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# GCSE (9–1) Combined Science B (Twenty First Century Science)

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## J260/08 Combined Science (Higher Tier)

Sample Question Paper

## 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.

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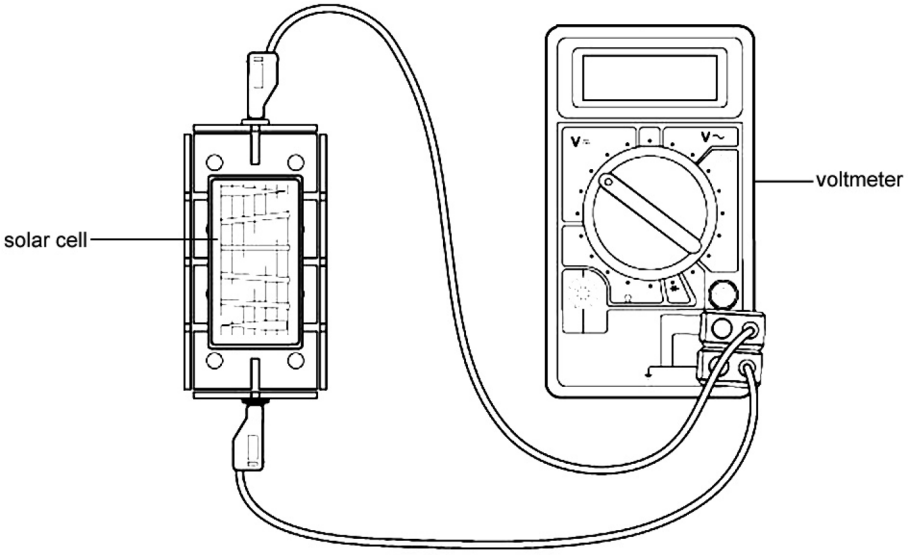
Answer **all** the questions.

**1** Solar cells generate electricity using energy from the Sun.

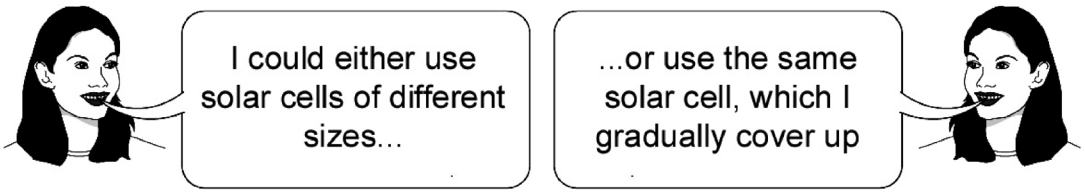
A class of students is investigating factors that affect the output of solar cells.

**(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.

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..... **[1]**

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

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..... **[1]**

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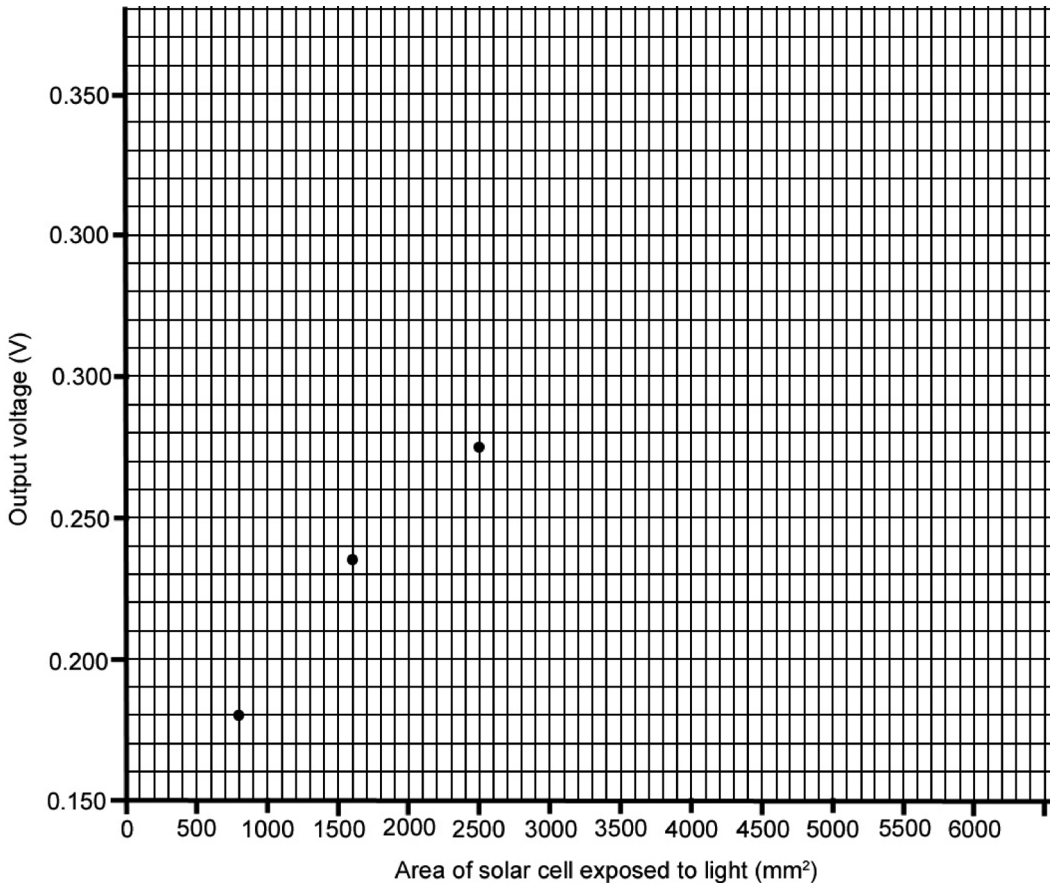
**(b)** Eve's results are shown below.

| 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]**

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**(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.

- 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.

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

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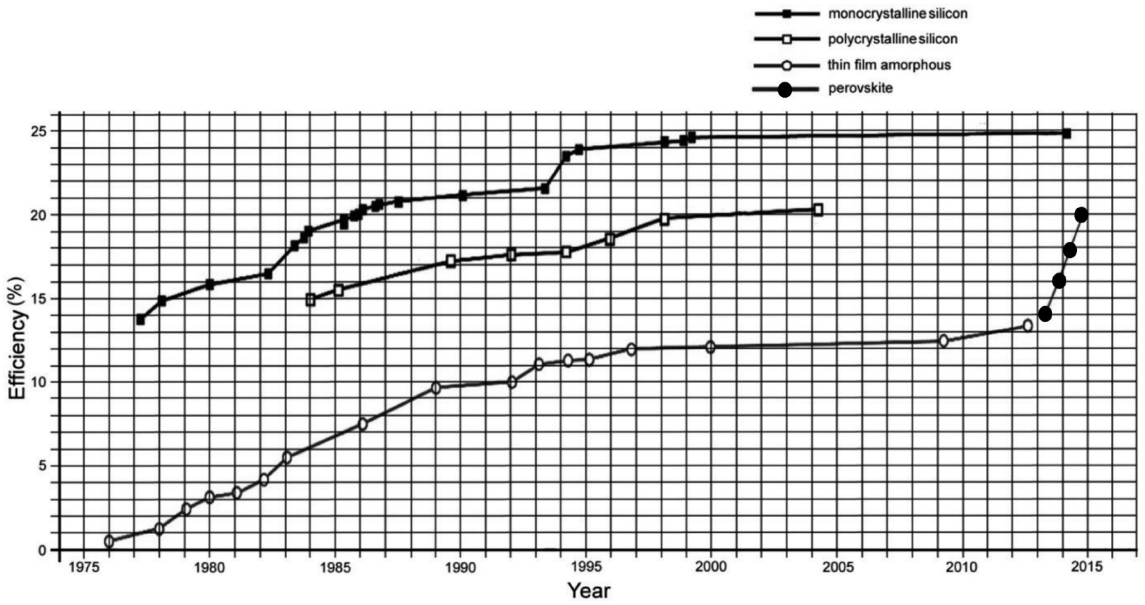
**(d)** Eve used solar cells made from polycrystalline silicon.

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.

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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.
- 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.

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..... **[2]**

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**(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.<br>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]**

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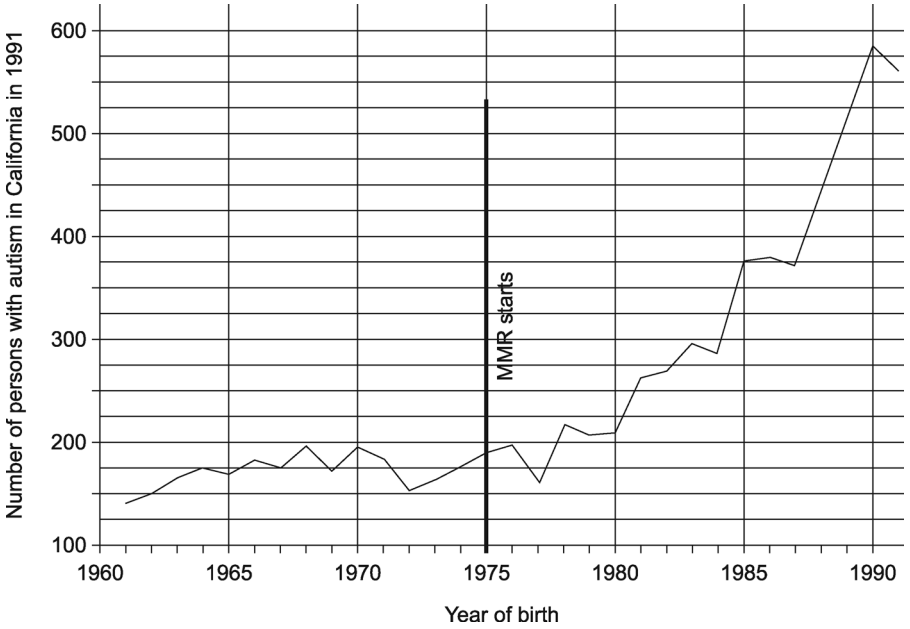
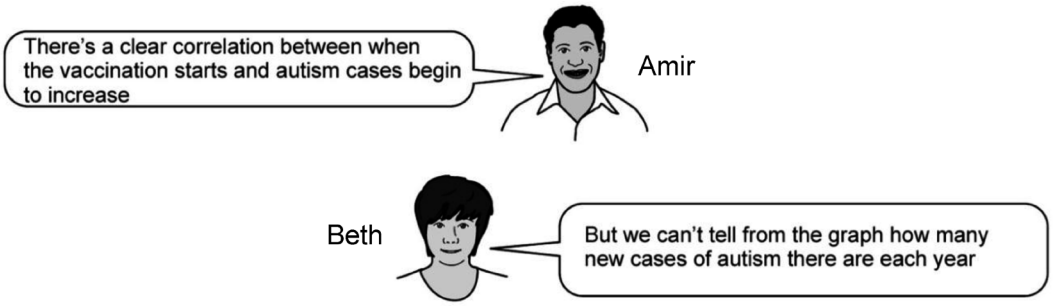
**(c) (i)** Several follow-up studies were made.

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.

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**(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.

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..... **[3]**

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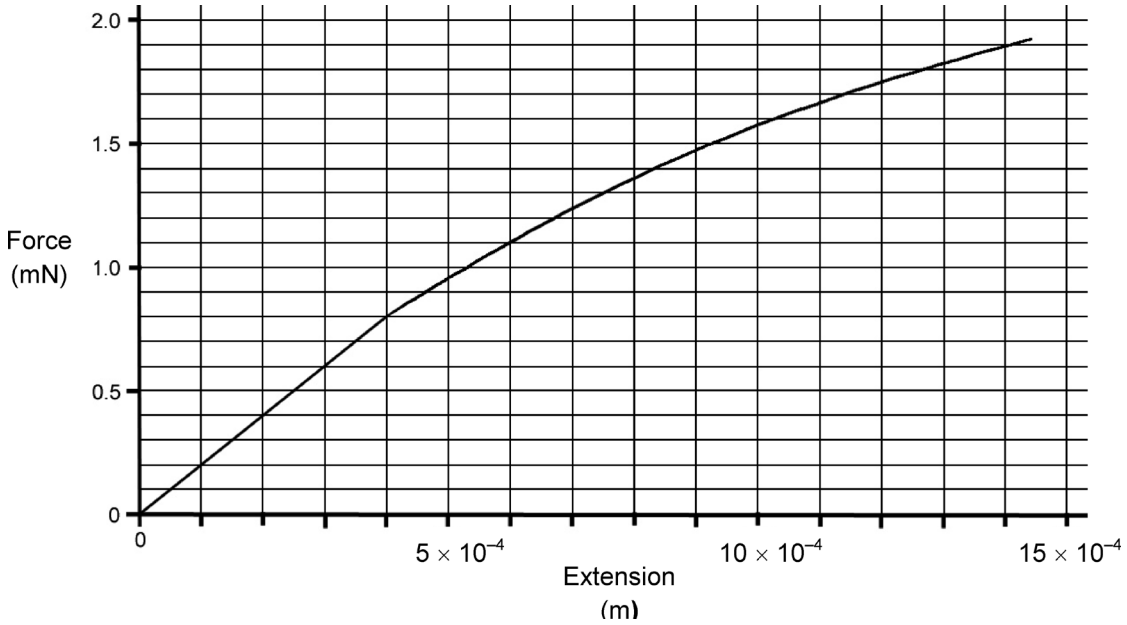
**3** **(a)** Scientists are studying the properties of spider silk.

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

The graph 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]**

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**(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 × spring constant (N/m) × (extension (m))$^2$

Energy stored = ……J **[2]**

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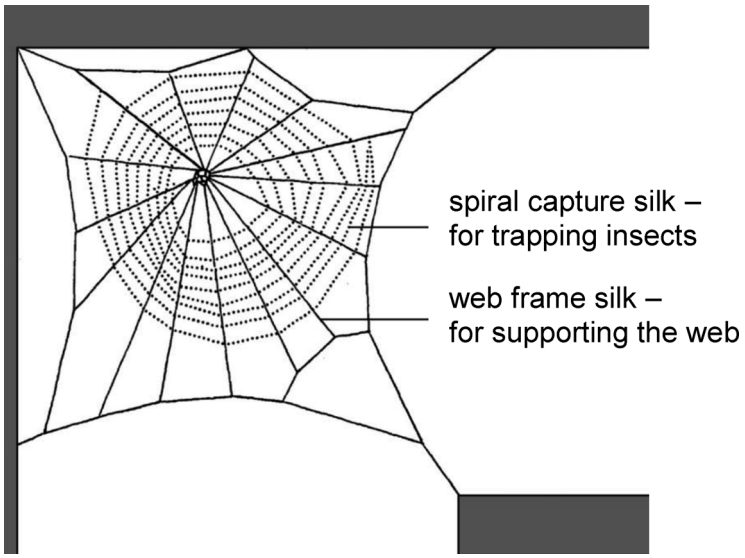
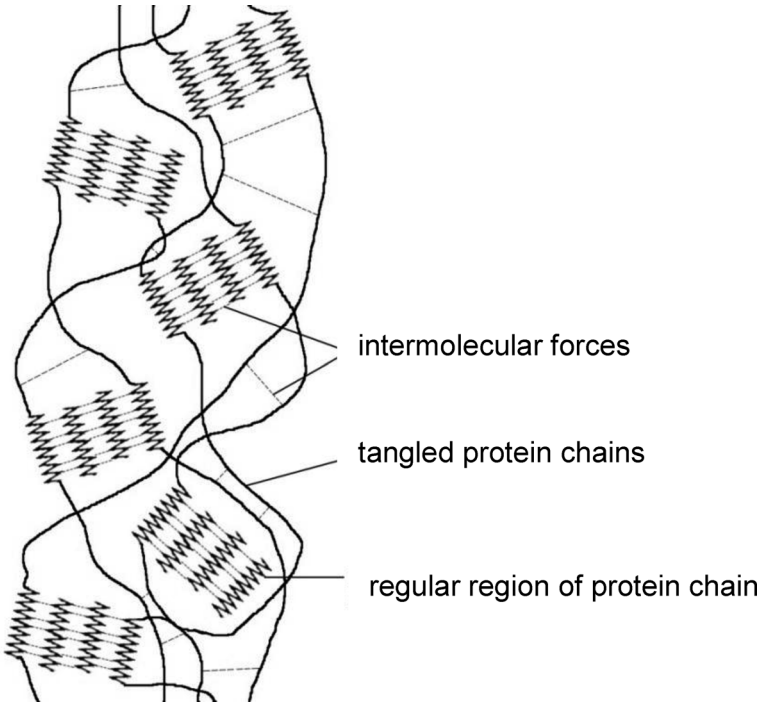
**(b)** A spider spins different types of silk when making its web.




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.

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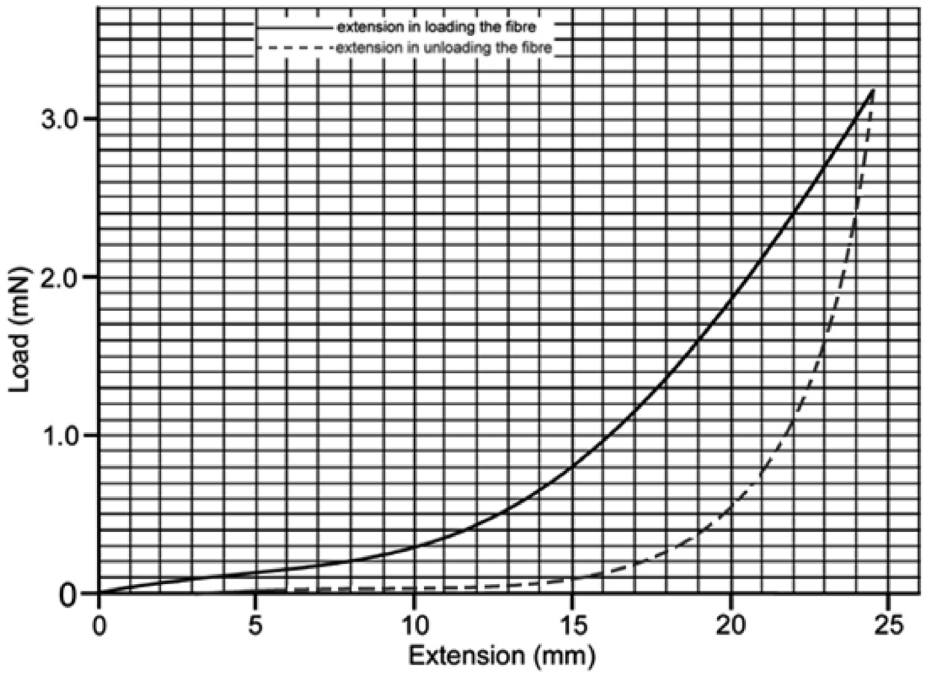
**(c)** Scientists studied the extension of spiral capture silk fibres.

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




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 trapping an insect.

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..... **[2]**

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**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 → 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.

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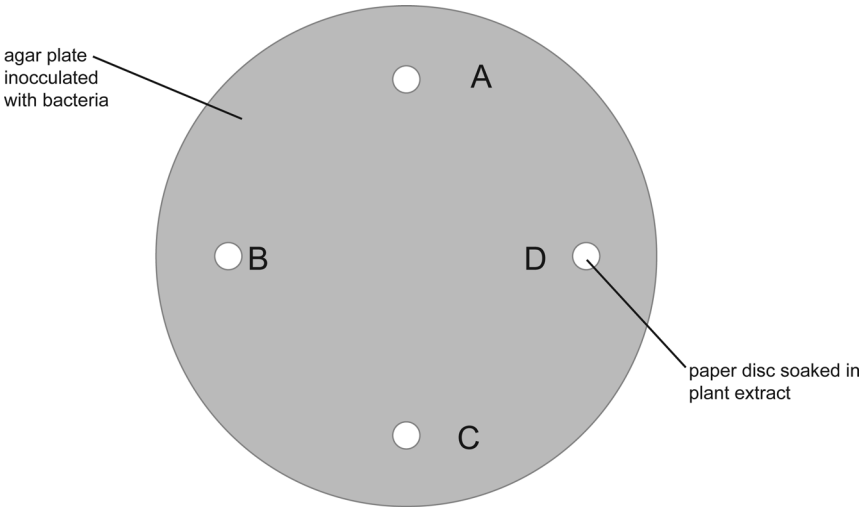
**(b)** The scientists at Kew Gardens extract chemical substances from the plants using ethanol as a solvent.

- The extracts are tested as possible new antibiotics 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**.

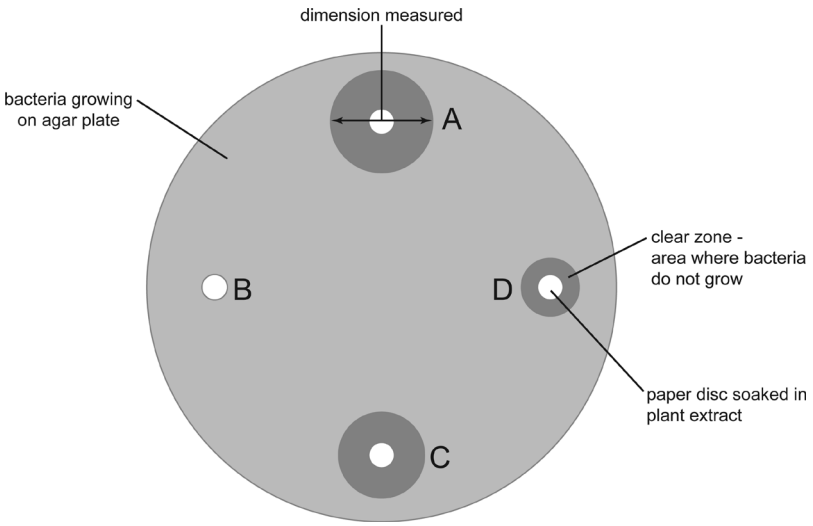
**Step 1** The scientists set up a series of agar plates.
Each plate is inoculated with the bacterium.

**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.



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**(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 = ……$mm^2$ **[2]**

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

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..... **[1]**

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**(c)** The scientists are evaluating their results.


Explain why the evaluation of each scientist is important.

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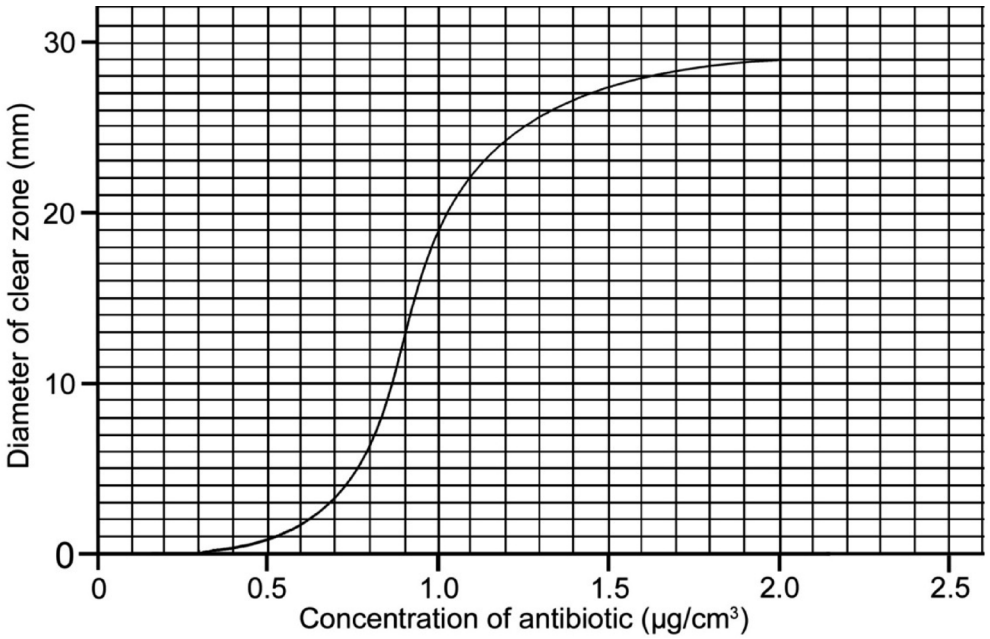
**(d)** One of the extracts was tested against the bacterium in concentrations from 0–2.5 μg/cm$^3$.

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. ☐

Above a concentration of 1.9 μg/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 μg/cm$^3$. ☐

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

**[1]**

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**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 |

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

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..... **[2]**

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

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

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

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

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**

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## Summary of updates

| Date | Version | Details |
|---|---|---|
| December 2021 | 2.2 | Updated copyright acknowledgements. |

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# …day June 20XX – Morning/Afternoon

**GCSE (9–1) Combined Science B (Twenty First Century Science)**

**J260/08 Combined Science (Higher Tier)**

**SAMPLE MARK SCHEME**

**Duration:** 1 hour 45 minutes

**MAXIMUM MARK 75**

**This document consists of 20 pages**

# MARKING INSTRUCTIONS

## PREPARATION FOR MARKING

### SCORIS

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *scoris assessor Online Training*; *OCR Essential Guide to Marking*.

2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are posted on the RM Cambridge Assessment Support Portal http://www.rm.com/support/ca

3. Log-in to scoris and mark the **required number** of practice responses ("scripts") and the **required number** of standardisation responses.

   YOU MUST MARK 10 PRACTICE AND 10 STANDARDISATION RESPONSES BEFORE YOU CAN BE APPROVED TO MARK LIVE SCRIPTS.

## MARKING

1. Mark strictly to the mark scheme.

2. Marks awarded must relate directly to the marking criteria.

3. The schedule of dates is very important. It is essential that you meet the scoris 50% and 100% (traditional 50% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.

4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone, email or via the scoris messaging system.

5. Work crossed out:
   a. where a candidate crosses out an answer and provides an alternative response, the crossed out response is not marked and gains no marks
   b. if a candidate crosses out an answer to a whole question and makes no second attempt, and if the inclusion of the answer does not cause a rubric infringement, the assessor should attempt to mark the crossed out answer and award marks appropriately.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there then add a tick to confirm that the work has been seen.

7. There is a NR (No Response) option. Award NR (No Response)
   - if there is nothing written at all in the answer space
   - OR if there is a comment which does not in any way relate to the question (e.g. 'can't do', 'don't know')
   - OR if there is a mark (e.g. a dash, a question mark) which isn't an attempt at the question.

   Note: Award 0 marks – for an attempt that earns no credit (including copying out the question).

8. The scoris **comments box** is used by your Team Leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**
   If you have any questions or comments for your Team Leader, use the phone, the scoris messaging system, or email.

9. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

10. For answers marked by levels of response:

Read through the whole answer from start to finish, using the Level descriptors to help you decide whether it is a strong or weak answer. The indicative scientific content in the Guidance column indicates the expected parameters for candidates' answers, but be prepared to recognise and credit unexpected approaches where they show relevance.
Using a 'best-fit' approach based on the skills and science content evidenced within the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer. Once the level is located, award the higher or lower mark:

**The higher mark** should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met.
**The lower mark** should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing.

**In summary:**

**The skills and science content determines the level.**
**The communication statement determines the mark within a level.**

Level of response question on this paper is **4(a)**.

11. **Annotations**

| Annotation | Meaning |
|---|---|
| **DO NOT ALLOW** | Answers which are not worthy of credit |
| **IGNORE** | Statements which are irrelevant |
| **ALLOW** | Answers that can be accepted |
| ( ) | Words which are not essential to gain credit |
| __ | Underlined words must be present in answer to score a mark |
| **ECF** | Error carried forward |
| **AW** | Alternative wording |
| **ORA** | Or reverse argument |

12. **Subject-specific Marking Instructions**

**INTRODUCTION**

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

The breakdown of Assessment Objectives for GCSE (9–1) in Combined Science B:

| | Assessment Objective |
|---|---|
| **AO1** | **Demonstrate knowledge and understanding of scientific ideas and scientific techniques and procedures.** |
| **AO1.1** | Demonstrate knowledge and understanding of scientific ideas. |
| **AO1.2** | Demonstrate knowledge and understanding of scientific techniques and procedures. |
| **AO2** | **Apply knowledge and understanding of scientific ideas and scientific enquiry, techniques and procedures.** |
| **AO2.1** | Apply knowledge and understanding of scientific ideas. |
| **AO2.2** | Apply knowledge and understanding of scientific enquiry, techniques and procedures. |
| **AO3** | **Analyse information and ideas to interpret and evaluate, make judgements and draw conclusions and develop and improve experimental procedures.** |
| **AO3.1** | Analyse information and ideas to interpret and evaluate. |
| **AO3.1a** | Analyse information and ideas to interpret. |
| **AO3.1b** | Analyse information and ideas to evaluate. |
| **AO3.2** | Analyse information and ideas to make judgements and draw conclusions. |
| **AO3.2a** | Analyse information and ideas to make judgements. |
| **AO3.2b** | Analyse information and ideas to draw conclusions. |
| **AO3.3** | Analyse information and ideas to develop and improve experimental procedures. |
| **AO3.3a** | Analyse information and ideas to develop experimental procedures. |
| **AO3.3b** | Analyse information and ideas to improve experimental procedures. |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| 1 | (a) | (i) | Different panels may have different characteristics / produce different voltages ✓ | 1 | 2.2 | |
| | | (ii) | **Any one from**<br>Type / intensity of light source ✓<br>Distance of light source from panel ✓<br>Temperature ✓ | 1 | 2.2 | |
| | (b) | (i) | Points plotted correctly ✓✓ | 2 | 2.2 | All four points plotted correctly – 2 marks<br>2-3 plotted correctly – 1 mark |
| | | (ii) | Points joined appropriately ✓ | 1 | 2.2 | |
| | | (iii) | Increase in voltage with increasing area ✓<br>Non-linear / graph levelling off ✓ | 2 | 3.1a | |
| | (c) | | Circuit has ammeter in series ✓<br>Voltmeter in parallel ✓<br>Suitable load, e.g. light bulb, resistor ✓<br>Use of equation to calculate the power output of the solar cell: power in watts = voltage / potential difference in volts x current in amps ✓ | 4 | 2.2 x3<br><br>2.1 | One mark for circuit diagram without elaboration / description |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| | (d) | | **Any four from**<br>Other types currently more efficient ✓<br>Only developed since 2013 ✓<br>Rate of improvement in efficiency suggests that these will be most efficient type of cell by 2016 / exceed efficiency of monocrystalline silicon by 2016 / data on efficiency data to support ✓<br>Other factors to consider e.g. cost, environmental impact, toxicity ✓<br>But we don't know how they will perform in non-laboratory situations ✓ | **4** | **3.2b** | |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| 2 | (a) | | Less chance of coming into contact with the disease / reference to herd immunity ✓<br>(More) communicable diseases are more likely to be passed on / spread ✓ | 2 | 1.1 | |
| | (b) | | ✓ The results could not be repeated by other scientists<br>✓ The sample size was too small | 2 | 2.2 | |
| | (c) | (i) | **Any three from**<br>Amir is correct because after the MMR vaccination is introduced, the number of cases increased ✓<br>*Beth is correct because:*<br>We don't know the factors affecting the population / named fa factor, e.g. birth rate, immigration, death rate, migration ✓<br>(Numbers affected by) increased awareness of condition / increased diagnosis / better reporting ✓<br>The data doesn't show / account for any variations in the age of the person at which the condition was diagnosed / developed ✓<br>The data doesn't take into account the percentage of children vaccinated ✓ | 3 | 3.1a | |
| | | (ii) | | 3 | 3.3b | |

| | 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. | | ✓ |

| Question | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|
| (d) | **Any three from**<br>If autism develops in one identical twin the probability of it developing in the other is high ✓<br><br>A connection with pesticides means there is an environmental link to autism ✓<br>Human genome analysis suggests genetic component ✓<br>(But) not all inherited / pass down in families as 3% of cases arise by mutation ✓<br>Range of genetic contribution revealed ✓ | **3** | **3.1a**<br><br>**3.2b x2** | Award 1 mark for studies suggest environmental and genetic links<br>**ALLOW** further DNA / genomic studies needed |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| 3 | (a) | (i) | **FIRST CHECK THE ANSWER ON THE ANSWER LINE IF** answer = 2 (N / m) award 5 marks<br><br>Recall formula – force exerted by a spring = extension (m) x spring constant (N / m) ✓<br><br>Interpolate extension / 4 X $10^{-4}$ ✓<br>Convert 8 mN value into N / 0.0008 N / 8.0 x $10^{-4}$ N ✓<br>Rearrangement 0.0008 ÷ 0.0004 / 8 x $10^{-4}$ ÷ 4 x $10^{-4}$ ✓<br>Answer = 2 ( N / m) ✓ | **5** | **1.1**<br><br>**2.2 x4** | Answer = 5 marks |
| | | **(ii)** | **FIRST CHECK THE ANSWER ON THE ANSWER LINE IF** answer = 1.6 x $10^{-7}$ (J) award 2 marks<br><br>Substitute values in the formula Energy (j) =<br>0.5 x spring constant (N / m) x (extension (m))$^2$ E = 0.5 x 2 x $0.0004^2$ ✓<br>Answer = 1.6 x $10^{-7}$ (J) ✓ | **2** | **2.2** | ALLOW non-standard form answer, e.g. 0.16 x $10^{-6}$<br>ECF for the spring constant from (a)(i) |
| | **(b)** | | **Any one from**<br>Strength reduced / described ✓<br>Intermolecular forces / bonds broken ✓<br>**AND**<br>Chains of molecules will separate / molecular structure changed ✓ | **2** | **3.2b**<br><br>**2.1** | Answer must include a description and an explanation |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| | (c) | | **Any four from**<br>*In loading*<br>Extension less for larger loads ✓<br>Because molecular chains are straightening / untangling so easier to stretch ✓<br>*In unloading*<br>The thread does not recover its original length ✓<br>As molecular chains do not return to original positions ✓<br>Area between curves shows that not all energy stored in the thread is recovered during unloading ✓ | **4** | **3.2b** | |
| | **(d)** | | Silk stretches as insect flies into it ✓<br>Stays stretched so that insect does not bounce from web ✓ | **2** | **3.1a**<br>**3.2b** | |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| 4 | (a*) | | Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.<br><br>**Level 3 (5–6 marks)**<br>Correctly identifies investigation into the effect on the rate of reaction of changes in lactic acid concentration.<br>**AND**<br>Provides a method detailing the majority of the main points required in plan needed to conduct this investigation.<br>**AND**<br>Includes details of how to develop the practical work further by detailing how results would be processed.<br><br>*There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated*<br><br>**Level 2 (3–4 marks)**<br>Correctly identifies investigation into the effect on the rate of reaction of changes in lactic acid concentration.<br>**AND**<br>Provides a method detailing the majority of the main points required in plan needed to conduct this investigation.<br>**OR**<br>Includes how to develop the practical work by providing information on how results would be processed. | 6 | 1.2<br>2.2 x4<br>3.3a | **AO1.2: Prediction based on hypothesis**<br>An increase in concentration of lactic acid increases the rate of reaction (between lactic acid and calcium carbonate)<br><br>**AO2.2 Method**<br>For example:<br>• control variable – volume of acid, mass of calcium carbonate, temperature<br>• dependent variable – measurement of calcium carbonate remaining (mass/dimensions) at the end of the reaction after a specified time<br>• independent variable – different concentrations of acid<br>• selection of appropriate equipment<br>• justification of appropriate equipment<br><br>**AO3.3a Development and processing**<br>For example:<br>• Plot change in mass over independent variable, graphical or mathematical calculation of reaction rate by (initial) gradient of graph or amount of reactant used up/time or amount of product produced/time |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| | | | *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.*<br><br>**Level 1 (1–2 marks)**<br>Correctly predicts an increase in concentration of lactic acid will increase the rate of reaction and plans investigation into the effect on the rate of reaction of changes in acid lactic acid concentration.<br>**AND**<br>Provides a basic method detailing some of the main points required in plan needed to conduct this investigation.<br><br>*There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.*<br><br>**0 marks**<br>*No response or no response worthy of credit.* | | | |

| Question | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|
| (b) | **Any three from**<br>*Benefits:*<br>PLA biodegradable ✓<br>(nanoparticles prevent microbe growth so) reduce deaths / food poisoning / illness ✓<br>*Risks:*<br>Nanoparticles may enter food ✓<br>May be enhanced by biodegradability ✓<br>Nanoparticles may be absorbed into bloodstream (from gut / digestive system) ✓<br>Possible health risks ✓<br>Owing to size and surface area ✓ | **3** | **2.1** | |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| 5 | (a) | (i) | Chemical / compound that kills microorganisms / bacteria / prevents their growth ✓ | 1 | 1.1 | |
| | | (ii) | **Any four from**<br>A mutation / change in base sequence / DNA / variation ✓<br>(Causes) bacteria to become resistant ✓<br>When the antibiotic is used, the resistant bacteria are more likely to survive ✓<br>To reproduce / resistance is passed on to the next generation ✓<br>The number of resistant bacteria increases ✓<br>The antibiotic is the selection pressure ✓ | 4 | 1.1 | **ALLOW** 1 mark for referral to antibiotic resistance |
| | (b) | (i) | **FIRST CHECK THE ANSWER ON THE ANSWER LINE IF** answer = 64 $mm^2$ award 2 marks<br><br>4.5 x 4.5 x 3.14 ✓<br>Answer = 64 $mm^2$ ✓ | 2 | 1.2 | |
| | | (ii) | Extract C, Test 6 is outlier / 25 in Test 6 **AND** value not consistent with the other data / other values 14 – 16 mm ✓ | 1 | 3.1b | Both extract and justification needed for 1 mark |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| | (c) | | *Kai*<br>Likely to be / could be some inhibition of bacteria by ethanol ✓<br>**OR**<br>(Area of clear zone) must be excluded to get a true value for inhibition by the (potential) antibiotic ✓<br>*Jack*<br>With variation in depth of agar, antibiotic will diffuse more / less far ✓<br>*Mia*<br>(With irregular area) difficult to determine area /<br>clear zone ✓ | **3** | **3.1b** | One mark should be awarded for a comment on each action |
| | (d) | | ✓ A concentration of greater than 0.3 μg / $cm^3$ is required to inhibit the growth of the bacteria | **1** | **3.1a** | |

| Question | | | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|---|---|
| 6 | (a) | (i) | $H^+ + OH^- \rightarrow H_2O$ ✓✓ | 2 | 1.1 | **ALLOW** correct formula of reactants in either order for 1 mark<br>**ALLOW** correct formula of product for 1 mark |
| | | (ii) | Relative formula mass of sodium hydroxide = 23.0 + 16.0 + 1.0 = 40 ✓ | 1 | 2.2 | |
| | | (iii) | **FIRST CHECK THE ANSWER ON THE ANSWER LINE IF** answer = 0.1 (g) award 2 marks<br><br>0.4 g in 1dm$^3$ ✓<br>0.1 (g) in 250 (cm$^3$) ✓ | 2 | 2.2 | **ALLOW ECF** for RFM in (i) |
| | (b) | (i) | **Any two from**<br>To get a rough estimate of the volume of hydrochloric acid required to neutralise the alkali required ✓<br>So she can slow down on subsequent titrations and approach the endpoint with care ✓<br>Doesn't overshoot the endpoint ✓ | 2 | 3.3b | |
| | | (ii) | **FIRST CHECK THE ANSWER ON THE ANSWER LINE IF** answer = 0.0053 mol / dm$^3$ award 4 marks<br><br>Correct substitution of values into formula ✓<br>Rearrangement of formula to make acid concentration subject ✓<br>Answer = 0.0053 ✓<br>Units: mol / dm$^3$ ✓ | 4 | 1.1<br>2.2 x3 | Correct answer gains first 3 marks (if units are missing) |

## Summary of updates

| Date | Version | Change |
|---|---|---|
| May 2018 | 2 | We've reviewed the look and feel of our papers through text, tone, language, images and formatting. For more information please see our assessment principles in our "Exploring our question papers" brochures on our website |