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

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 Peter 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.

Lipsticks are pure substances.	☐
All lipsticks have identical formulations.	☐
Lipsticks are mixtures of substances.	☐
Lipsticks are the appropriate colour for the technique.	☐

[1]

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

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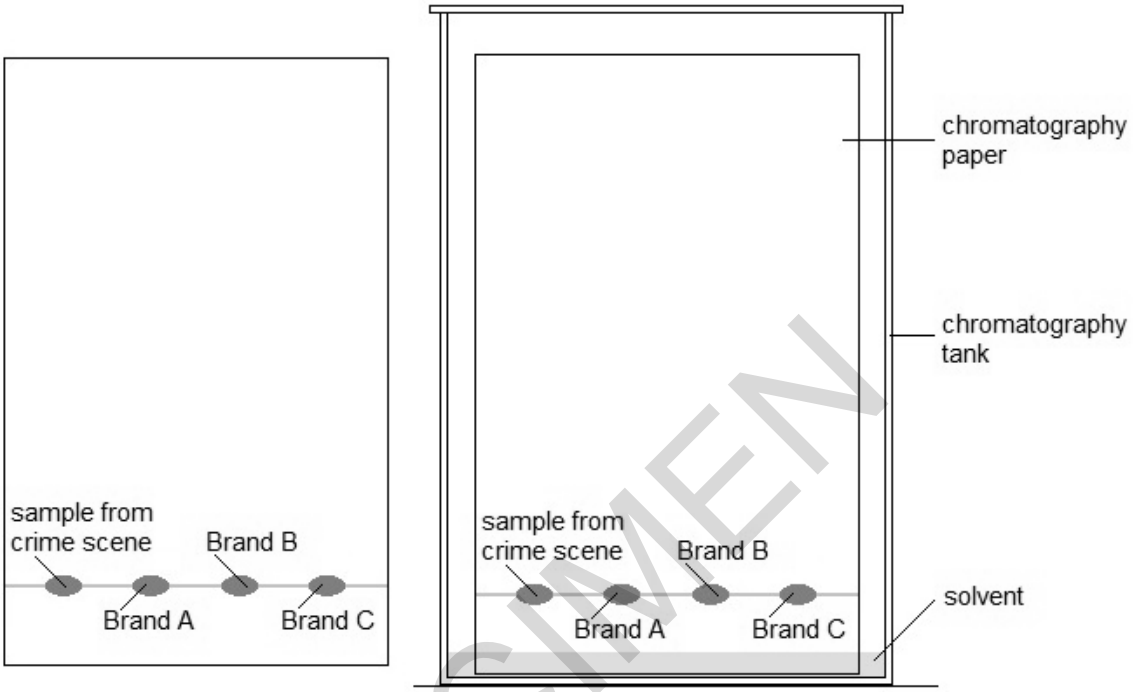
..... **[1]**

(b) Peter places the sample of lipstick from the crime scene and samples of three brands of lipstick 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 system that Peter uses is made up of:

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

Calculate how much methylbutanol he will need.

Show your working.

.....cm^3 **[3]**

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

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

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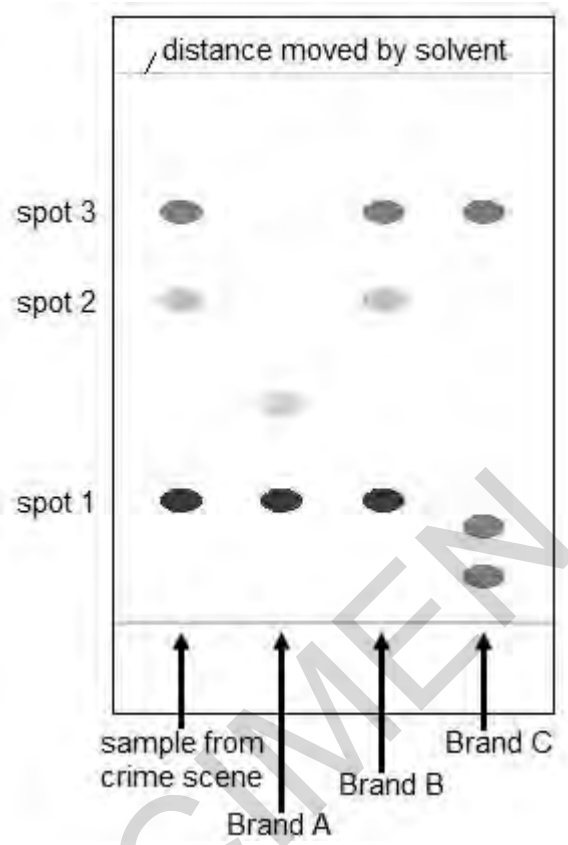
..... **[1]**

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

The chromatogram is shown below.



(i) What conclusion about the brand of lipstick on the paper tissue can you draw from the results?

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

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

The Rf 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

Sample	Distance moved by spot in cm	Distance moved by solvent in cm	Rf 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 Peter identify these?

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

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

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

(e) Some samples sent to Peter for analysis are colourless. How would he modify his technique?

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

Use a different solvent.	☐
Spray the chromatogram with a locating agent.	☐
Spray the chromatography paper with a dye before adding the sample.	☐
Run the chromatography for longer.	☐

[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 the sunscreens contain zinc oxide nanoparticles. This person is wearing the visible type of zinc oxide sunscreen.

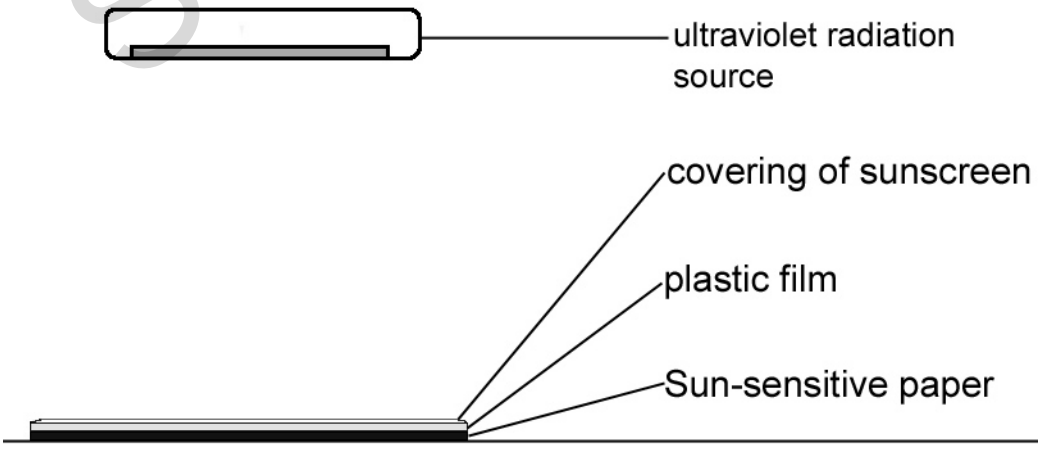
(a) In her science class, Anna is testing how well different types of sunscreen protect against the Sun.

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.



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

Why does Anna apply it in this way?

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

To limit the cost of the experiment.	☐
The variable is controlled, so that results from different sunscreens can be compared.	☐
More sunscreen would completely block ultraviolet radiation.	☐
So that the correct wavelengths of light are reflected.	☐

[1]

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

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

(iii) Complete Anna'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.

Zinc oxide is a gas at 1000 °C. ☐

The zinc is oxidised during the reaction. ☐

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

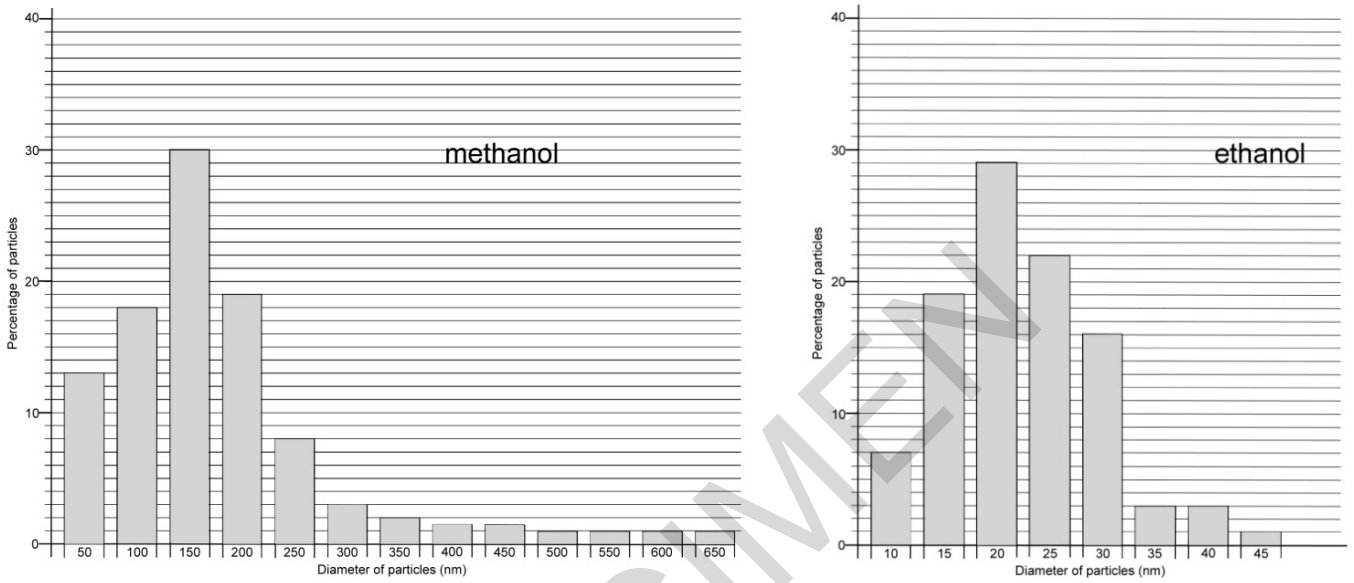
The oxygen reacts with solid zinc. ☐

[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 – 2500 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 the greatest proportion of microfine particles. ☐

Ethanol produces particles with the narrowest range of size. ☐

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 people's 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)** Josh 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 Josh's results, but not all are true.

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

	True	False	We cannot tell
Josh's results are accurate.	☐	☐	☐
The mean of Josh'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.

..... 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)

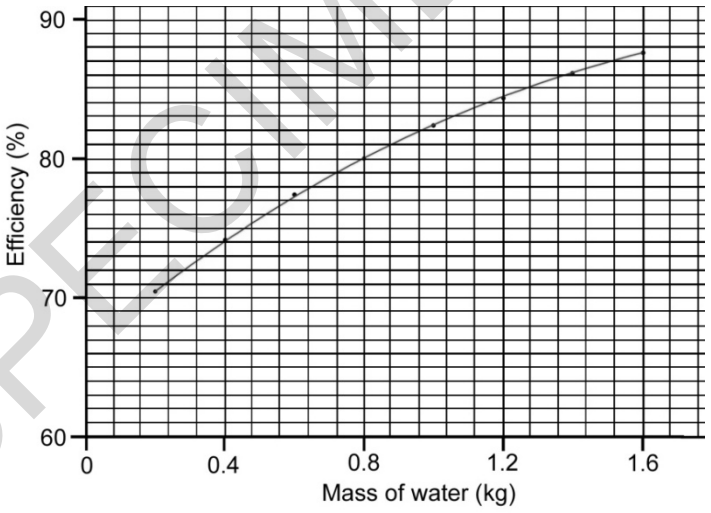
The specific heat capacity of water = 4200 J / kg / °C

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

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

Josh 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 Josh's prediction.

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

(b) Josh 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 that 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]**

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

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

The area measures 100 m x 50 m.

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

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

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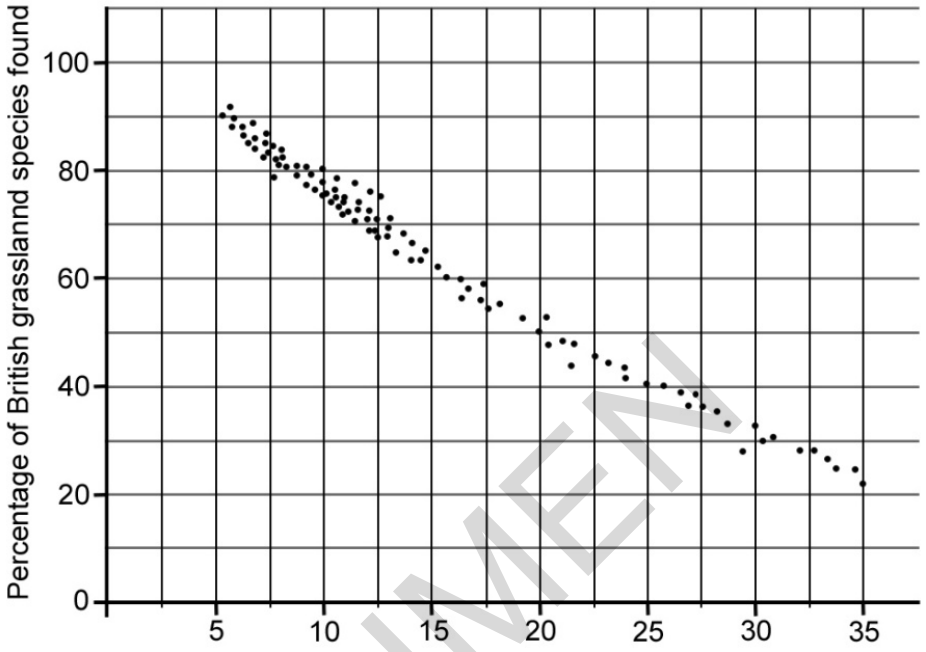
..... **[6]**

(b) Jess 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.

There is no correlation between nitrogen and numbers of plant species. ☐

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

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

Increasing nitrogen falling on the grassland reduces the biodiversity. ☐

[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 N / 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.

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

The plots must have measured 3 m x 3 m. ☐

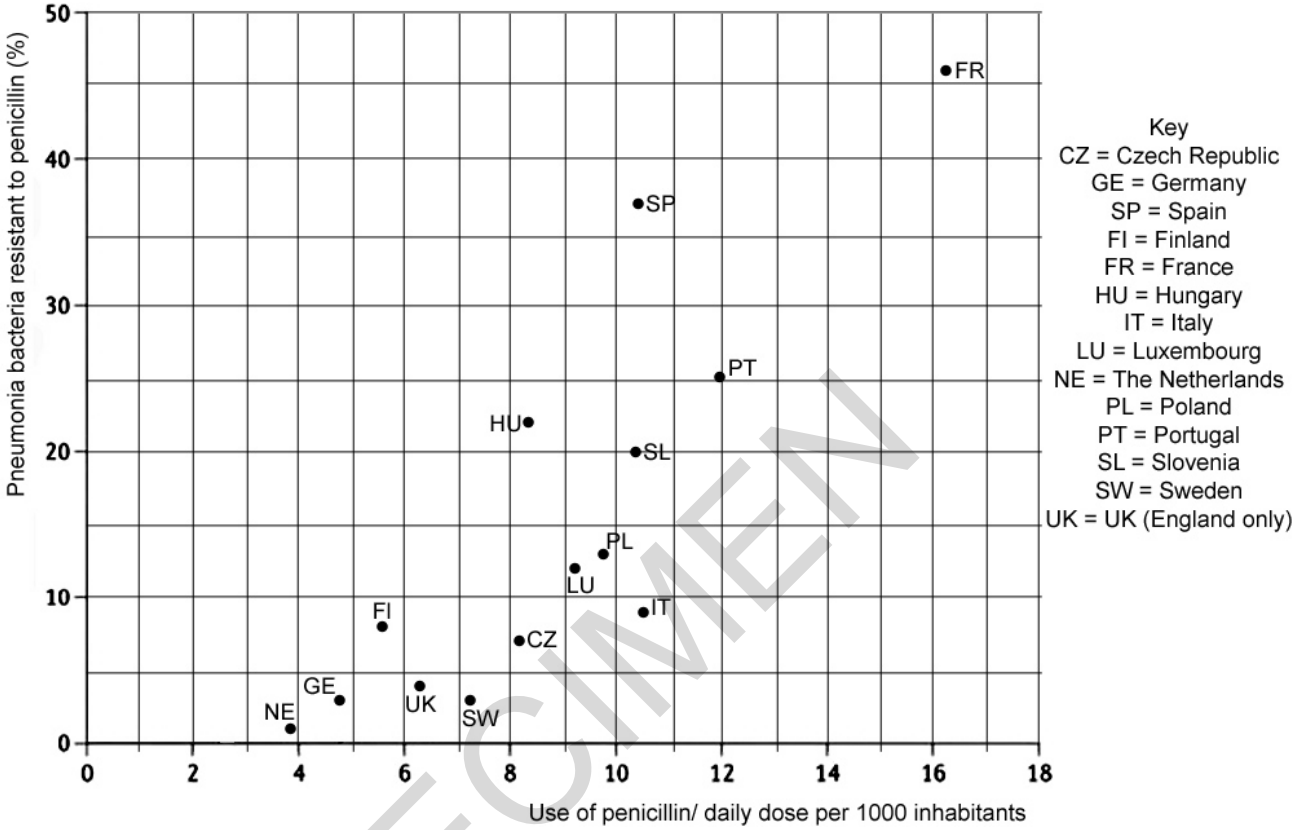
Biodiversity is affected as the nitrogen concentration increases. ☐

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

[1]

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 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.

Their responses are shown below.

	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 member's antibiotics or they have taken mine.	19	81

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

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

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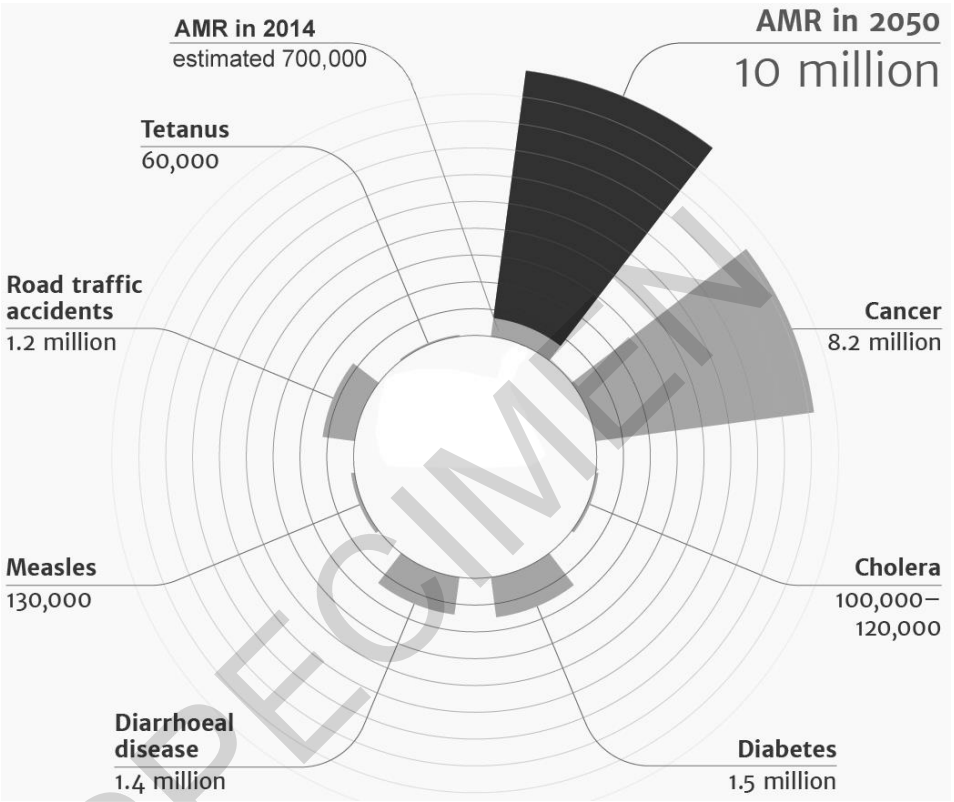
(c) A report at the beginning of 2015 reviewed evidence of antimicrobial resistance (AMR).

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 world's 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 above in 2014, in order.

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

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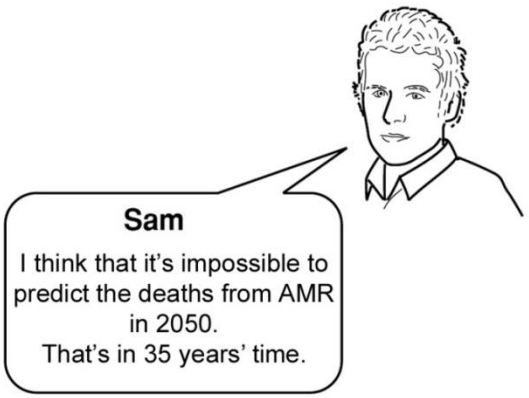
…… **[1]**

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



Discuss why Sam may think this.

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

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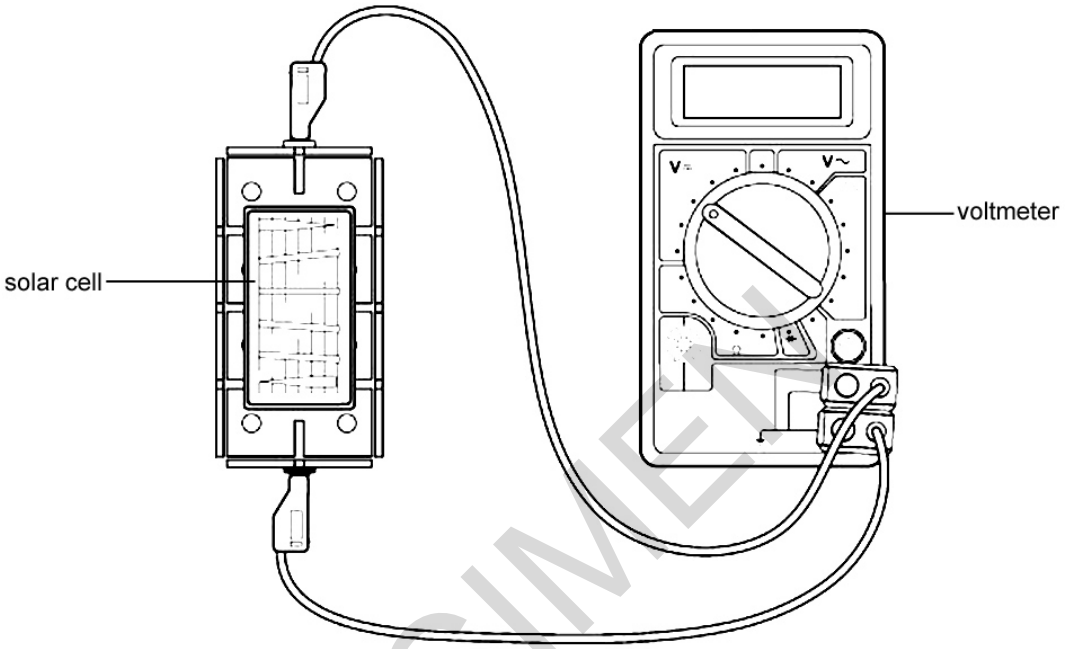
..... **[2]**

6 Solar cells generate electricity using energy from the Sun.

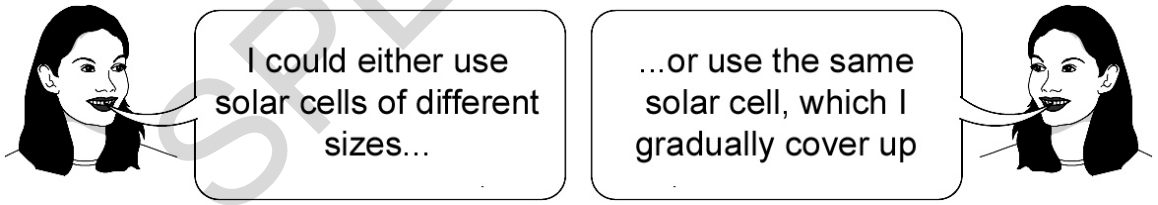
A class of students is investigating factors that affect the output of solar cells.

(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 choose to use one panel, which she covers up, to control this variable.

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

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

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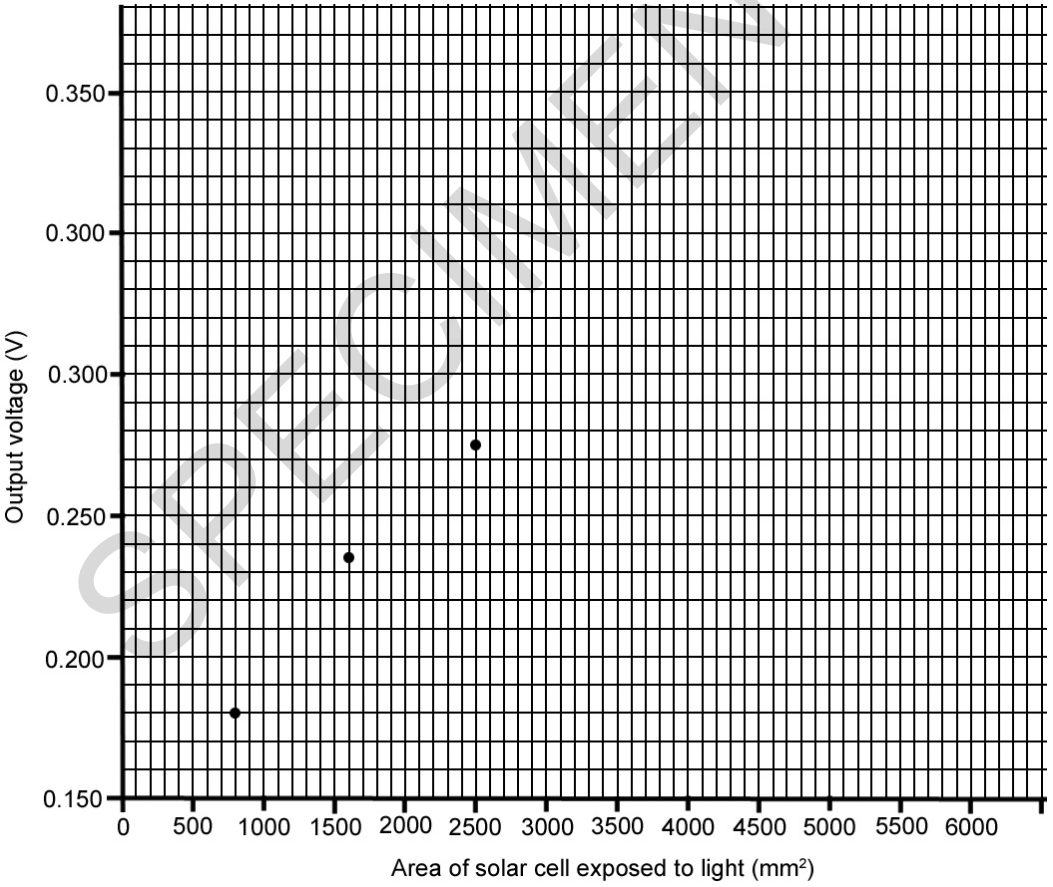
..... **[1]**

(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 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. You must 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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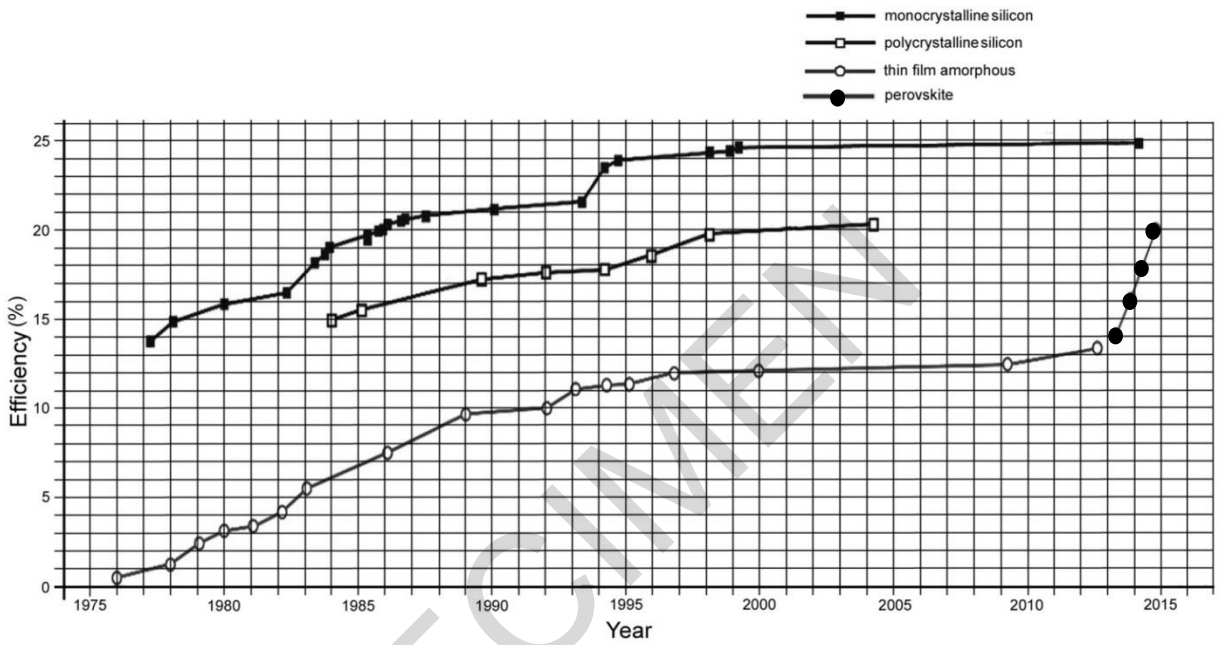
..... **[4]**

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



Discuss the newspaper's claims for perovskites.

Use data from the graph to support your answer.

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

END OF QUESTION PAPER