

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

H

Date – Morning/Afternoon

Version 2.2

Time allowed: 1 hour 45 minutes

You must have:

- a ruler (cm/mm)
- the Data Sheet

You may use:

- a scientific or graphical calculator



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.

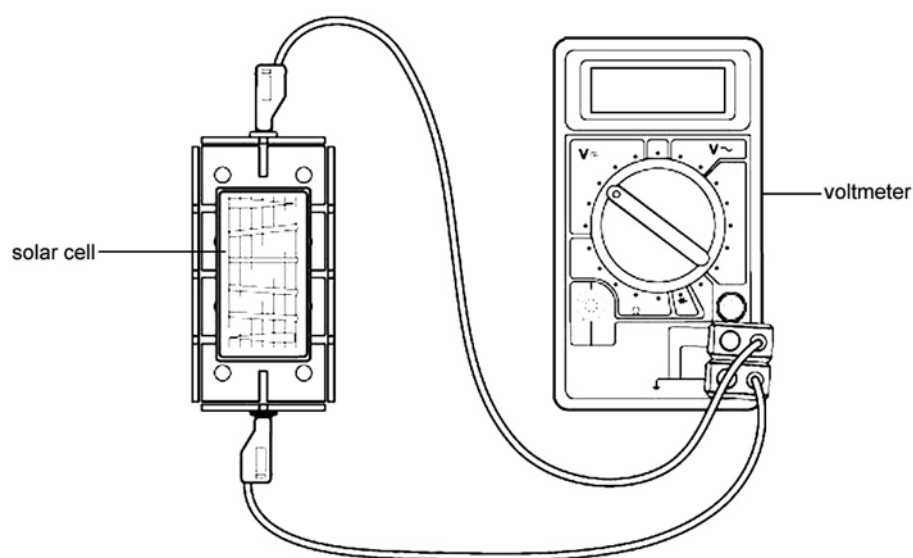
Answer **all** the questions.

1 Solar cells generate electricity using energy from the Sun.

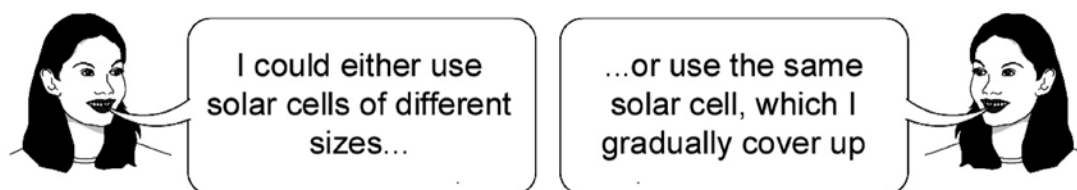
A class of students is investigating factors that affect the output of solar cells.

(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.



Give **one** reason why she should use one panel, which is gradually covered up, to control this variable.

.....
 [1]

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

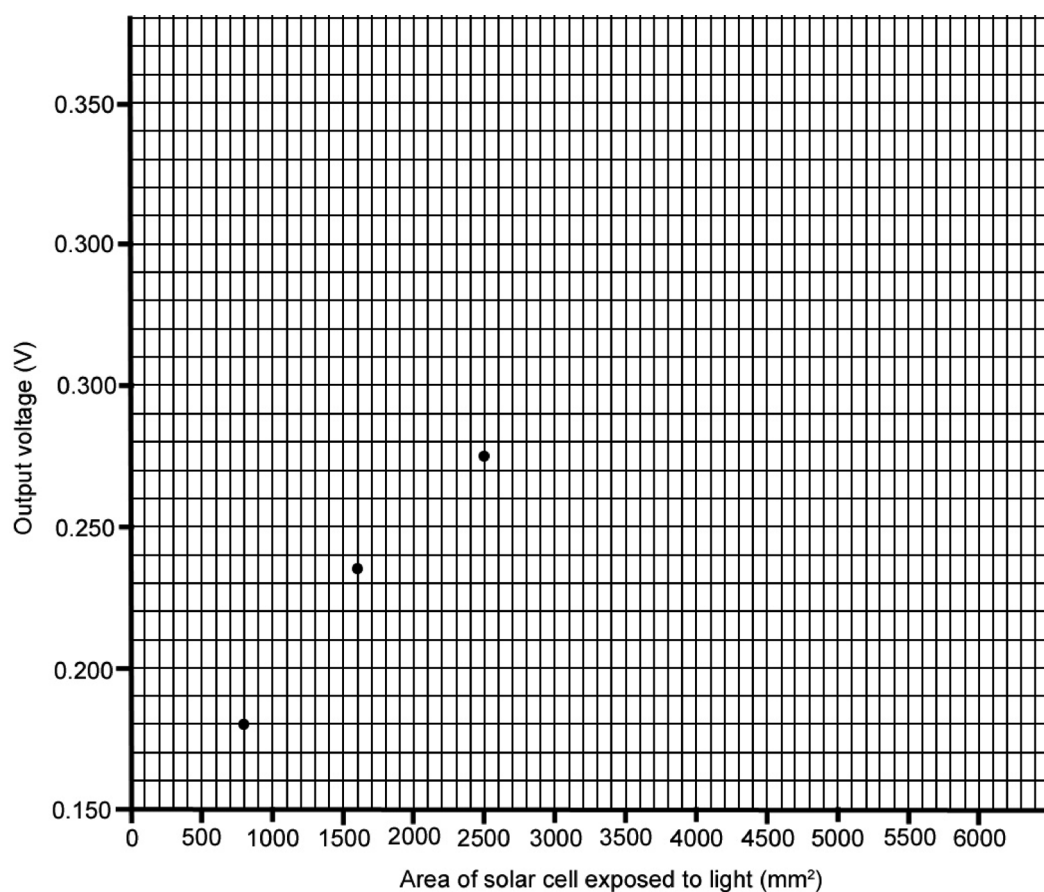
.....

 [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 points have been done for you. [2]



(ii) Connect the points with a smooth curve. [1]

4

(iii) Describe the trend in the graph.

.....

.....

.....

..... [2]

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

Describe the circuit she would use.

- Use a circuit diagram as part of your answer.
- Include how Eve would use these measurements to calculate the power output of the solar cell.

.....

.....

.....

.....

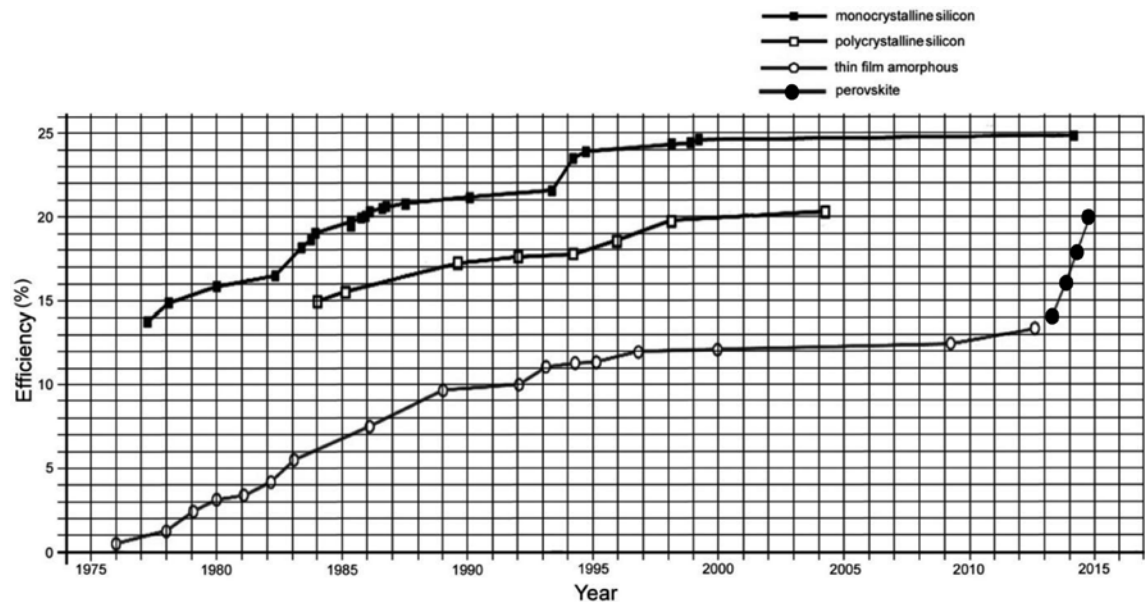
..... [4]

(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 newspapers claims for perovskites.

Use data from the graph to support your answer.

[4]

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.
- Measles, mumps and rubella are all communicable diseases and a high percentage of the population needs to be vaccinated to prevent epidemics,

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

Explain why.

.....

.....

.....

..... [2]

- (b) The table gives some information about the scientific paper in which the scientists research on Autism in (a) 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

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.

☐

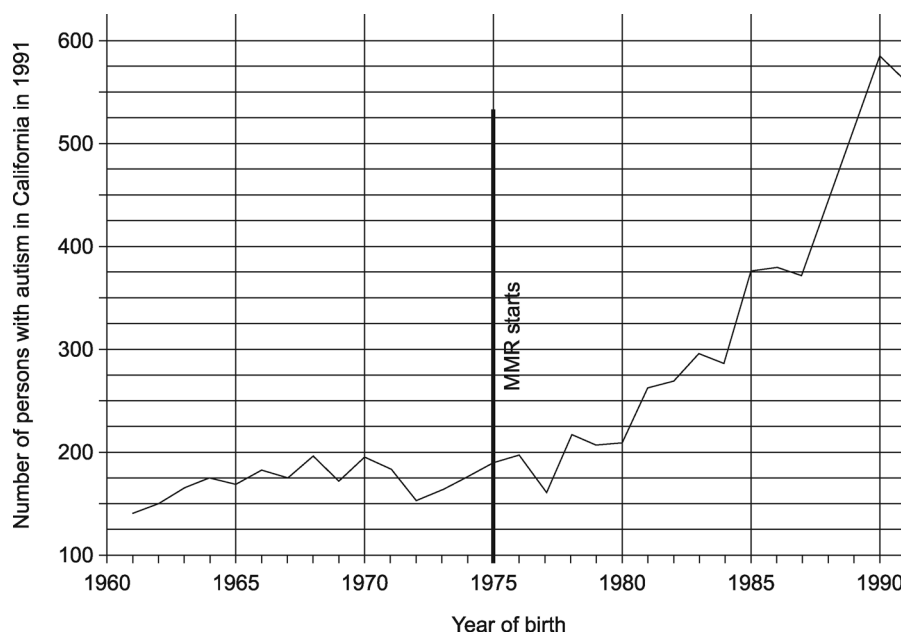
The sample size was too small.

☐

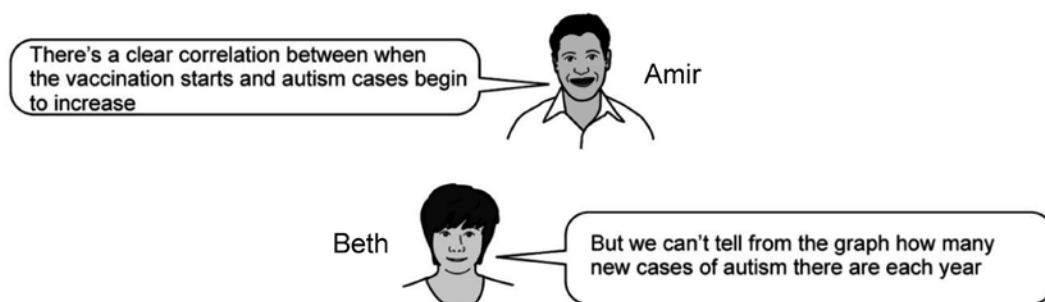
[2]

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

The graph shows the number of people in California who had autism in 1991 in relation to when they were born. The start of vaccination with MMR is also identified.



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



Discuss the students comments on the study.

.....

.....

.....

.....

..... [3]

9

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

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.

.....

.....

.....

.....

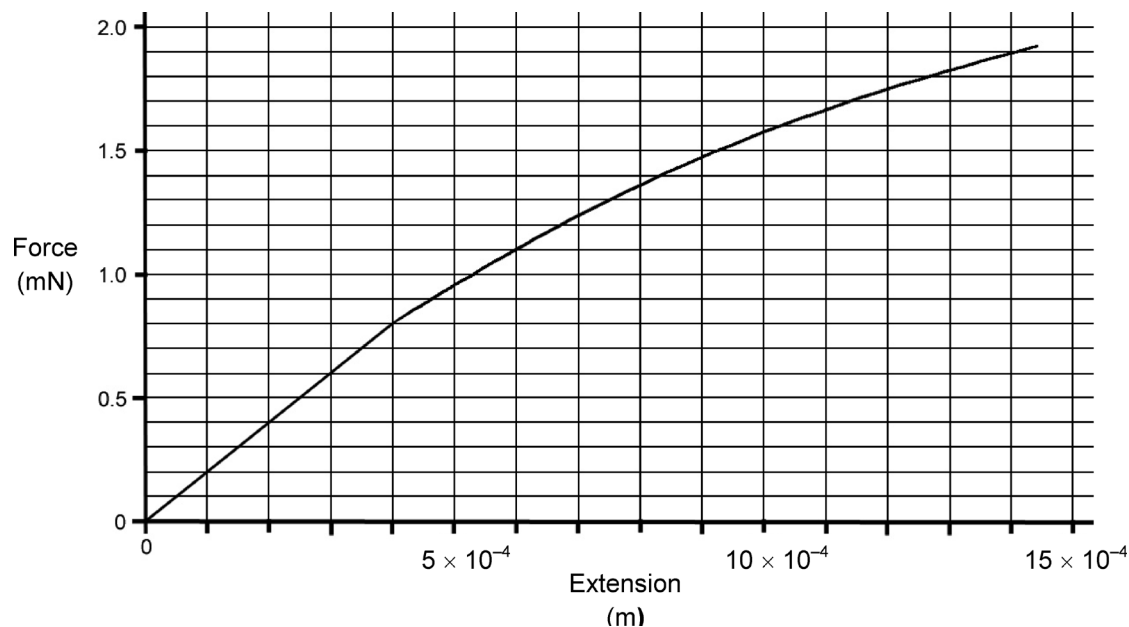
..... [3]

1

3 (a) Scientists are studying the properties of spidersilk.

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

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



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

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

Show your working.

Spring constant = ...N/m **[5]**

11

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

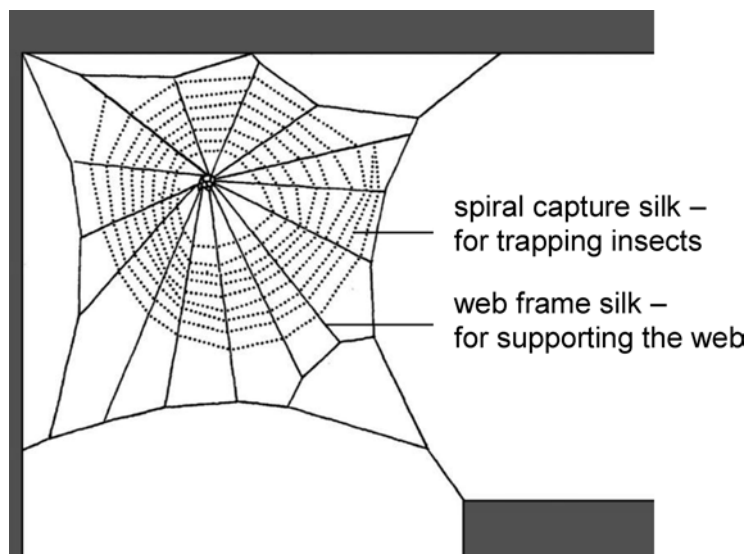
In your answer use the formula:

$$\text{Energy stored (J)} = 0.5 \times \text{spring constant (N/m)} \times (\text{extension (m)})^2$$

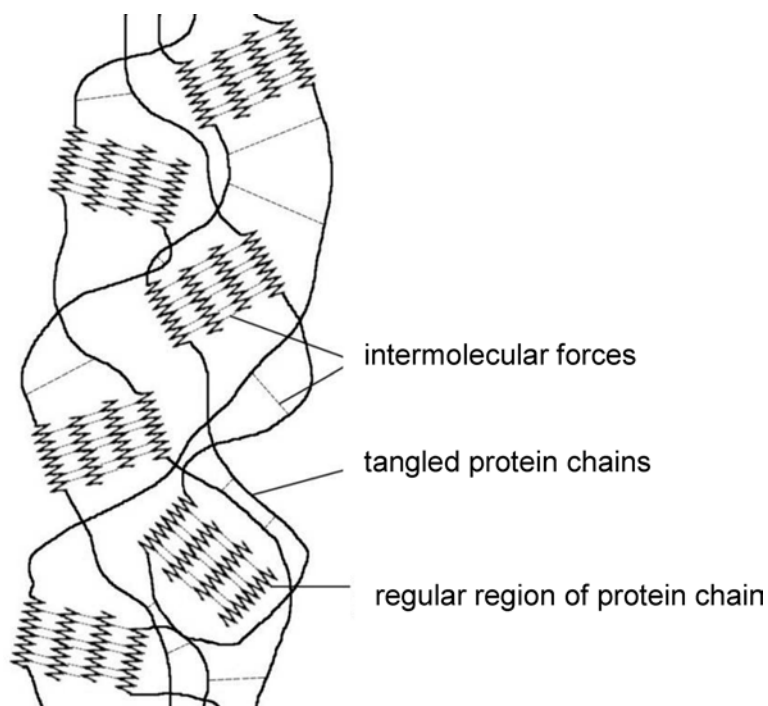
Energy stored = ...J [2]

12

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



Describe and explain how high temperatures could affect the properties of silk.

.....

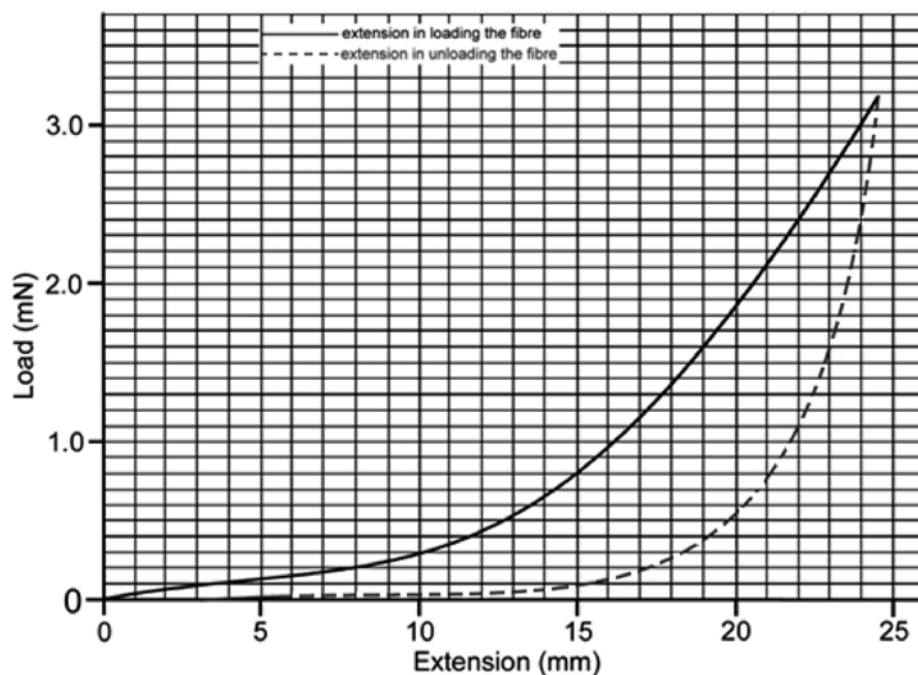
.....

.....

..... [2]

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

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



Describe the extension of the fibre as it is:

- loaded
- unloaded.

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

.....

.....

.....

.....

.....

.....

..... [4]

14

(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 trapping an insect.

.....

.....

.....

..... [2]

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, which contains calcium carbonate.

Limescale can form on heating elements.



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

The word equation for the reaction is:

calcium carbonate + lactic acid $\rightarrow$ calcium lactate + carbon dioxide + water

(a)* Some limescale removers contain lactic acid.

Sundip 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 would process your results.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

- (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 using this new nanoparticle food packaging.

.....

.....

.....

.....

.....

.....

..... [3]

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

What is an antibiotic?

.....
..... **[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.

.....
.....
.....
.....
.....
.....
..... **[4]**

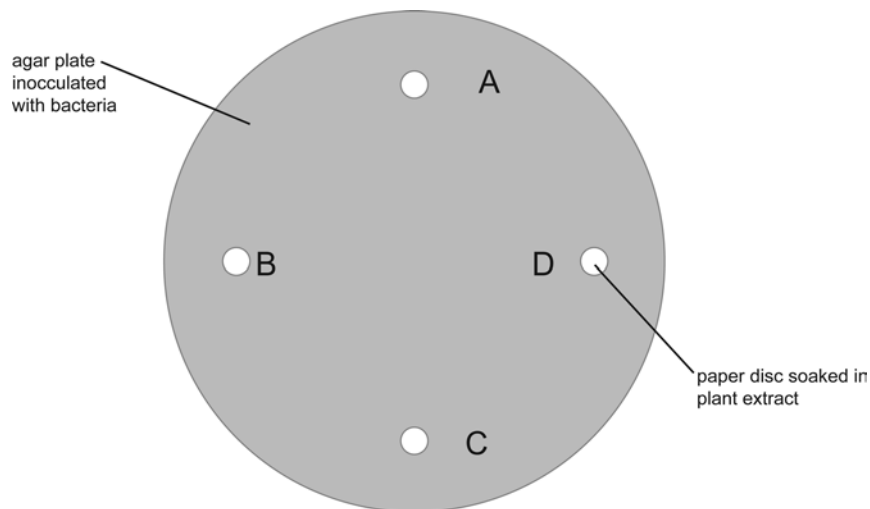
(b) The scientists at Kew Gardens extract chemical substances from the plants using ethanol as a solvent.

- The extracts are tested as possible new antibiotics using the method below.
- The extracts are tested on the bacterium, methicillin-resistant *Staphylococcus aureus* (MRSA) in the laboratory.

The scientists follow the steps below on four extracts: **A, B, C** and **D**.

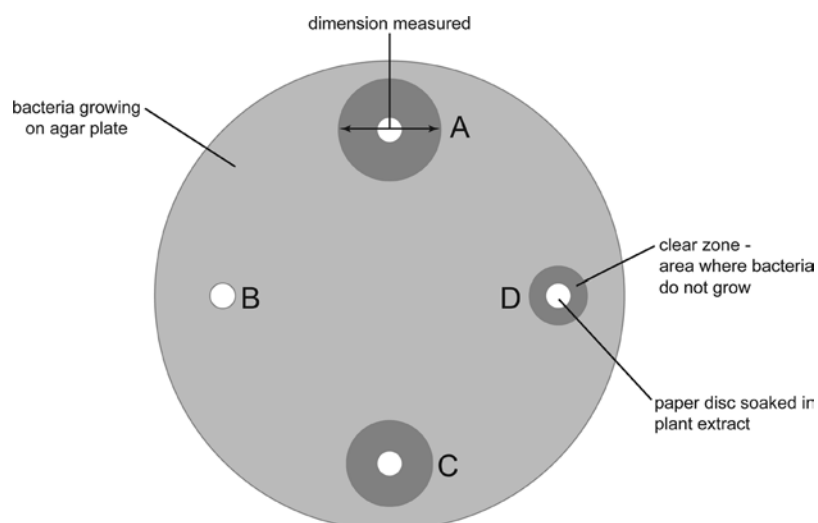
Step 1 The scientists set up a series of agar plates.
Each plate is inoculated with the bacterium.

Step 2 Discs of filter paper, soaked in each of the different extracts, **A, B, C** and **D**, are placed on an agar plate.



Step 3 The scientists incubate the agar plate at 37 °C and measure the diameter of the clear zones, where no bacteria grow.

The appearance of the agar plate is shown below.



- (i) They repeat steps 1–3 so that they have 10 sets of results (Tests 1–10).

The scientists results are shown in the table.

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 **2** significant figures.

Mean area of clear zone = ...mm² [2]

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

.....

 [1]

(c) The scientists are evaluating their results.



Explain why the evaluation of each scientist is important.

.....

.....

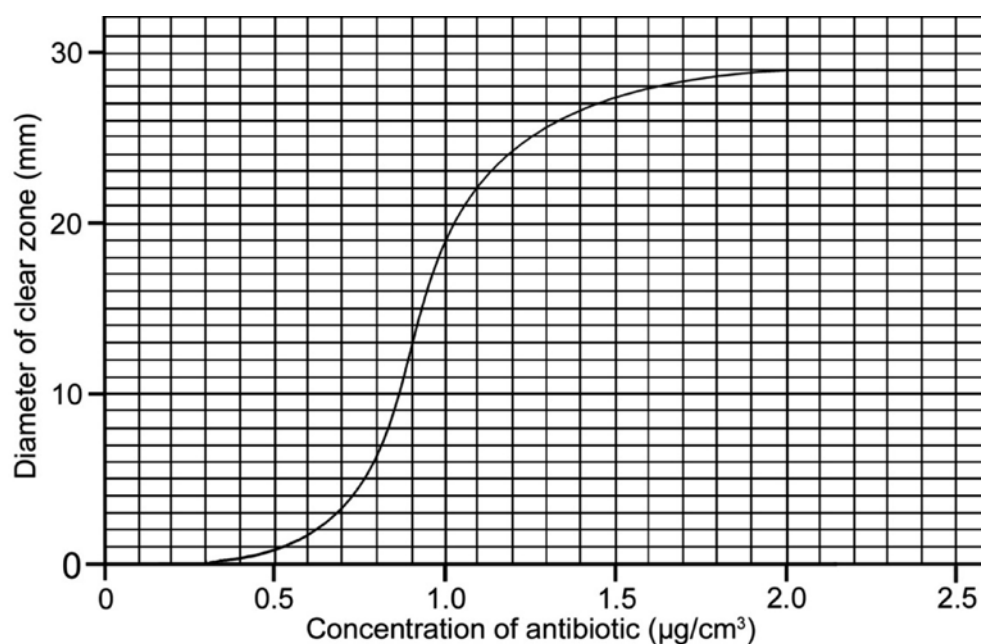
.....

.....

..... [3]

- (d) One of the extracts was tested against the bacterium in concentrations from 0–2.5 $\mu\text{g}/\text{cm}^3$.

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 $\mu\text{g}/\text{cm}^3$ is required to inhibit the growth of bacteria.

☐

Above a concentration of 1.9 $\mu\text{g}/\text{cm}^3$, all the bacteria are killed.

☐

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

☐

The maximum increase in inhibition of the bacteria is between 0.5 and 1.0 $\mu\text{g}/\text{cm}^3$.

☐

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

☐

[1]

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

- They detect sulfuric acid in the sample of pond water.
- They first make up a standard solution of 0.01 mol/dm^3 sodium hydroxide solution.
- They then titrate the sample of the pond water with the standard sodium hydroxide solution.

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

..... [2]

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

Relative formula mass = ... [1]

(iii) Calculate the mass of sodium hydroxide required to produce 250 cm^3 of the 0.01 mol/dm^3 standard solution.

Mass = ...g [2]

(b) Eve does a titration as outlined below.

- She adds 25 cm^3 of the 0.01 mol/dm^3 sodium hydroxide solution to a conical flask.
- She uses pond water (containing sulfuric acid) in a burette.
- The volume of pond water needed to neutralise the sodium hydroxide is recorded.

Eve's results are shown below.

Burette reading	Volume of pond water (cm^3)			Mean volume (cm^3)
	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 Eve's results are improved by carrying out the rough titration.

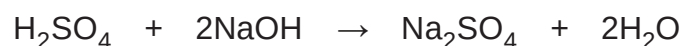
.....

.....

.....

..... [2]

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



When the alkali is neutralised, this formula can be used to calculate the concentration of acid in the pond water:

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

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.

Concentration = ... Units [4]

END OF QUESTION PAPER

Summary of updates

Date	Version	Details
December 2021	2.2	Updated copyright acknowledgements.

Copyright Information:

Adpated from The Journal of Experimental Biology, M. Denny, The physical properties of spider's silk and their role in the design of orb-webs, Pages No 579-87, 1976, with permission from The Company of Biologists Ltd. <https://jeb.biologists.org/content/65/2/483.article-info>
© Nomadsoul1 / iStock, www.istockphoto.com Reproduced with permission

OCR is committed to seeking permission to reproduce all third-party content that it uses in the assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements booklet. This is produced for each series of examinations and is freely available to download from our public website (www.ocr.org.uk) after the live examination series.

If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity. For queries or further information please contact the Copyright Team, The Triangle Building, Shaftesbury Road, Cambridge, CB2 8EA. OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.