OCR
Oxford Cambridge and RSA

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Friday 3 November 2017 – Afternoon

GCSE TWENTY FIRST CENTURY SCIENCE PHYSICS A / SCIENCE A

A181/02 Modules P1 P2 P3 (Higher Tier)

Candidates answer on the Question Paper.
A calculator may be used for this paper.

OCR supplied materials:
None

Other materials required:
- Pencil
- Ruler (cm/mm)

Duration: 1 hour

A181/02

2770294365

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- 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 FOR CANDIDATES

- The quality of written communication is assessed in questions marked with a pencil (✎).
- A list of physics equations is printed on page **2**.
- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **60**.
- This document consists of **16** pages. Any blank pages are indicated.

TWENTY FIRST CENTURY SCIENCE DATA SHEET

Useful Relationships

The Earth in the Universe

distance = wave speed × time

wave speed = frequency × wavelength

Sustainable Energy

energy transferred = power × time

power = voltage × current

$$\text{efficiency} = \frac{\text{energy usefully transferred}}{\text{total energy supplied}} \times 100\%$$

Explaining Motion

$$\text{speed} = \frac{\text{distance travelled}}{\text{time taken}}$$

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$$

momentum = mass × velocity

change of momentum = resultant force × time for which it acts

work done by a force = force × distance moved in the direction of the force

amount of energy transferred = work done

change in gravitational potential energy = weight × vertical height difference

$$\text{kinetic energy} = \frac{1}{2} \times \text{mass} \times [\text{velocity}]^2$$

Electric Circuits

power = voltage × current

$$\text{resistance} = \frac{\text{voltage}}{\text{current}}$$

$$\frac{\text{voltage across primary coil}}{\text{voltage across secondary coil}} = \frac{\text{number of turns in primary coil}}{\text{number of turns in secondary coil}}$$

Radioactive Materials

energy = mass × [speed of light in a vacuum]^2

Answer **all** the questions.

1 The table shows data for P-waves and S-waves produced by an earthquake.
Each type has a range of frequencies.

Type of wave	Speed in m/s	Smallest frequency in Hz	Largest frequency in Hz
P-wave	7000	2	10
S-wave	4000	2	10

(a) Use the equation

$$\text{wavelength} = \frac{\text{speed}}{\text{frequency}}$$

to calculate the **longest** wavelength of any of these waves.

wavelength = ... m **[2]**

(b) There is an earthquake 500 km away from a city.
Use the equation

$$\text{time} = \frac{\text{distance travelled}}{\text{speed}}$$

to calculate the time taken for S-waves to reach the city.

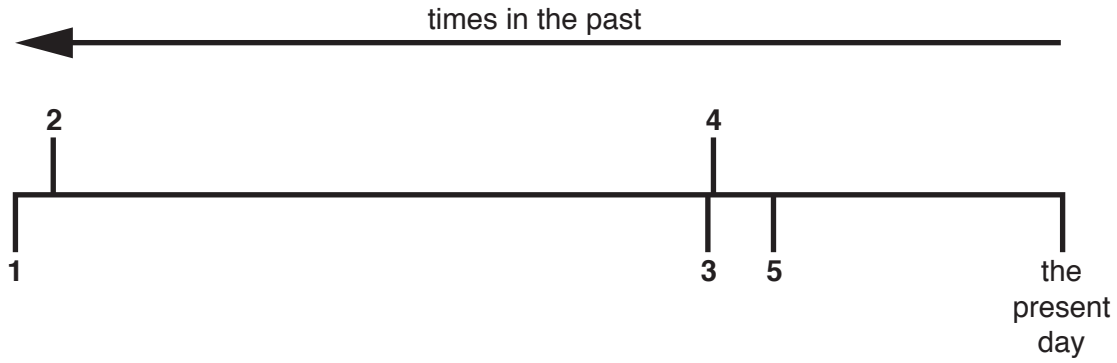
time = ... seconds **[2]**

(c) Another city is 420 km from the earthquake.
Show that the P-waves arrive at this city 45 seconds before the S-waves.

[2]

[Total: 6]

2 **(a)** The timeline below shows the whole history of the Universe.
The timeline is drawn to scale.



Here are seven different events in the history of the Universe.
Only **five** of these events correspond to the numbers **1** – **5** in the diagram.

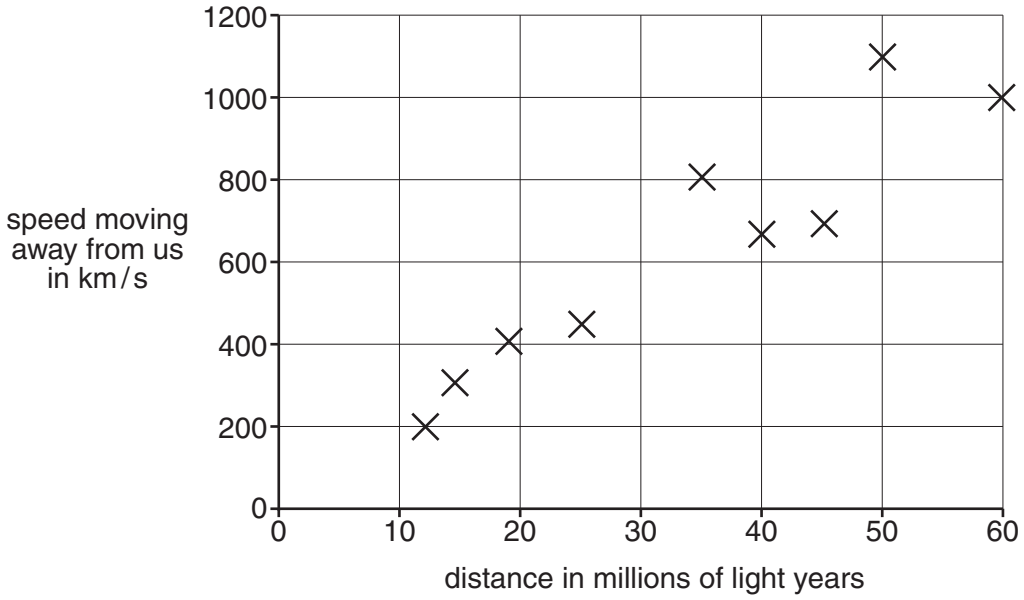
A	the 'big bang'
B	life starts on Earth
C	the first human space-flight
D	the Sun is formed
E	the Milky Way galaxy is formed
F	the beginning of the 20th Century
G	the Earth is formed

For each of the numbers **1** – **5** in the diagram, put the letter **A** – **G** of the event which would have happened at that time. The first one is given for you.

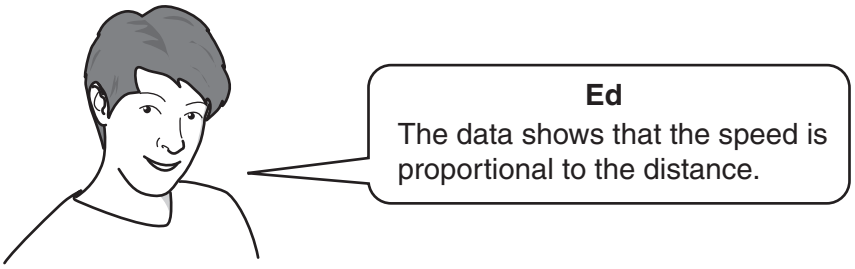
time	**event**
1	A
2	.....
3	.....
4	.....
5	.....

[3]

(b) The graph below shows the distance from us to nine galaxies and the speeds at which they are moving.



(i) Ed has been looking at these data.



Is Ed correct? Justify your answer.

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

(ii) What do these data suggest about how the Universe is changing?

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

(iii) The data plotted in the graph were obtained from satellite measurements, even though astronomers had already made measurements from the ground.
Explain why the graph uses only the satellite measurements.

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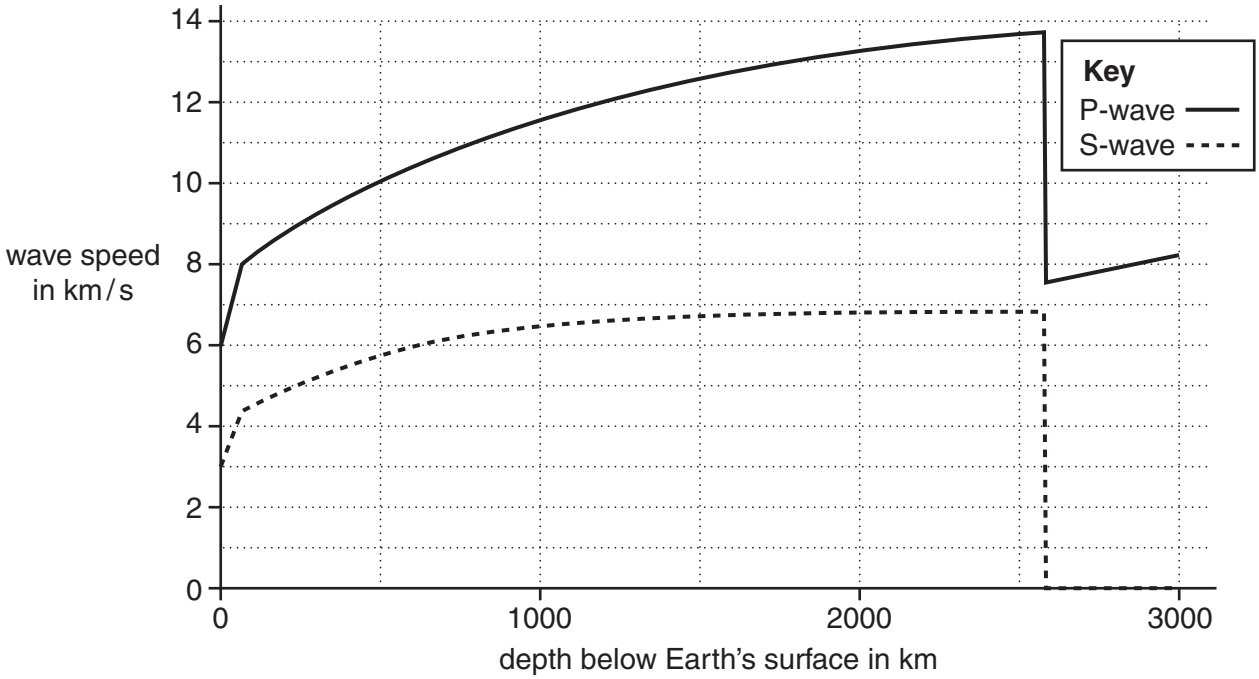
..... **[2]**

[Total: 8]

3 The graph shows how the speeds of two different types of earthquake waves change as they travel deeper into the Earth.
The radius of the Earth is 6400 km, and its crust is about 70 km thick.



Describe how the speeds of the two sorts of wave change with depth, and suggest reasons for these changes.

The quality of written communication will be assessed in your answer.

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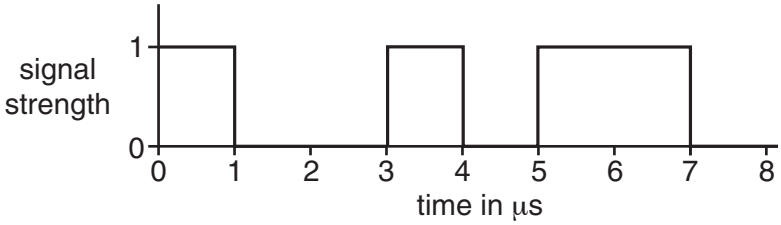
..... **[6]**

[Total: 6]

4 This question is about digital signals.
You will need to use data from this table in your answer.

Prefix	Symbol	Meaning
mega	M	× 1 000 000
kilo	k	× 1000
milli	m	÷ 1000
micro	μ	÷ 1 000 000

The diagram shows the first 8 pulses of a digital signal.



(a) Each pulse is called a **bit**.
The rate of transmission of a signal is measured in Mbits per second.
What is the transmission rate for the signal shown above?
Put a (ring) around the correct value in Mbits per second.

1 **8** **1 000 000** **8 000 000**

[1]

(b) Eight bits make up one **byte** (B).
Sam emails a digital photo to a friend.
The photo is 2.4 MB in size.
It takes 35 seconds to send the email.
Calculate the transmission rate from Sam's computer in Mbits per second.

rate = ... Mbits per second **[2]**

(c) New mobile computing networks are being introduced, and these will allow up to 100 Mbit/second transmission rates to and from computers.
Suggest and explain one advantage of this development.

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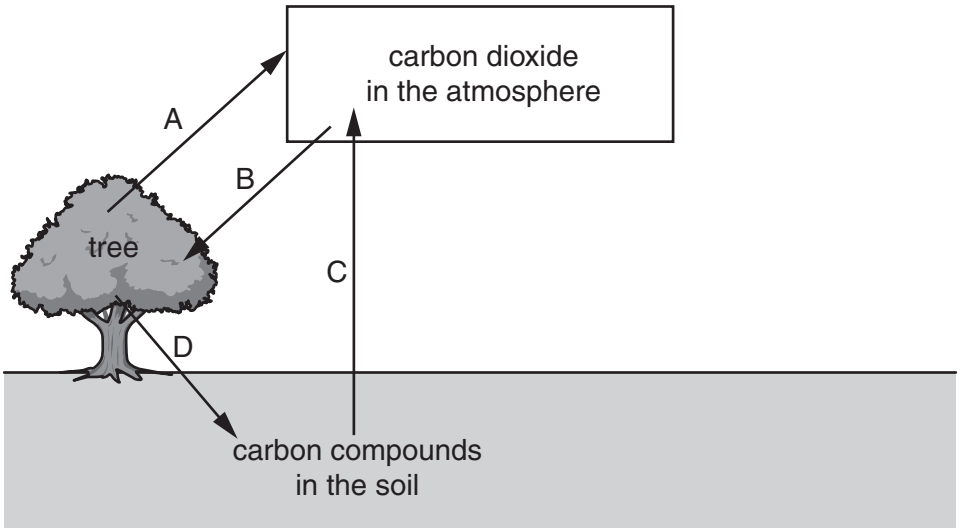
..... **[2]**

[Total: 5]

5 **(a)** The diagram shows **part** of the carbon cycle.



The carbon dioxide levels in the atmosphere were approximately constant for thousands of years but have risen steadily over the past two hundred years.

Use the diagram and other ideas to explain this.

You may add to the diagram to help your answer.

The quality of written communication will be assessed in your answer.

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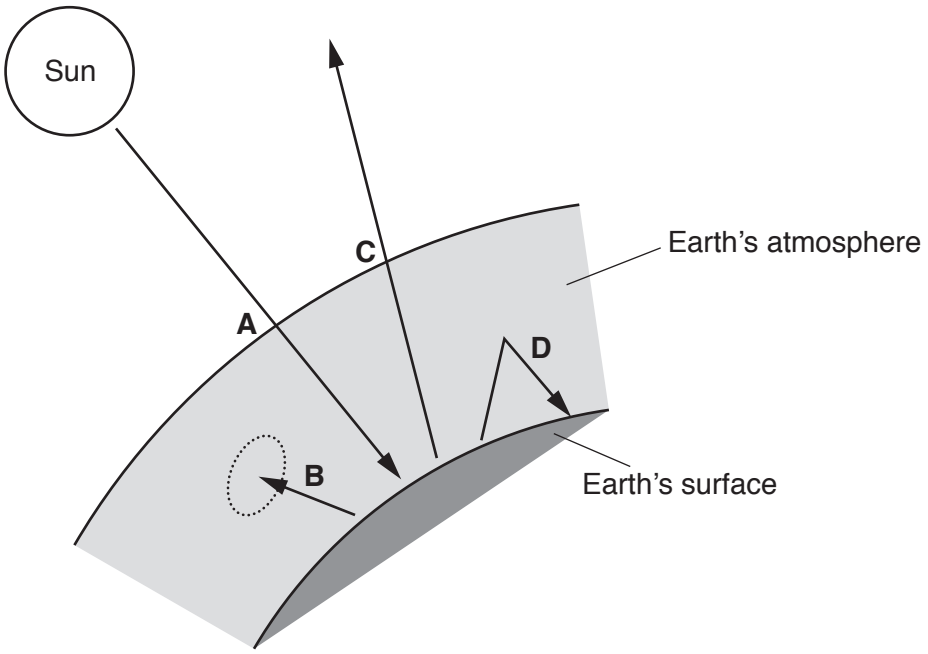
..... **[6]**

(b) In the diagram below, label **A** shows radiation from the Sun reaching the Earth's surface. Labels **B**, **C** and **D** show how radiation leaves the Earth's surface. The dotted region shows where some radiation is absorbed.



(i) Which one of the following statements **must** be correct for the average temperature of the Earth to remain constant?

A = **D** ☐

B = **C** ☐

B > **C** + **A** ☐

B = **A** + **C** + **D** ☐

[1]

(ii) Radiations **B** and **D** are both electromagnetic radiations.
Which two of the following statements about **B** and **D** are true?

B has a lower speed than **D** ☐

B has a lower intensity than **D** ☐

B has a higher frequency than **D** ☐

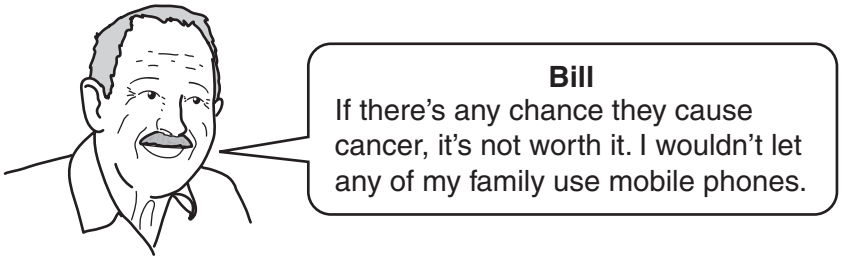
B has a longer wavelength than **D** ☐

B has a higher photon energy than **D** ☐

[2]

[Total: 9]

6 Bill thinks the microwaves given out by mobile phones are dangerous.



(a) Suggest and explain one way to reduce any possible risk from cancer to someone who uses a mobile phone.

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

(b) The table compares the radiation from a mobile phone and a microwave oven.

Device	Power in W	Wavelength in m	Frequency in Hz
A mobile phone	1	0.15	2.0×10^9
A microwave oven	850	0.12	2.5×10^9

Both devices use electromagnetic radiation. Use the data in the table to show this.

[2]

(c) Some people think mobile phones may be dangerous, but few people worry about health risks from microwave ovens. Explain why.

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

[Total: 6]

7 The amount of energy lost each second by a house depends on the temperature difference between the inside and the outside.
The table gives government statistics for an average house in the UK in two different years.

Year	Energy loss in joules per second for every degree difference			
	Walls	**Windows**	**Roofs**	**Floors**
1970	130	70	65	21
2005	105	50	20	25

(a) Suggest reasons for the change in energy loss through roofs and floors.

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

(b) The data in the table are for the years 1970 and 2005 only.
Using only these two years might not give a true value of the trends in reducing energy demands in the home.
Suggest reasons why.

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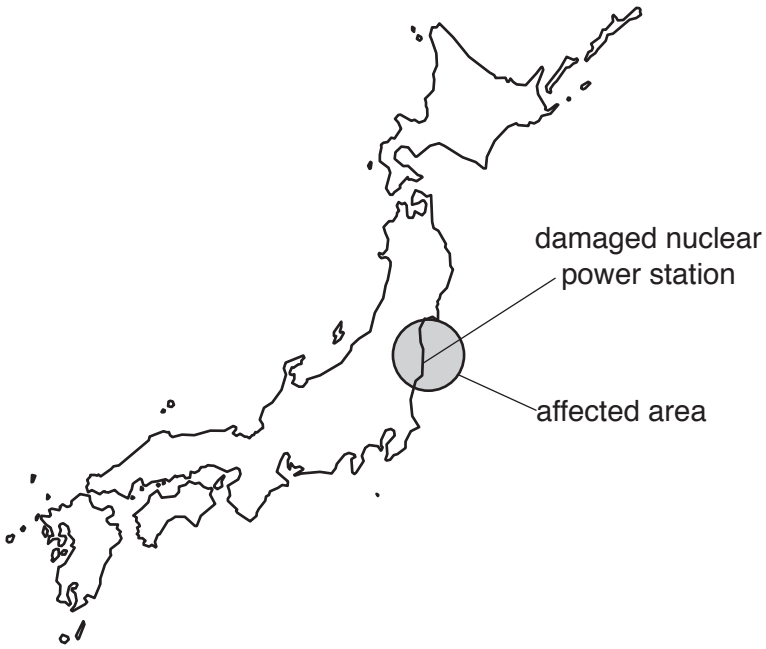
..... **[2]**

[Total: 4]

8 In March 2011, an earthquake and tsunami caused serious damage to a nuclear power station in Japan and spread radioactive materials over the area shown on the map. A lot of radioactive materials were washed into the sea.



Fish form a large part of the Japanese diet.
Most fish caught in the affected area had low levels of radiation and were safe to eat. However, some fish which feed near the seabed were found to be very radioactive many months after the tsunami.

Explain the contamination risk to the Japanese people and how it could be reduced.

The quality of written communication will be assessed in your answer.

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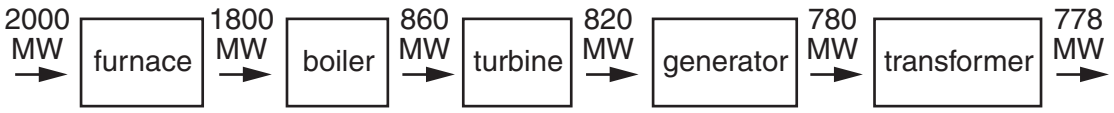
[Total: 6]

9 The block diagram below represents a very large coal-burning power station.
The numbers show the energy per second going into and out of each stage.



(a) Calculate the percentage efficiency of the **least** efficient stage. Give your answer to two significant figures. Make clear which stage you are using.

efficiency = ... % **[2]**

(b) Some of the energy lost by the power station could be used to heat nearby homes, greenhouses and factories. If that were done, the energy supplied per second to the turbine would drop.

Discuss the advantages and disadvantages of this plan.

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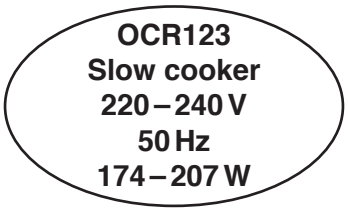
..... **[2]**

[Total: 4]

10 The diagram below shows the information plate on the bottom of a slow cooker.



(a) It takes 4 hours for the slow cooker to cook a meal.
At 230 V, the cooker draws a current of 0.83 A.
Calculate the cost of the energy used in this time if 1 kWh costs 18p.

cost = ... p **[2]**

(b) Ranges are shown on the information plate for voltage and power.
This has been done because the voltage may vary from one place to another.
Explain how this affects the operation of the slow cooker.

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

(c) It is suggested that the power is proportional to the square of the voltage

$$\text{power} = (\text{constant}) \times (\text{voltage})^2.$$

Use the data to check this suggestion.

[2]

[Total: 6]

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).