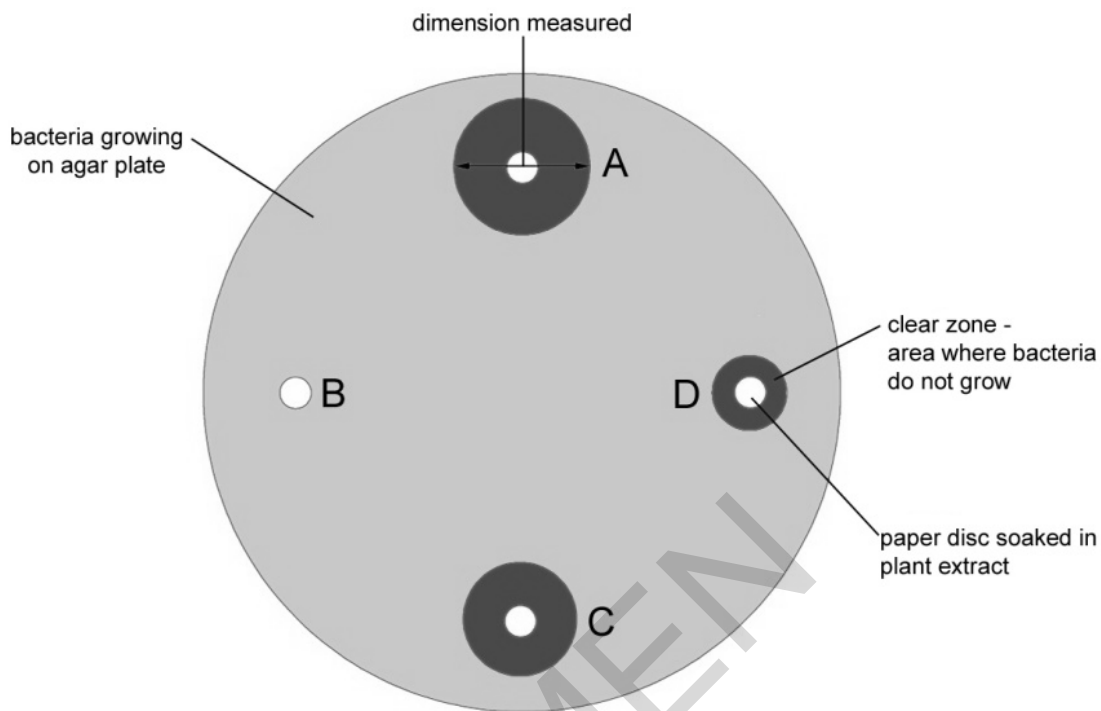
(i) The scientists' results are shown below:

Extract from plant	Diameter of clear zone (mm)										Mean diameter of clear zone (mm)	Mean area of clear zone (mm^2)
	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Test 8	Test 9	Test 10		
A	17	18	17	17	17	18	17	17	17	18	17	227
B	4	4	5	4	4	4	4	4	4	4	4	13
C	14	14	15	15	14	25	14	15	16	16	15	177
D	9	9	8	9	9	9	9	8	9	9	9	

Complete the table by calculating, for **Extract D,** the mean area of the clear zone.

Show your working.

Give your answer to two significant figures.

....mm^2 **[2]**

(ii) Identify the outlier in the data. Justify your choice.

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.... **[1]**

(c) The scientists are evaluating their results.

Simon
The area of the clear zone for ethanol must be deducted from the area of the clear zone produced by the antibiotic

Tom
We have not included any results where there's a variation in the depth of agar

Megan
We have excluded any results where the clear zone is not completely circular

Explain why each of these actions is important.

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(d) One of the extracts was tested against the bacterium in concentrations from $0 – 2.5$ µg / cm^3.

A graph was drawn of the results.
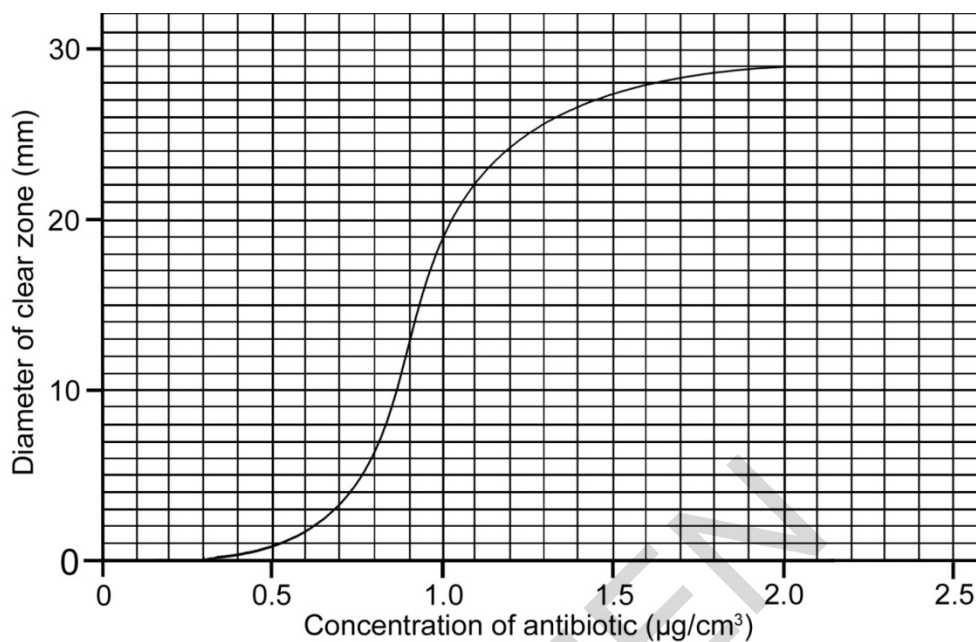
What does the data tell us about the effect of the antibiotic on the growth of the bacteria?

Put a tick (✓) in the box next to the correct statement.

A concentration of greater than 0.3 µg / cm^3 is required to inhibit the growth of bacteria.

The antibiotic has no effect on the growth of the bacteria.

Above a concentration of 1.9 µg / cm^3, all the bacteria are killed.

The steep part of the curve is where bacteria show least variation in their resistance.

The maximum increase in inhibition of the bacteria is between 0.5 and 1.0 µg / cm^3.

[1]

6 **(a)** A science class samples water from a small pond.

Sulfuric acid is detected in the sample of pond water.

The students titrate the sample of the pond water with sodium hydroxide solution.

They first make up a standard solution of 0.01 mol / dm^3 sodium hydroxide solution.

(i) Write the ionic equation for the reaction that happens when **any** acid reacts with **any** alkali.

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(ii) Calculate the relative formula mass of sodium hydroxide.

The formula of sodium hydroxide is NaOH.

…………………………………… **[1]**

(iii) Calculate the mass of sodium hydroxide required to produce 250 cm^3 of the standard solution.

…………………………………g **[2]**

SPECIMEN

(b) 25 cm³ of the 0.01 mol dm⁻³ sodium hydroxide solution was placed in a conical flask.

The volume of pond water (containing sulfuric acid) from a burette, used to neutralise the sodium hydroxide, was recorded.

Emma's results are shown below.

Burette reading	Volume of pond water (cm³)			Mean volume (cm³)
	Rough	1ˢᵗ	2ⁿᵈ	
Final reading	23.90	47.60	23.70	
Start reading	0.00	23.90	0.00	
Volume used	23.90	23.70	23.70	**23.70**

(i) Explain how Emma's results are improved by carrying out the rough titration.

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(ii) The symbol equation for the neutralisation of sodium hydroxide with sulfuric acid is:

$$H_2SO_4 \quad + \quad 2NaOH \quad \rightarrow \quad Na_2SO_4 \quad + \quad 2H_2O$$
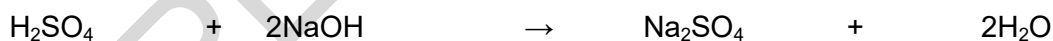
When the alkali is neutralised, this formula can be used to calculate the concentration of acid in the pond water:

$$\frac{M_A \times V_A}{1} \quad = \quad \frac{M_B \times V_B}{2}$$

Where:
M_A = concentration of acid V_A = volume of acid
M_B = concentration of alkali V_B = volume of alkali

Use this formula to calculate the concentration of sulfuric acid in the pond water.

Give your answer to 2 significant figures, and include the units in your answer.

.......……………………… units …………… **[4]**

END OF QUESTION PAPER