OCR
Oxford Cambridge and RSA

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

J260/08 Combined Science (Higher Tier)

Monday 11 June 2018 – Morning

Time allowed: 1 hour 45 minutes

7034093402

You must have:
- the Data Sheet (for GCSE Combined Science B (inserted))
- a ruler (cm/mm)

You may use:
- a scientific or graphical calculator
- an HB pencil

J260008

First name									
Last name									
Centre number						Candidate number				

INSTRUCTIONS
- The Data Sheet will be found inside this document.
- Use black ink. You may use an HB pencil for graphs and diagrams.
- 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. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

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 Parkinson's disease is a condition that affects the nervous system. There is currently no cure for the disease.

(a) It is estimated that 145 000 people will have Parkinson's disease in 2018.

It is predicted that by 2025 the number of people with Parkinson's disease will rise by $\frac{1}{5}$.

Calculate how many more people will have Parkinson's disease in 2025 than in 2018.

Number of people = ... **[2]**

(b) Scientists have observed that smoking affects people's risk of developing the disease.

The scientists investigated three groups of patients with Parkinson's disease.

A total of 1808 patients were studied.

Smoking habit of group investigated	Number of patients with Parkinson's disease
Never smoked	909
Former smokers	750
Current smokers	149

Discuss the findings of the study.

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

(c) One hypothesis states that nicotine in cigarettes may protect against Parkinson's disease.

People use e-cigarettes because they may be a less harmful source of nicotine.

Pure nicotine is a liquid at room temperature.

Fig. 1.1 is a simplified diagram showing how an e-cigarette works.

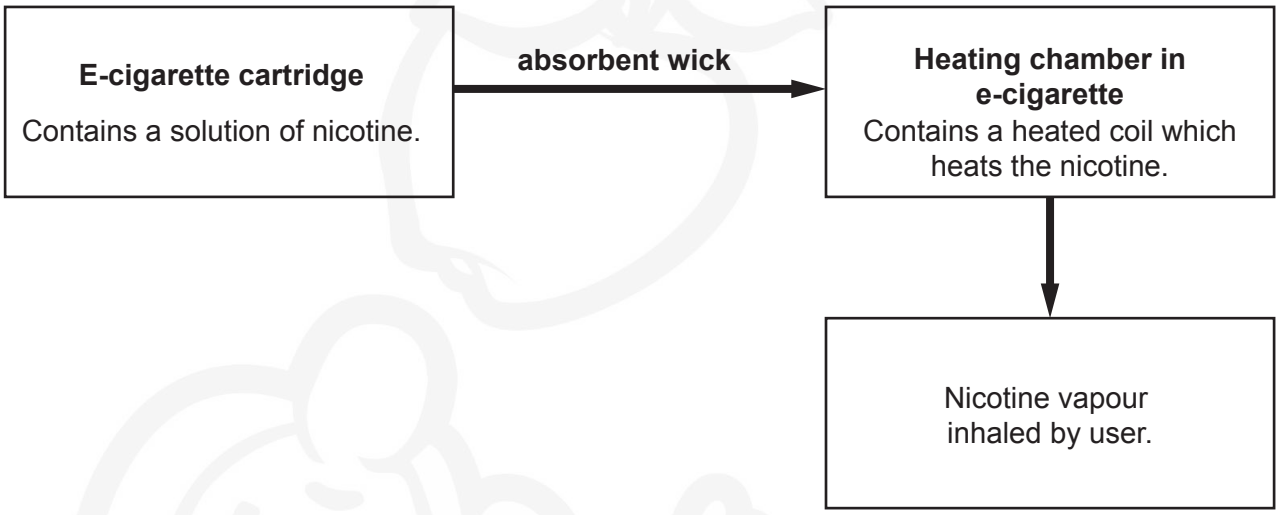

Fig. 1.1

(i) Describe what happens to nicotine **particles** in the heating chamber in an e-cigarette.

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

(ii) Compare the changes that occur in an e-cigarette with those in a cigarette that burns tobacco.

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

(d) Some students are talking about using e-cigarettes to reduce the risk of Parkinson's disease.

Ali
Is it the nicotine that's involved in protection against Parkinson's disease, or some other factor?

Kai
Nicotine raises heart rate and blood pressure. It also increases the risk of cardiovascular disease.

Layla
Nicotine is very addictive and should be avoided, whether it's in tobacco cigarettes or e-cigarettes.

Sarah
Scientists have found that nicotine affects levels of a chemical transmitter molecule between neurons in the brain.

(i) Which student is discussing the idea of correlation and cause?

Tick (✓) **one** box.

Ali ☐

Kai ☐

Layla ☐

Sarah ☐

[1]

(ii) Which student has suggested a possible mechanism for the action of nicotine?

Tick (✓) **one** box.

Ali ☐

Kai ☐

Layla ☐

Sarah ☐

[1]

(e)* Food plants in the same family as tobacco also contain nicotine.

Scientists have studied how eating these foods affects the numbers of people with Parkinson's disease.

People with Parkinson's disease answered a questionnaire about their diet.

Scientists assessed the risk of developing Parkinson's disease in people that ate plant foods containing nicotine. The results are shown in **Table 1.1**.

Plant food in diet	Concentration of nicotine in the food (µg nicotine / kg food)	Risk of developing Parkinson's disease*
Foods containing no nicotine	0	1.00
Peppers	102	0.24
Potatoes	19	0.92
Tomatoes	44	0.58
Tomato juice	30	2.16

Table 1.1

*This is the person's risk compared with patients who ate foods containing no nicotine.

For example:
- if the risk is 2.00, you are twice as likely to get the disease
- if the risk is 0.50, you are half as likely to get the disease.

7

Use the information to determine if there is a correlation between eating plant foods with different concentrations of nicotine and the risk of developing Parkinson's disease.

Use the date in **Table 1.1** to support your answer.

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

2 Alex and Beth are investigating reaction time.

Alex drops a 30 cm ruler. Beth catches the ruler between her thumb and fingers as shown in **Fig. 2.1**.

The distance the ruler fell before being caught is recorded.

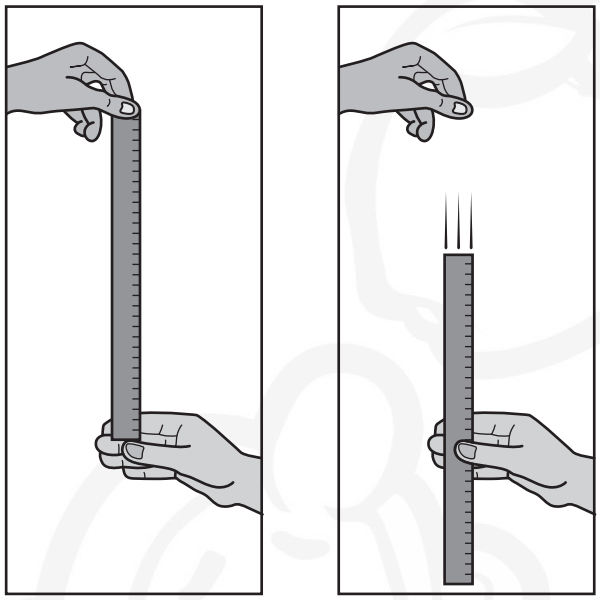

Fig. 2.1

(a) The students' results are shown in **Table 2.1**.

Trial	Distance the ruler dropped before being caught (mm)
1	115
2	113
3	109
4	111
5	112
6	107
7	109
8	108
9	109
10	108

Table 2.1

(i) Calculate the mean distance the ruler dropped.

Mean distance = ... mm **[1]**

(ii) The time taken to catch the ruler, and therefore the person's reaction time, can be calculated using the following formula:

$$t = \sqrt{\frac{2d}{a}}$$

t = time in seconds
d = mean distance in metres
a = acceleration as a result of gravity = $9.81\,m/s^2$

Use your answer to **(a)(i)**. Calculate the mean reaction time in milliseconds.

Give your answer to **3** significant figures.

Mean reaction time = ...ms **[5]**

(b) Receptors in the eye detect the stimulus that results in the ruler being caught.

Use your knowledge of the nervous system to describe this sequence of events.

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

3 The majority of the world's alcohol, 93%, is produced by the traditional method of fermentation of glucose with yeast.

Nina is investigating alcohol (ethanol) production as a sample of beer is brewed.

(a) Fermentation of glucose with yeast can be represented by an equation.

Balance the chemical equation for the reaction.

glucose → ethanol + carbon dioxide

$C_6H_{12}O_6$ (aq) → ..... C_2H_5OH (aq) + ... CO_2 (g)

[1]

(b) Nina's class investigates the rate of the reaction.

To do this, groups of students:
- measure the volume of ethanol produced over a period of time
- measure the rate of carbon dioxide production.

(i) Suggest **one other** physical method for determining the rate of chemical reactions.

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

(ii) Nina plots the graph in **Fig. 3.1** to show the volume of ethanol produced over a period of time when yeast are added to glucose.

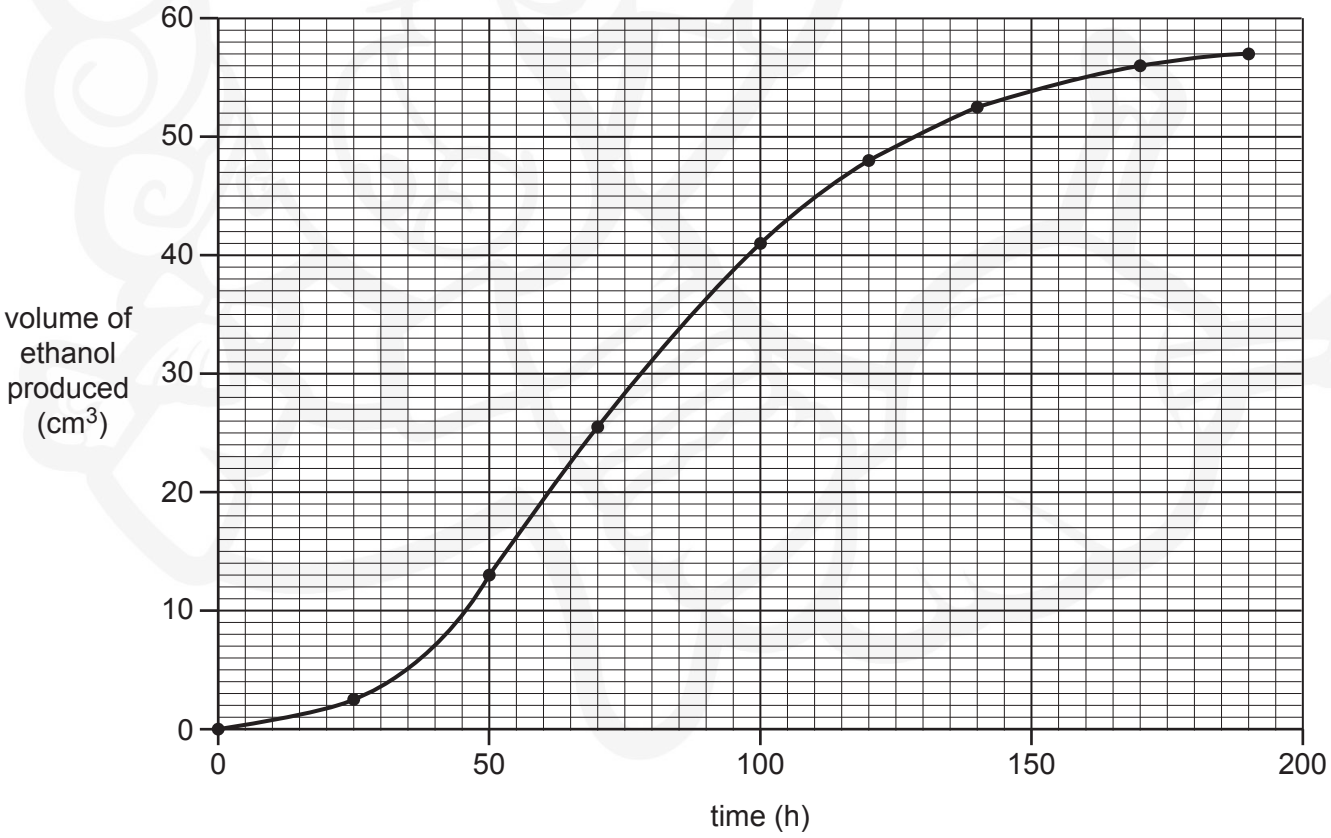

Fig. 3.1

Draw a tangent on the graph in **Fig. 3.1** to help you calculate the rate of reaction after 120 hours.

Rate = ... cm^3 / h **[5]**

(c) The students carry out investigations to determine the rate of reaction at different temperatures.

The graph in **Fig. 3.2** shows how the rate of reaction changes over a range of temperatures.

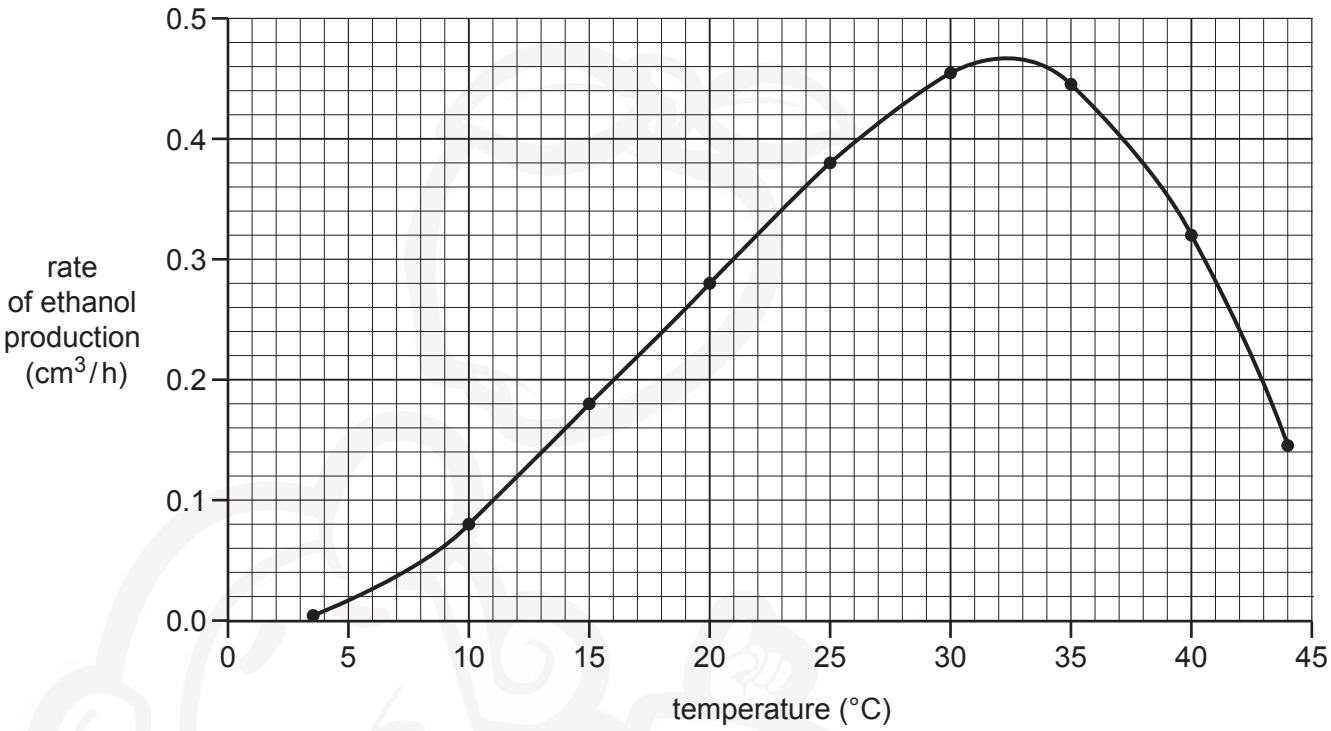

Fig. 3.2

(i) What conclusions can be made from the graph in **Fig. 3.2**?

Explain your answer.

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

(ii) Suggest how the optimum temperature could be estimated with more accuracy.

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

(d) Ethanol can be made industrially from ethene.

The chemical reaction is shown below.

ethene + water $\rightleftharpoons$ ethanol

C_2H_4 (g) + H_2O (g) $\rightleftharpoons$ CH_3CH_2OH (g)

The reaction is carried out at 300 °C at a pressure of 6–7 MPa with a phosphoric (V) acid catalyst.

Suggest **two** reasons why 93% of the world's ethanol is produced by fermentation.

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2 .....

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[2]

4 PET is the main type of polymer used for manufacturing plastic drinks bottles.

(a) **Table 4.1** shows part of a Life Cycle Assessment (LCA) for PET bottles.

The LCA is from the production of PET to the sale of the bottles in supermarkets.

Part of LCA	**LCA for 1000 PET bottles**	
	New PET	**30% recycled PET**
Coal used (kg) – energy	17.1	14.1
Oil used (kg) – feedstock and energy	49.8	39.2
Gas (m^3) – feedstock and energy	45.2	34.8
Energy used (MJ)	5053.0	3979.0
Carbon dioxide production (kg)	164.0	132.0

Table 4.1

(i) Which statements about the Life Cycle Assessment for PET bottles are **true**, and which are **false**?

Put a tick (✓) in one box in each row.

	True (✓)	**False (✓)**
Coal, oil and gas are used as chemical feedstock for producing PET.		
The energy to produce new PET bottles is 5053 kJ per bottle		
Carbon dioxide production is around one-fifth less when using 30% recycled PET.		

[3]

(ii) Describe **one** of the processes used to recycle PET drinks bottles.

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

(b) The PET polymer was considered non-biodegradable.

In 2016, scientists in Japan discovered a type of bacterium, normally found in the soil, living on the surface of waste PET bottles. The bacterium produces enzymes that break down the polymer.

The scientists think that the bacterium may be useful in the recycling of the plastic.

(i) Suggest **one** way in which the bacterium might improve recycling.

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

(ii) PET was developed in 1941. PET bottles were first used in 1973.

Until 2016, no bacterium had been found that would biodegrade this plastic.

Suggest the genetic changes that occurred in this soil-living bacterium after 1973.

Explain your answer.

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

5 The decay of radioactive isotopes is important in dating archaeological and fossil objects.

(a) An isotope of carbon, called carbon-14, is present in small amounts in all living things.

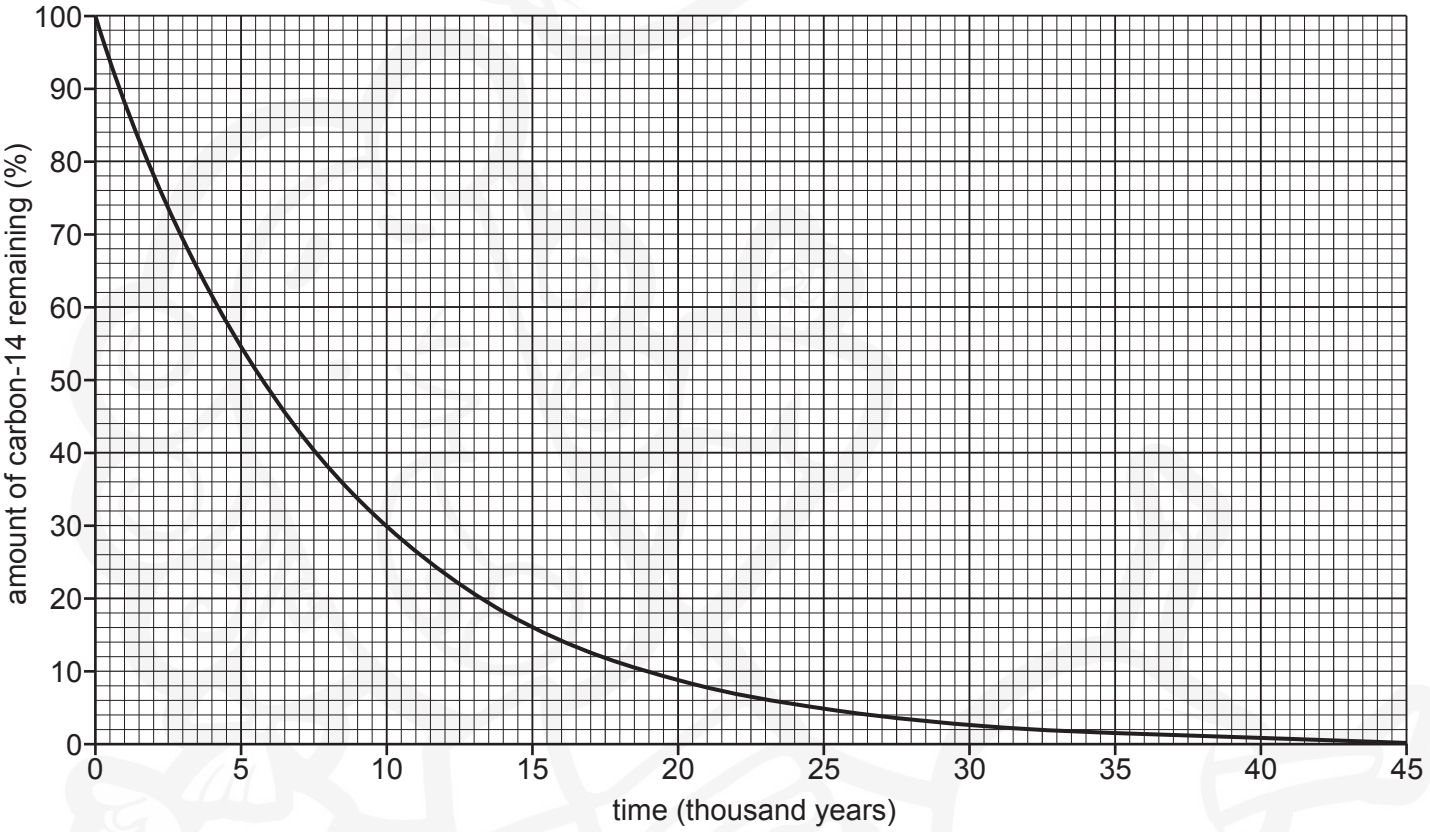
Carbon-14, or ^{14}C, is important in dating objects in archaeological studies.

(i) Carbon-14 decays by emitting a β-particle and forming an isotope of nitrogen.

Complete the equation for the decay of carbon-14.

$$^{14}_{6}C \rightarrow {}^{.....}_{.....}N + {}^{.....}_{.....}\beta$$ **[3]**

(ii) The graph shows the decay curve for carbon-14.



Use the graph to find the half-life of carbon-14.

Show your working on the graph.

Half-life = ...years **[2]**

(b) Living organisms exchange carbon, including carbon-14, between themselves and the environment. When an organism dies, this carbon is no longer exchanged and the amount of carbon-14 present decreases as the organism decays.

The age of the archaeological remains of humans and other organisms can be estimated from the proportion of carbon-14 that remains undecayed.

(i) Suggest **one** assumption that must be made when dating samples using carbon-14.

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

(ii) When potassium-40 decays, one decay product is argon-40.

Argon-40 makes up 99.6% of the argon on earth.

The half-life of potassium-40 is 1.251×10^9 years.

Explain why carbon-14 can only be used to date objects up to around 50 000 years old, but potassium-40 can be used to date rocks containing fossils many millions of years old.

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..... **[5]**

(c) Some stable isotopes are used to investigate archaeological objects.

In 2012, the skeleton of King Richard III was discovered under a car park in Leicester.

Scientists analysed levels of the stable isotopes nitrogen-15 and oxygen-18 in teeth from the king's skeleton. These isotopes do not decay and their levels remain constant.

Suggest how the ^{15}N was taken into the king's body.

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

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6 Amir is investigating the properties of types of resistor.

(a) He sets up a circuit to measure the resistance of a thermistor at different temperatures.

(i) Draw a suitable circuit diagram for the experiment.

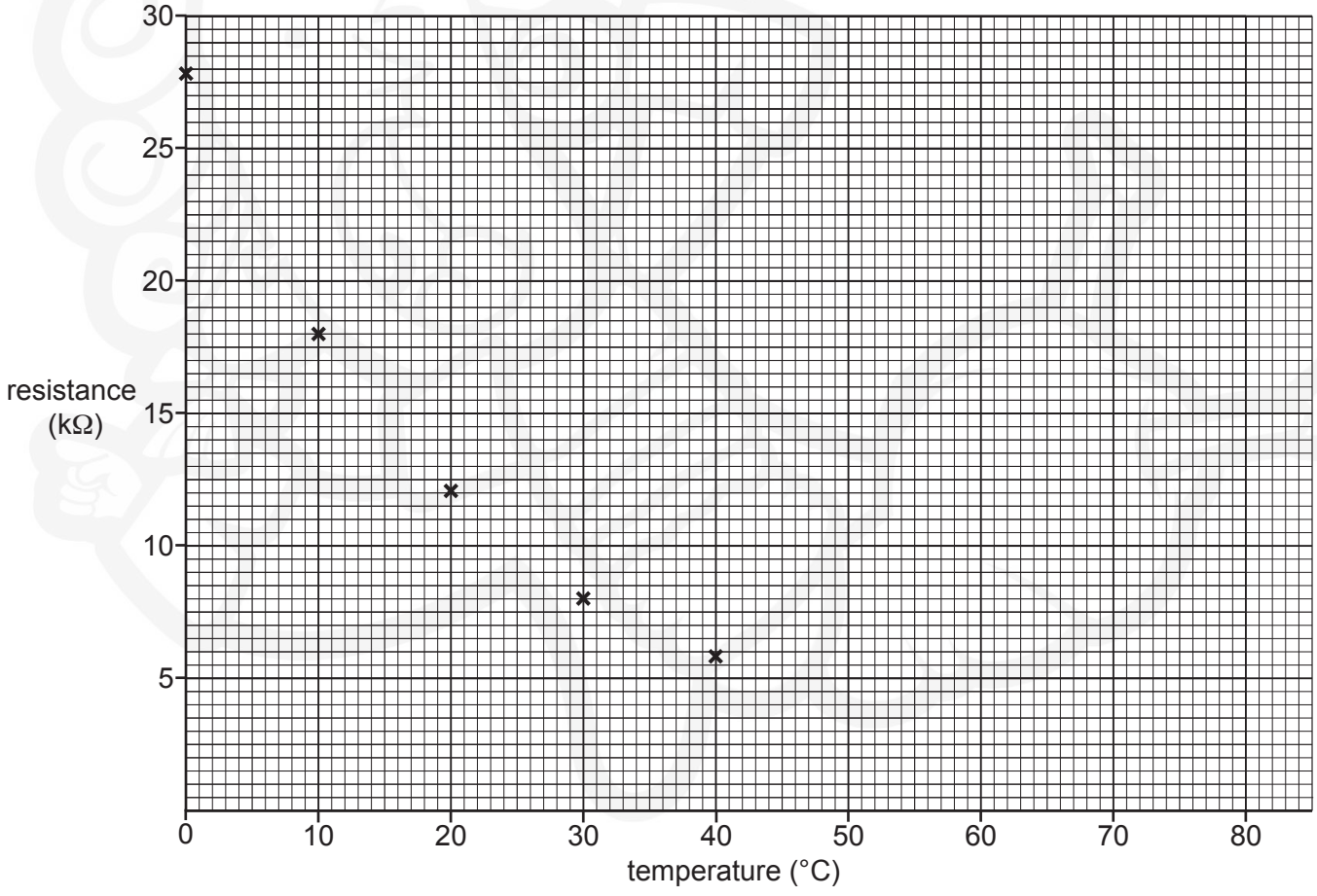
[2]

The results of Amir's experiment are shown in **Table 6.1**.

Temperature (°C)	Resistance (kΩ)
0	27.7
10	18.1
20	12.1
30	8.3
40	5.8
50	4.1
60	3.0
70	2.2
80	1.7

Table 6.1

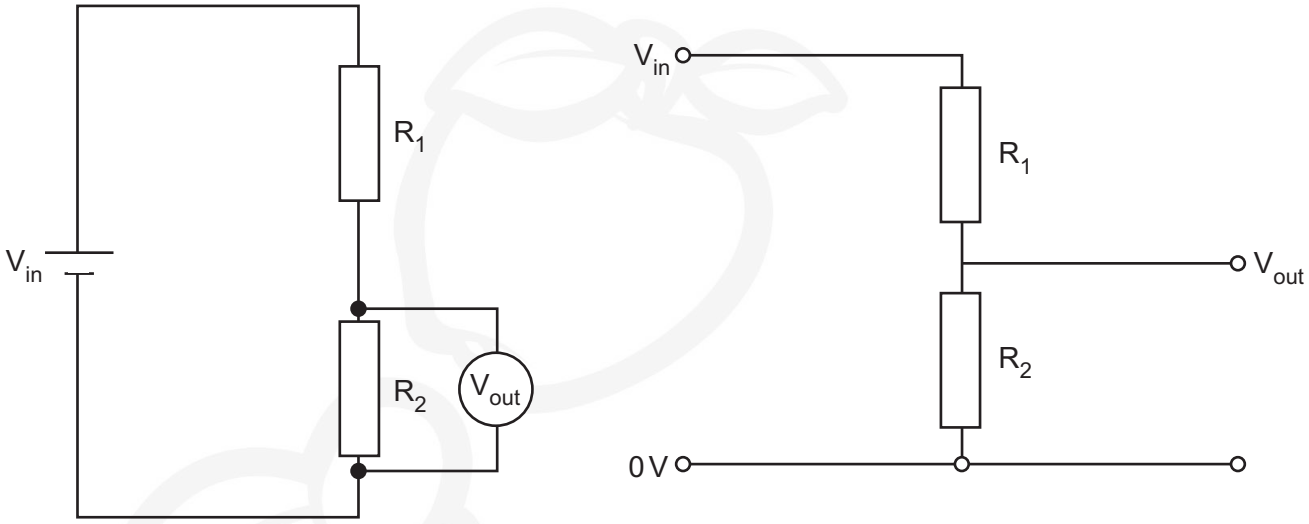
(ii) Complete the graph by plotting the results from **Table 6.1** and draw a line of best fit. Some have been plotted for you.



[2]

(b) Two resistors in series produce a potential divider circuit. The resistors divide the input voltage between them.

The diagrams below show a potential divider circuit. The same circuit is shown in two different ways.



The equation below is a mathematical model for the potential divider circuit.

$$V_{out} = \frac{R_2}{R_1 + R_2} \times V_{in}$$

(i) Amir sets up the circuit above.

$V_{in} = 10\,V$

Resistor R_2 has a value of $10\,k\Omega$.

Amir replaces R_1 in the circuit diagram with the thermistor he used in his experiment.

He carries out this new experiment at 15 °C.

Using the equation above, and the information from the graph, predict a value of V_{out}.

Give your answer to **1** decimal place.

Predicted value of V_{out} = ... V **[3]**

(ii) Using this model, what effect would increasing the temperature to 90 °C have on V_{out}?

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

(iii) Calculate the current in the potential divider circuit at 60 °C.

Current = ... A

[4]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).