OCR
Oxford Cambridge and RSA

Accredited

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

F

J260/04 Combined Science (Foundation Tier)

Sample Question Paper

Date – Morning/Afternoon

Version 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 **28** pages.

Answer **all** the questions.

1 James is a forensic scientist.

He has a sample of lipstick on a paper tissue from a crime scene for analysis.

(a) Lipsticks contain wax, oil and coloured dyes.

(i) Why can chromatography be used to analyse the chemical substances in lipsticks?

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

All lipsticks are made from the same substances. ☐

Lipsticks are mixtures of substances. ☐

Lipsticks are pure substances. ☐

Lipsticks are the appropriate colour for the technique. ☐ **[1]**

(ii) Suggest why James uses some, but not all, of the lipstick for his analysis.

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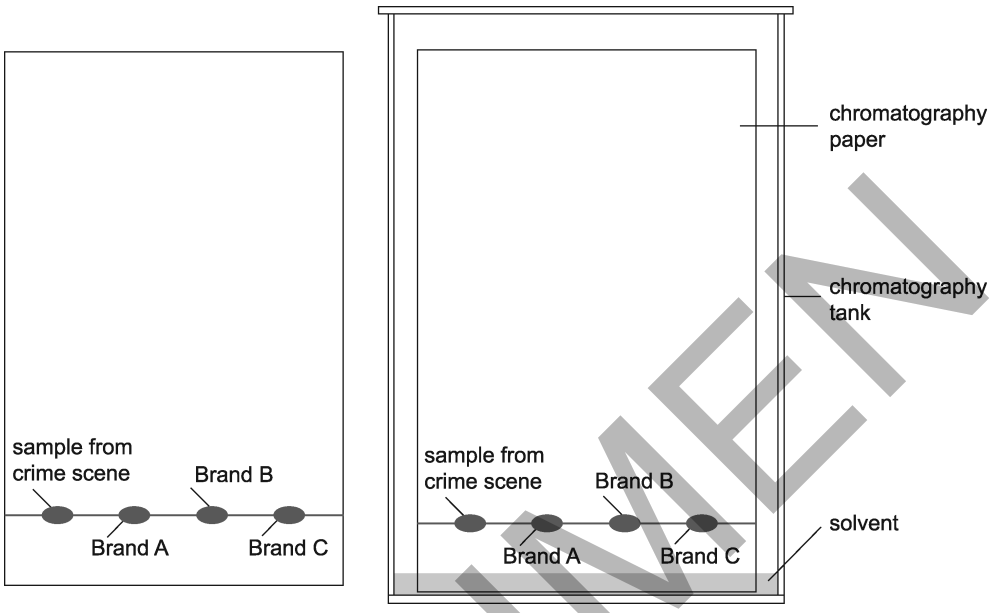
..... **[1]**

(b) James places the sample of lipstick from the crime scene and samples of three brands of lipstick (**A, B** and **C**) on the chromatography paper.

He mixes up 120 cm^3 of solvent and pours it into the chromatography tank. This is a large glass jar.

He then places the chromatography paper in the tank.



(i) The solvent that James uses is made up of four liquids in the proportions shown below

	methylbutanol	**propanone**	**water**	**ammonium hydroxide**
In the proportions of	25 :	18 :	15 :	2

Calculate how much methylbutanol he will need.

Show your working.

Methylbutanol = …….cm^3 **[3]**

(ii) The lipstick spots are above the level of the solvent in the tank.

Why is it important that the lipstick spots do not dip into the solvent?

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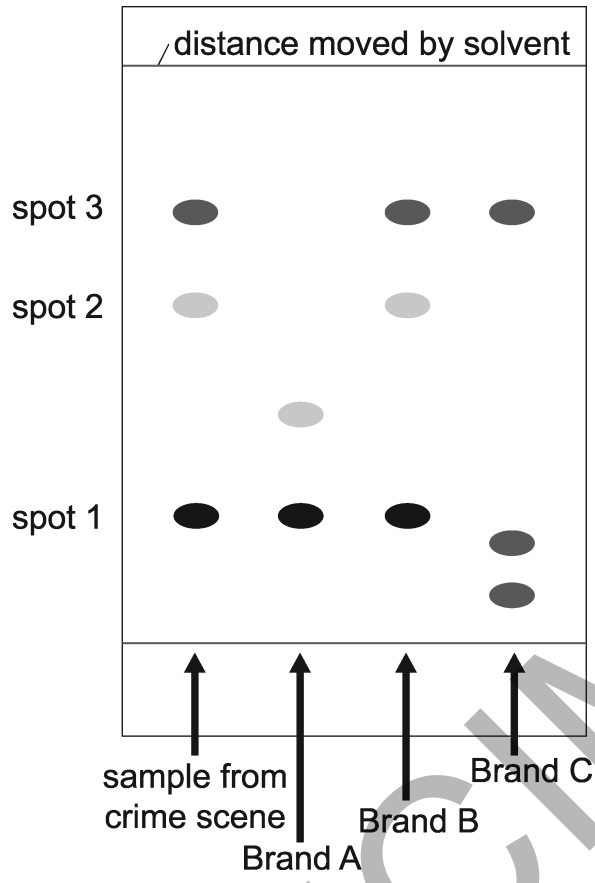
..... **[1]**

(c) After 2 hours, the solvent has moved up the chromatography paper.

The chromatogram is shown below.



(i) What conclusion can you make from the results about the brand of lipstick found at the crime scene?

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

(ii) James calculates R_f values for each spot found in the sample from the crime scene.

$$R_f \text{ value} = \frac{\text{distance moved by the spot}}{\text{distance moved by the solvent}}$$

Complete the table below for the sample from the crime scene

Spot	Distance moved by spot (in cm)	Distance moved by solvent (in cm)	*R*f value
Spot **1**	1.6	7.2	0.22
Spot **2**			
Spot **3**			

[2]

(iii) Six different types of coloured dye were found on the chromatogram.

How could James identify these?

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

(d) Suggest why the technique used by James may **not** be suitable for identifying other colours of lipstick.

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

(e) Some samples sent to James for analysis are colourless.

How would he modify his technique?

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

Run the chromatography for longer. ☐

Spray the chromatogram with a locating agent. ☐

Spray the chromatography paper with a dye before adding the sample ☐

Use a different solvent. ☐

[1]

2 Sunscreens contain particles of chemicals that reflect or absorb damaging ultraviolet radiation from the Sun.

Some sunscreens contain particles of zinc oxide mixed with substances that make it easy to spread on the skin.

Newer versions of sunscreens contain zinc oxide nanoparticles.

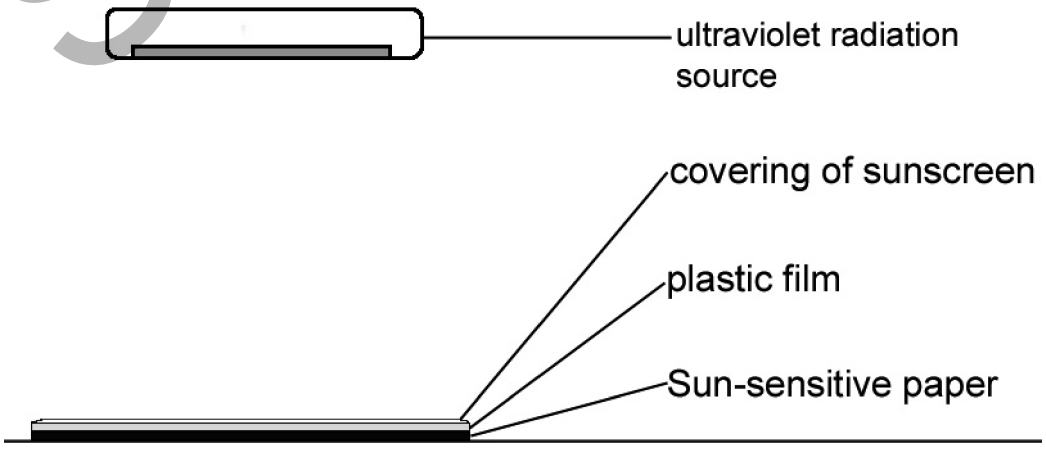
This person is wearing the visible type of zinc oxide sunscreen.

(a) In her science class, Mia is testing how well different types of sunscreen protect against the Sun.

- She covers pieces of plastic film with each of the sunscreens she is testing.
- She places each piece of plastic on a sheet of Sun-sensitive paper.

  Sun-sensitive paper changes colour when exposed to ultraviolet radiation.
- She turns on an ultraviolet radiation source.
- She records the time taken for the Sun-sensitive paper to change colour.

The diagram shows how she setup her experiment.



(i) Mia decides to apply 2 mg of sunscreen to every cm^2 of plastic film or human skin.

Why does Mia apply the sunscreen in this way?

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

More sunscreen would completely block ultraviolet radiation. ☐

So that the correct wavelengths of light are reflected. ☐

The variable is controlled, so that results from different sunscreens can be compared. ☐

To limit the cost of the experiment. ☐ **[1]**

(ii) Give **one** other variable that Mia needs to keep constant.

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

(iii) Complete Mia's Risk Assessment for the ultraviolet radiation source:

Source of hazard	Hazard	Risk	Safety precaution
Ultraviolet radiation source	Ionising radiation		

[2]

(b) (i) Pure zinc oxide, used in sunscreens, can be manufactured by reacting zinc with oxygen at 1000°C.

The word equation is written below.

Complete and balance the symbol equation for the reaction.

zinc + oxygen → zinc oxide

..... (g) + ... (g) → ..... ZnO (s) **[2]**

(ii) These statements are about this reaction between zinc and oxygen.

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

The oxygen reacts with solid zinc. ☐

The symbol (s) stands for the substrate of the reaction. ☐

The zinc is oxidised during the reaction. ☐

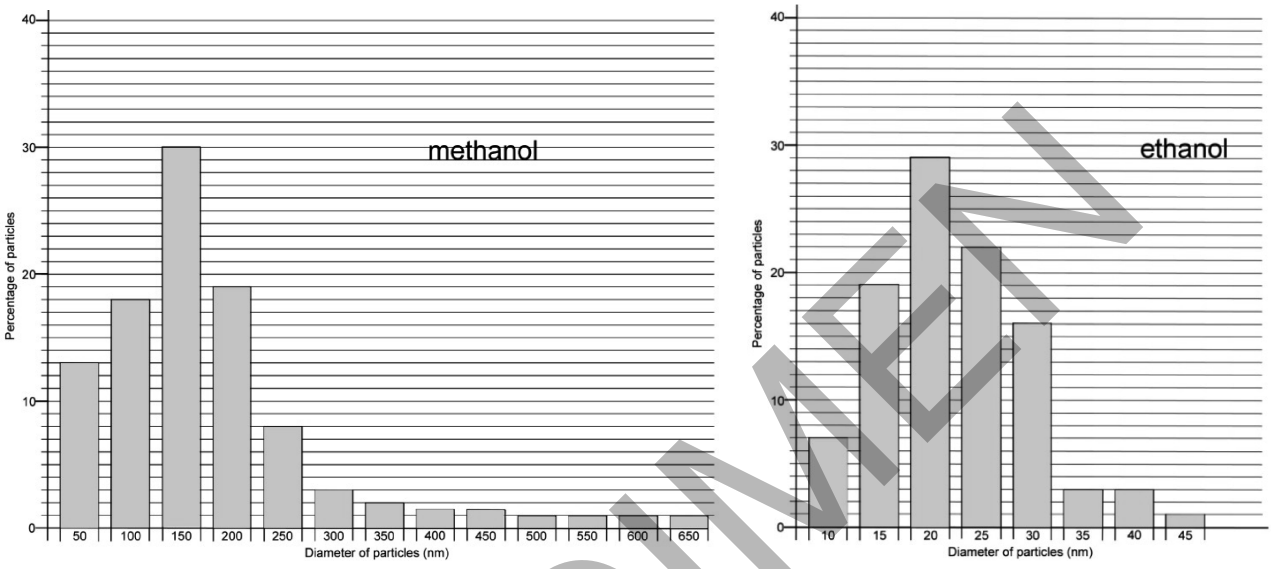
Zinc oxide is a gas at 1000°C. ☐ **[1]**

(c) Zinc oxide nanoparticles can be made by reacting zinc with an alcohol.

Nanoparticles are particles that are smaller than 100 nm in size.

Particles ranging from 100–2 500 nm in diameter are called microfine particles.

The bar charts show the range in particle size of nanoparticles made using the two different alcohols, methanol and ethanol.



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

Ethanol produces particles with the narrowest range of size. ☐

Ethanol produces the greatest proportion of microfine particles. ☐

Methanol is best for producing particles of 20 nm in diameter. ☐

Methanol produces the greatest proportion of particles in the nanoparticle range. ☐ **[1]**

(d) Exposure to ultraviolet radiation can cause a type of skin cancer called melanoma.

This headline appeared in a newspaper.

(i) **DRINKING COFFEE PREVENTS SKIN CANCER**
JUST FOUR CUPS A DAY REDUCES THE RISK

The study was carried out by the National Cancer Institute in the USA.
The total number of people involved in the study was 447 357.
They were cancer-free at the beginning of the study.
Questionnaires were used to find out peoples coffee intake during the study.

	Coffee intake per day			
	None	**1 cup**	**2–3 cups**	**4 cups**
Number in study	44 574	140 843	188 020	73 920
Number who developed melanoma	310	942	1253	399
Percentage who developed melanoma	0.695	0.669	0.666	0.539

Is the newspaper headline correct?
What can you conclude from this study?

Justify your answer by:

- referring to the data
- discussing **two** possible limitations of the investigation.

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

(ii) If coffee does affect melanoma development, what must scientists do to establish a link?

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

3 **(a)** Amir is investigating the efficiency of his electric kettle.

He makes a prediction:

'The efficiency of my electric kettle will increase as I increase the amount of water I heat.'

He tests the prediction by boiling his kettle containing different masses of water.

(i) He first boils **0.2 kg** of water.

He measures the time it takes to boil.

He carries out the process twice. Here are his results:

These statements are about Amir's results, but **not** all are true.

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

	True	False	We cannot tell
Amir's results are accurate.	☐	☐	☐
The mean of Amir's results is 32.3 s.	☐	☐	☐
It is always best to collect three sets of results.	☐	☐	☐

[3]

(ii) The power rating of the kettle he uses is 3000 W.

Calculate the energy supplied to the kettle.

Energy = ……J **[4]**

(iii) The starting temperature of the water was 19°C. The boiling point of water is 100°C.

Calculate the change in internal energy of the water using the formula:

change in internal energy (J) = mass (kg) × specific heat capacity (J/kg/°C) × change in temperature (°C)

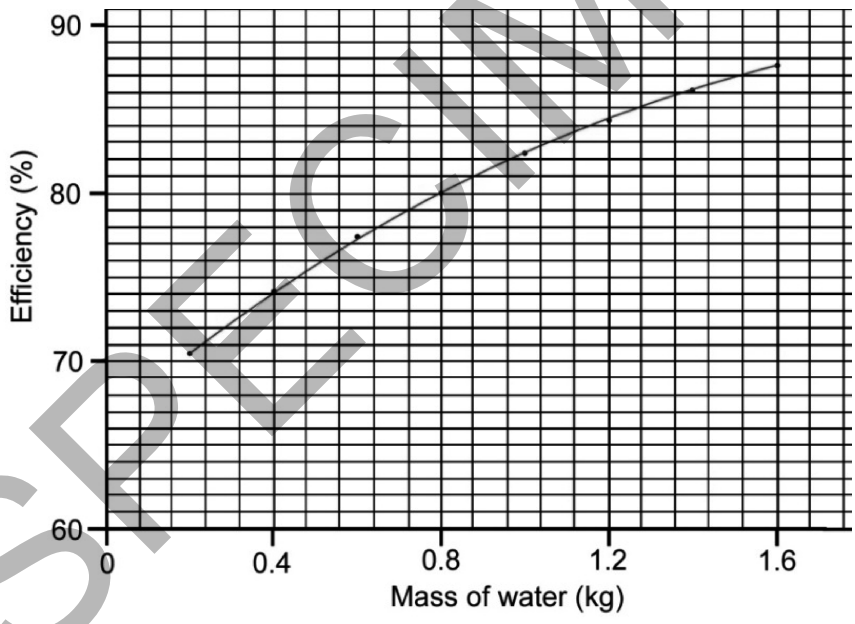
- The specific heat capacity of water = 4200 J/kg/°C

Change in internal energy = ...J **[3]**

(iv) The percentage efficiency of the kettle with 0.2 kg water is 70.4 %.

Amir now varies the mass of water in the kettle from 0.4 kg to 1.6 kg.

He plots a graph of efficiency against mass. His graph is shown below.



Discuss the extent to which the data support Amir's prediction.

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

(b) Amir thinks that some energy is lost through the surface of the kettle.

He researches some of the materials that kettles are made from.

Material	Thermal conductivity (W/m/K)
Copper	390.00
Glass	0.80
Low Density Poly(ethene)	0.34
Poly(propene)	0.15
Stainless steel	17.00

- Suggest which material can be used to manufacture the best-insulated kettle.
- Explain why this material is most suitable.
- Give reasons why the other materials are less suitable.

Use your knowledge and understanding of chemical bonding, and data from the table, in your explanation.

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

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TURN OVER FOR THE NEXT QUESTION

4 Jane is an ecologist. She carries out an ecological survey to investigate the distribution of plants in grassland.

(a)* Jane identifies 20 different plant species in the area.

The area measures 100 m × 50 m.

Describe a technique that Jane could use to estimate the abundance of each of the plant species per m^2 of the grassland.

Include details of how Jane could take care to preserve the grassland and how she might process the data she collects.

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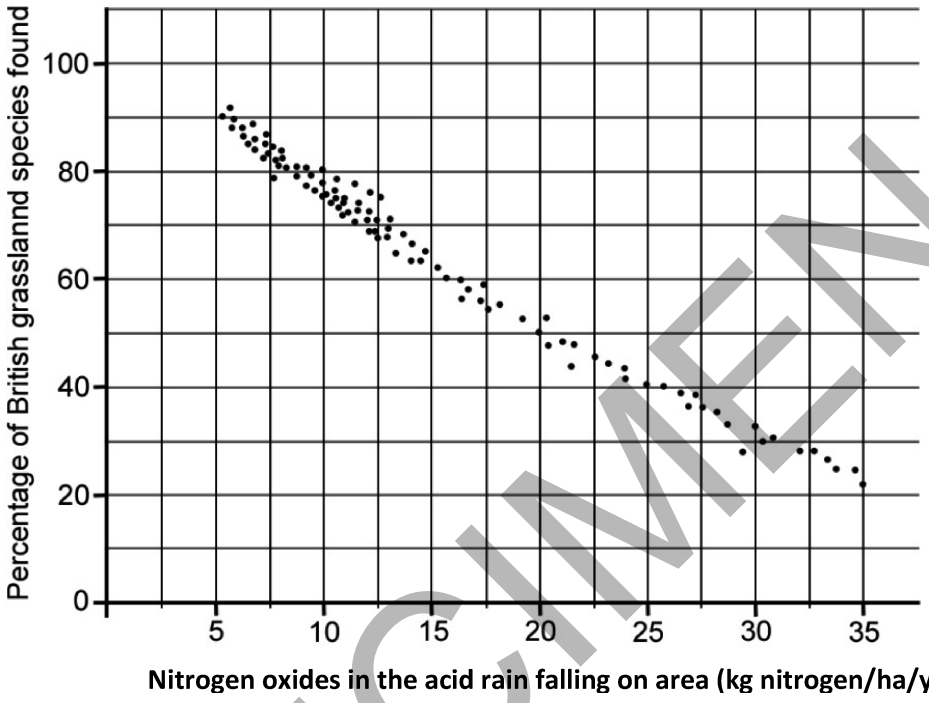
..... **[6]**

(b) Jane finds a scientific paper on the effects of acid rain on grassland plant species.

It shows the number of grassland plant species in parts of the country affected by different amounts of acid rain. The acid rain is caused by oxides of nitrogen.

A point is plotted for each part of the country investigated.



This question is about the graph.

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

Fewer than 30 results are recorded on the scatter graph. ☐

Increasing nitrogen falling on the grassland reduces the biodiversity. ☐

No results are available for parts of the country where nitrogen content is less than 10 kg nitrogen/ha/yr. ☐

There is no correlation between nitrogen and numbers of plant species. ☐ **[1]**

(c) Ecologists have modelled the effect of nitrogen deposited in the environment.

- They prepared three plots where a grassland plant species had been planted.
- They sprayed the plots with a dilute solution of nitric acid.

  Nitric acid is one form of nitrogen pollution.
- They counted the number of flowers produced by the grassland plants.

Here are their results:

Nitrogen added to plots (kg nitrogen/ha/yr)	**Mean number of flowers (9 m^2 plot)**
0	88
35	70
140	19

Below are some statements about this research on the three plots, but only one is correct.

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

Biodiversity is affected as the nitrogen concentration increases. ☐

In conditions of 140 kg nitrogen/ha/yr, five times the number of flowers are produced. ☐

The experiment could be improved by testing different sources of nitrogen pollution. ☐

The plots must have measured 3 m × 3 m. ☐ **[1]**

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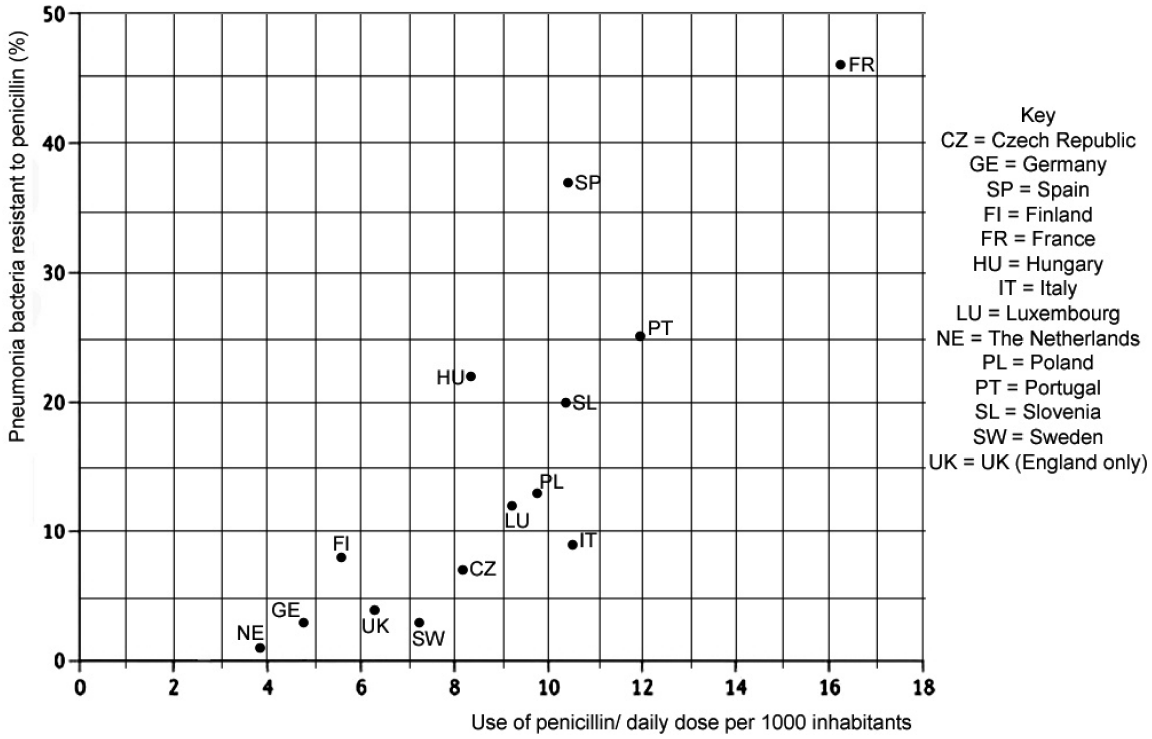
TURN OVER FOR THE NEXT QUESTION

5 **(a)** In 2006, scientists reported on numbers of pneumonia bacteria resistant to the antibiotic penicillin.

They investigated the relationship between antibiotic resistance and antibiotic dose in European countries.

Their results are shown below.



Use the information in the graph.

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

Bacteria in France show the highest percentage of bacteria resistance. ☐

The daily dose of antibiotics per 1000 inhabitants in the UK is the fifth lowest reported. ☐

The daily dose of penicillin in Portugal is 25 per 1000 inhabitants. ☐

The percentage of resistant bacteria decreases as the daily dose is increased. ☐ **[1]**

(b) Too many antibiotics! Patients and prescribers speak up.

In the USA, Medscape interviewed healthcare providers and patients.

1174 patients were surveyed about their use of antibiotics.

They were asked whether each of the following statements was true for them.

	Yes %	**No %**
My healthcare provider talked to me about antibiotic resistance.	53	47
I save unused antibiotics at home for future use.	18	82
I have taken another family members antibiotics or they have taken mine.	19	81

Explain the consequences to patients as a result of these statements.

Include ideas about **antibiotic resistance** in bacteria in your answer.

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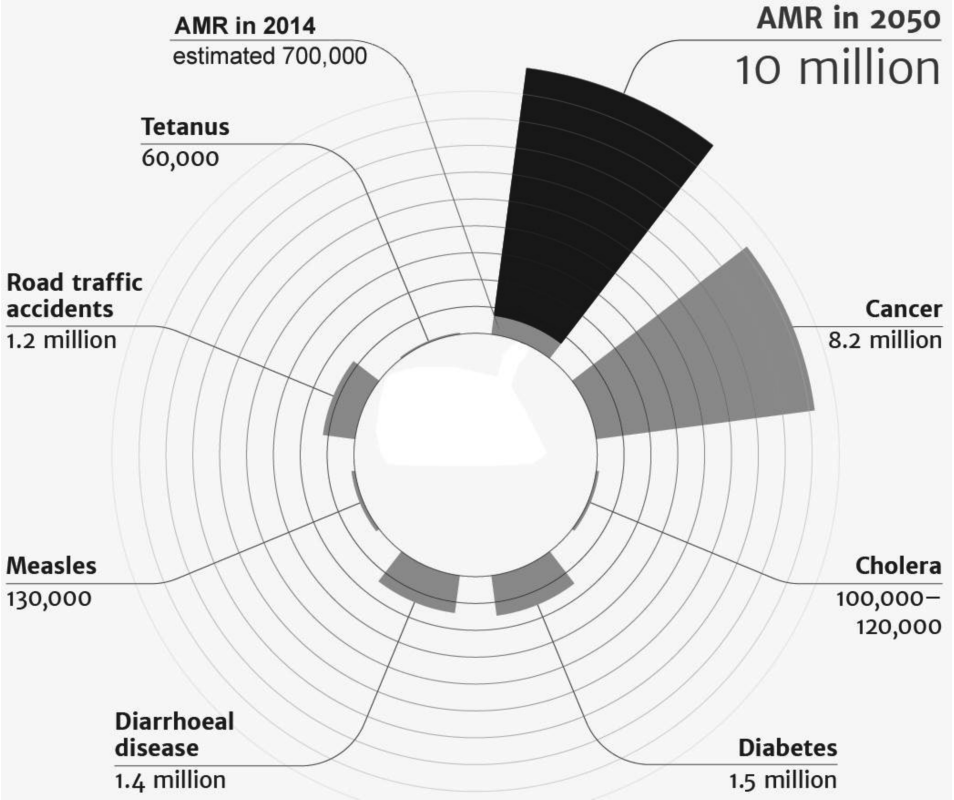
..... **[3]**

(c) A report at the beginning of 2015 reviewed evidence of antimicrobial resistance (AMR).

Antimicrobials include antibiotics and other medicines used to control organisms that cause disease.

The report predicted the effects of AMR on numbers of world deaths and on the worlds economy in 2050.

The chart shows the number of deaths from antimicrobial resistance (AMR) in 2014 compared with other causes of death. Each ring represents 1 million deaths.



(i) Put the risk of dying from the different causes in the chart in 2014, in order.

Put the cause with the greatest risk first, the lowest last.

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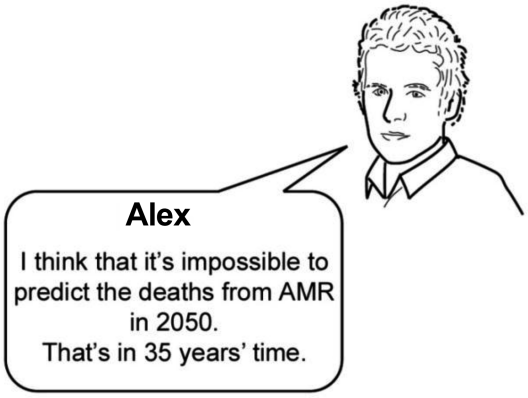
..... **[1]**

(ii) A student makes a comment on the report.



Discuss why Alex may think this.

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

(iii) Suggest ways in which AMR might lead to increases in costs to the worlds economies.

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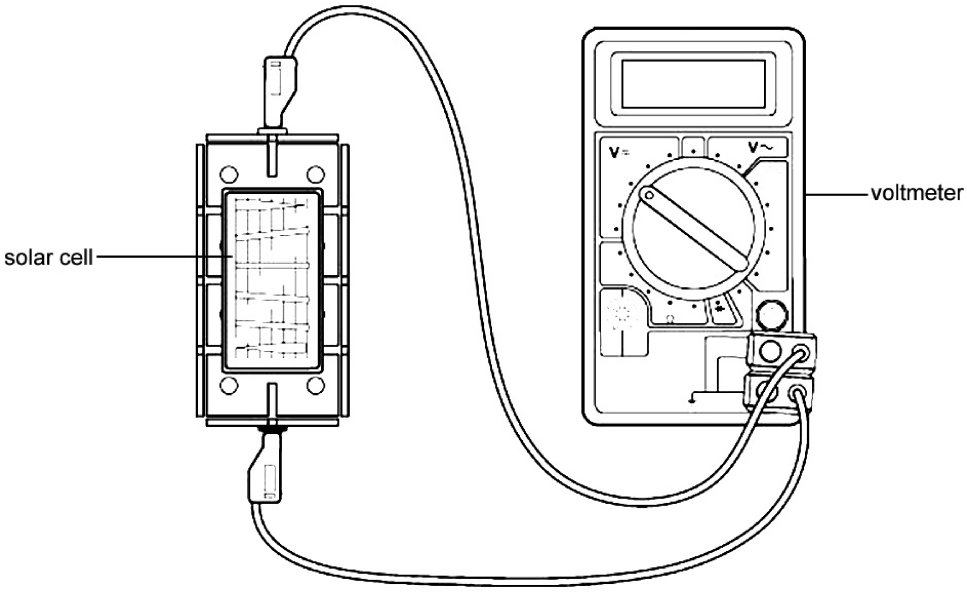
..... **[2]**

6 Solar cells generate electricity using energy from the Sun.

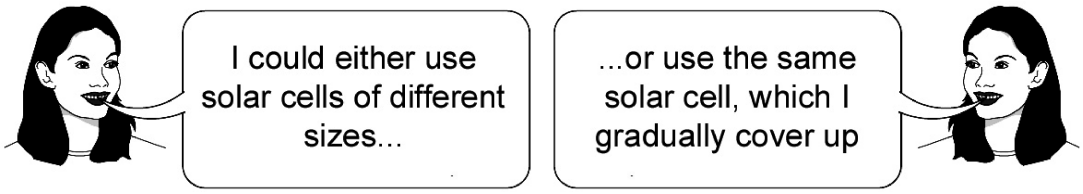
A class of students is investigating factors that affect the output of solar cells.

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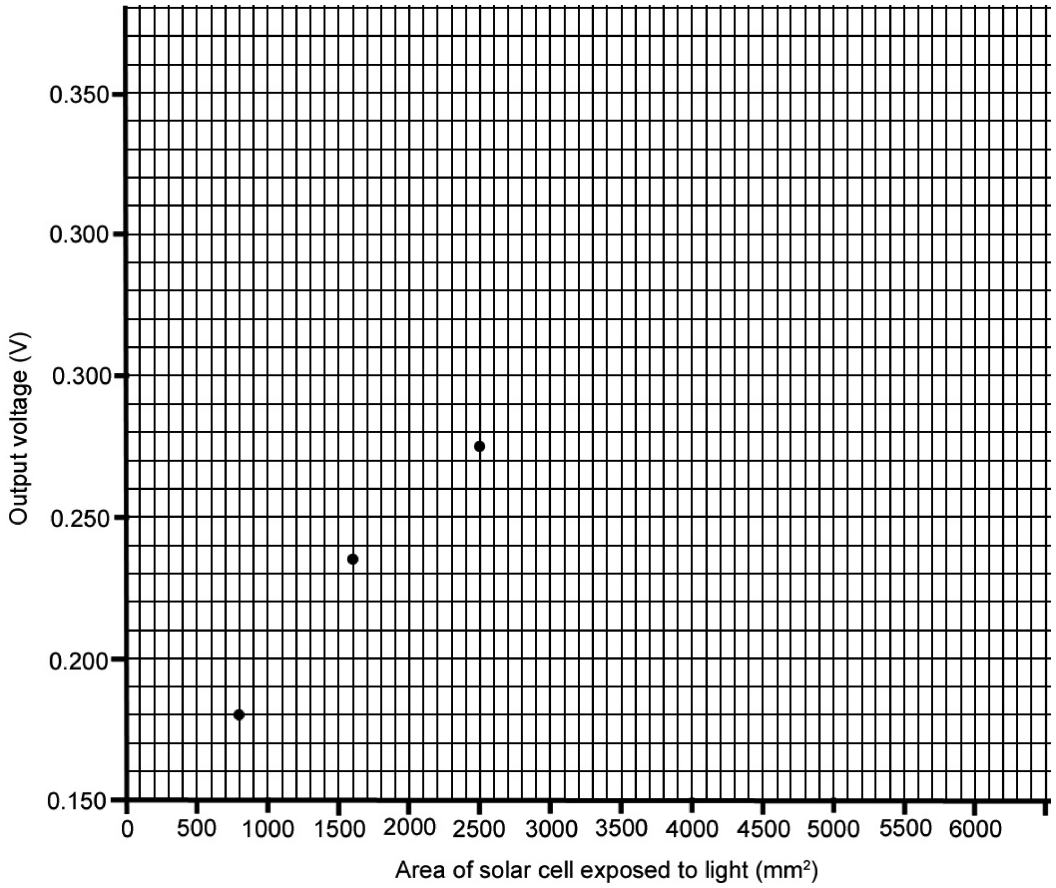
..... **[1]**

(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]**

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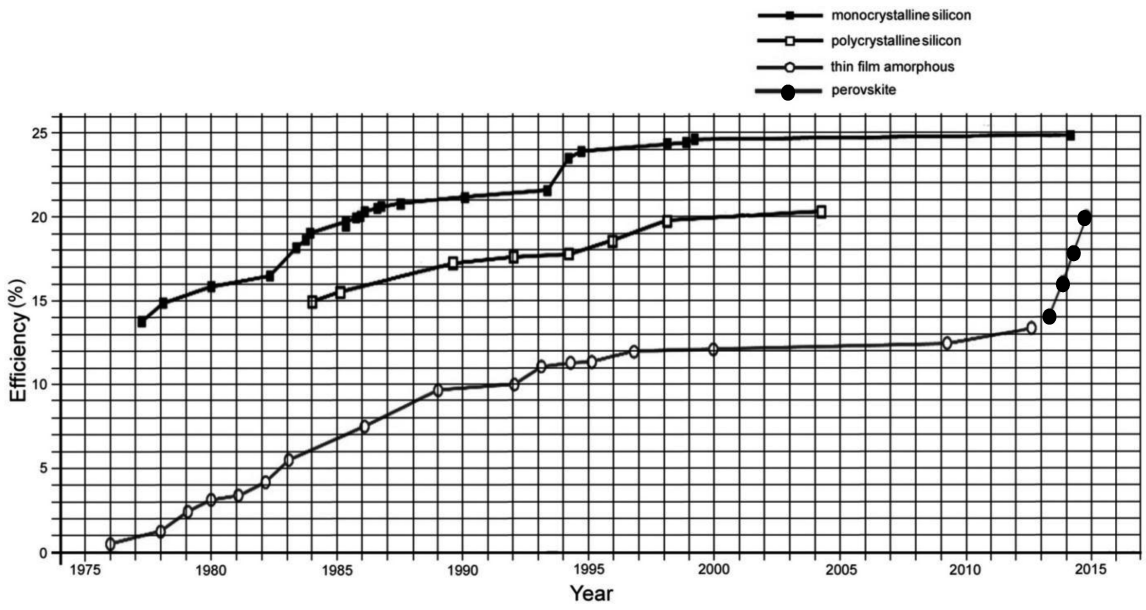
..... **[4]**

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

END OF QUESTION PAPER

OCR
Oxford Cambridge and RSA

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…day June 20XX – Morning/Afternoon

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

J260/04 Combined Science (Foundation 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.

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AO element</th><th>Guidance</th></tr>
<tr><td>1</td><td>(a)</td><td>(i)</td><td>✓ lipsticks are mixtures of substances</td><td>1</td><td>1.2</td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td>Any one from
So that he has other samples for other analyses ✓
Has another sample if analysis goes wrong ✓
Sample available for others, e.g. defence lawyer, to check results ✓</td><td>1</td><td>2.2</td><td></td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>FIRST CHECK THE ANSWER ON THE ANSWER LINE IF answer = 50 cm^3 award 3 marks

25 + 18 + 15 + 2 = 60 ✓
120 / 60 x 25 ✓
50 cm^3 ✓</td><td>3</td><td>2.2</td><td>ALLOW ECF for addition</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>Would dissolve spot into solvent / would remove spot ✓</td><td>1</td><td>2.2</td><td></td></tr>
<tr><td></td><td>(c)</td><td>(i)</td><td>Lipstick Brand B was on the tissue ✓</td><td>1</td><td>3.2b</td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td>
<table>
<tr><th>Sample</th><th>Distance moved by spot in cm</th><th>Distance moved by solvent in cm</th><th>Rf value</th></tr>
<tr><td>Spot 1</td><td>1.6</td><td rowspan="3">7.2</td><td>0.22</td></tr>
<tr><td>Spot 2</td><td>4.2</td><td>0.58</td></tr>
<tr><td>Spot 3</td><td>5.4</td><td>0.75</td></tr>
<tr><td></td><td>Both correct ✓</td><td></td><td>Both correct ✓</td></tr>
</table>
</td><td>2</td><td>2.2</td><td>Measurements correct to +/- 0.1 cm
Rf values to 2 d.p. for mark</td></tr>
</table>

Question			Answer	Marks	AO element	Guidance
		(iii)	Compare Rf value ✓ With literature value or AW ✓	2	1.2 2.2	
	(d)		**Any one from** Solvent (system) may not separate other dyes ✓ They may have dyes with similar Rf value so won't separate ✓	1	3.3a	
	(e)		✓ spray the chromatogram with a locating agent ✓	1	3.3b	

Question			Answer	Marks	AO element	Guidance
2	(a)	(i)	✓ the variable is controlled, so that results from different sunscreens can be compared	1	2.2	
		(ii)	**Any one from** Same UV / same wavelength source ✓ Distance of UV source ✓ Same type of plastic film ✓	1	2.2	
		(iii)	Risk ✓ Safety precaution ✓	2	1.1 2.2	Sensible risks and safety precautions, e.g. risk – damaging to eyes, safety precaution – do not look directly at light source
	(b)	(i)	Symbols (Zn, O_2) ✓ Balancing (2Zn and 2ZnO) ✓	2	1.1 2.2	
		(ii)	✓ the zinc is oxidised during the reaction	1	2.1	
	(c)		Ethanol produces particles with the narrowest range of size ✓	1	3.1a	

Question			Answer	Marks	AO element	Guidance
	(d)	(i)	*Interpreting data* 1 - 3 cups some reduction of melanoma ✓ 4 cups bigger / more marked reduction ✓ **OR** Percentage stays very similar for all coffee intakes ✓ Reduction in percentage for 4 cups not big enough to support the claim ✓ **Any two from** *Limitations* Accuracy of recording coffee intake ✓ Prior exposure to Sun ✓ Coffee intake may be correlated with other behavioural ✓ Characteristics that may affect melanoma ✓ Other factors that may affect melanoma ✓ Exposure to Sun variable ✓ Variation in different protective measures between different people ✓	**4**	**3.1a x2** **3.2b x2**	Maximum 2 marks for interpreting data
		(ii)	(suggest / establish a) plausible mechanism ✓	**1**	**1.2**	

Question			Answer	Marks	AO element	Guidance
3	(a)	(i)	We cannot tell ✓ False ✓ False ✓	3	1.2	
		(ii)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE IF** answer = 96 600 (J) award 4 marks Recall of formula – Energy transferred (J) = power (W) x time (s) ✓ Calculation of mean = 32.2 ✓ 32.2 x 3000 ✓ Correct calculation = 96 600 (J) ✓	4	 1.1 2.2 2.2 1.2	
		(iii)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE IF** answer = 68 040 J award 3 marks Calculation of temperature rise ✓ Substitute values into formula ✓ Correct answer = 68 040 J ✓	3	 2.2 1.1 2.2	
		(iv)	**Any two from** The data does support the prediction ✓ Efficiency does increase with volume ✓ Relationship is almost linear (as volume increases) ✓ Data quote in support of the prediction ✓	2	 3.1a 3.2a	**ALLOW** answers relating to prediction being proven / true / correct e.g. 74% with 0.4 kg rising to 87% with 1.6 kg so a 13% increase when increasing the mass x4

Question			Answer	Marks	AO element	Guidance
	(b)		Poly(propene) ✓ **Any three from:** Poly(propene) has the lowest thermal conductivity / has a value of 0.15 W/m/K Copper and stainless steel have a higher thermal conductivity / have thermal conductivity values of 390.00 and 17.00 In metals, heat transferred by free electrons ✓ Bonds between particles transfer heat in polymers ✓ Transfer of heat is quick in metals ✓ Transfer of heat is slow in polymers ✓	**4**	**3.2a** **3.1b x3**	**ALLOW** specific examples of metals **ALLOW** specific examples of polymers **ALLOW** metals in place of named metals from the table of data

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. **Level 3 (5-6 marks)** Gives a detailed method of how to carry out investigation. **AND** Describes how to preserve environment. **AND** Gives an indication of the processing of results. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated* **Level 2 (3-4 marks)** Builds on basic method and gives more details as to how to determine distribution. **AND** Either describes how to preserve the environment **OR** how the results will be processed *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1-2 marks)** Gives a basic method how to determine distribution of plants in area.	**6**	**1.2 x2** **2.2x4**	**AO1.2** **Recall of basic method** For example: • use of quadrat / counting numbers • idea of sampling **AO2.2** **Additional detail of method applied to the grassland** For example: • use of quadrat of appropriate area, e.g. 1 m^2 • appropriate number of quadrats, e.g. 50 • idea of random sampling • idea of preservation of habitat, e.g. identify / survey without damaging / uprooting plants / removing plants from the area / limits trampling • idea of random sampling using grid and (computer generated) random number table • details of processing: count numbers of each plant in each quadrat / calculate mean / species density

Question			Answer	Marks	AO element	Guidance
			There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant. **Level 0 (0 marks)** *No response or no response worthy of credit.*			
	(b)		✓ Increasing nitrogen falling on the grassland reduces the biodiversity	**1**	**3.1a**	
	(c)		✓ The experiment could be improved by testing different sources of nitrogen pollution	**1**	**3.3b**	

Question			Answer	Marks	AO element	Guidance
5	(a)		✓ Bacteria in France show the highest percentage of resistance	1	3.1a	
	(b)		**Any three from** Patients may not understand the effects of overuse of antibiotics / taking a course of antibiotics correctly ✓ (Not taking the full course) may lead to antibiotic resistance ✓ (Taking antibiotics prescribed for someone else) may lead to side effects ✓ (Antibiotics prescribed for someone else) may not be suitable for treating person's (communicable) disease ✓ (If the full course isn't taken), all in the population of bacteria (causing the disease) may not be killed ✓ Mutation with natural selection leads to whole population of bacteria becoming resistant ✓	3	3.2a	
	(c)	(i)	Cancer Diabetes Diarrhoeal disease Road traffic accidents AMR Measles Cholera Tetanus ✓	1	3.1a	All answers required in correct order for 1 mark

Question			Answer	Marks	AO element	Guidance
		(ii)	**Any three from** New antibiotics / ways of controlling bacteria may be developed/discovered ✓ Way of making (current) antibiotics more effective could be developed / discovered ✓ Figure based on mathematical model / only one projection of current data ✓ Current estimate may not be reliable / must be reliable (to produce model) ✓ Suggestion of other cause of deaths / catastrophic event that may affect world population ✓	**3**	**3.1b**	
		(iii)	**Any two from** Cost of treatment of disease / more medical staff required ✓ Research and development of new antibiotics / alternative treatments ✓ Effects on workforce ✓	**2**	**3.2a**	

Question			Answer	Marks	AO element	Guidance
6	(a)	(i)	Different panels may have different characteristics / produce different voltages ✓	1	2.2	
		(ii)	**Any one from** Type / intensity of light source ✓ Distance of light source from panel ✓ Temperature ✓	1	2.2	
	(b)	(i)	Points plotted correctly ✓✓	2	2.2	All four points plotted correctly – 2 marks 2-3 plotted correctly – 1 mark
		(ii)	Points joined appropriately ✓	1	2.2	
		(iii)	Increase in voltage with increasing area ✓ Non-linear / graph levelling off ✓	2	3.1a	
	(c)		Circuit has ammeter in series ✓ Voltmeter in parallel ✓ Suitable load, e.g. light bulb, resistor ✓ 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 2.1	One mark for circuit diagram without elaboration / description

Question			Answer	Marks	AO element	Guidance
	(d)		**Any four from** Other types currently more efficient ✓ Only developed since 2013 ✓ 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 ✓ Other non-performance factors to consider, e.g. cost, environmental impact, toxicity ✓ But we don't know how they will perform in non-laboratory situations ✓	**4**	**3.2b**	

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