OCR
Oxford Cambridge and RSA

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Wednesday 25 May 2016 – 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

* A 1 8 1 0 2 *

* 5 9 4 0 6 6 9 9 3 3 9 *

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 bar codes.

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

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

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

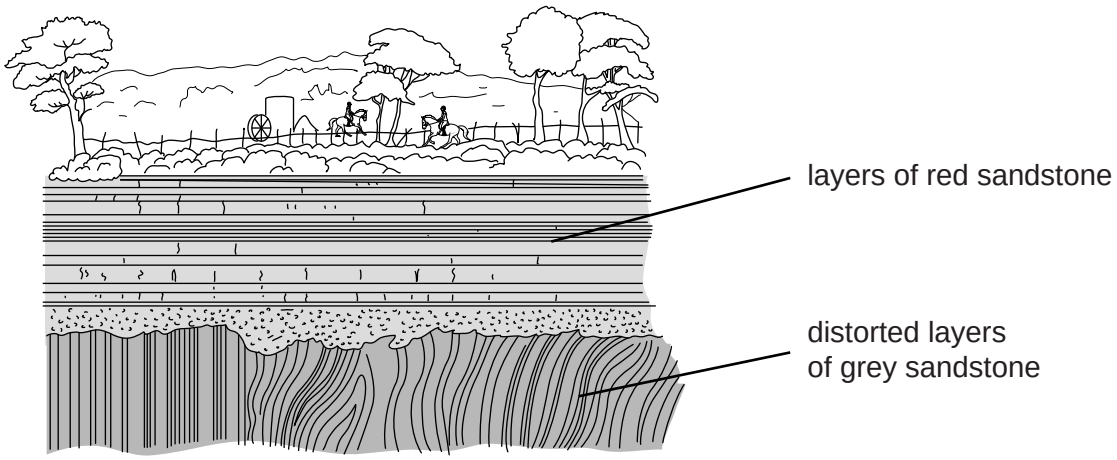
Radioactive materials

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

Answer **all** the questions.

1 The geologist James Hutton studied sedimentary rocks. He was particularly interested in places where the layers of rocks were distorted.

The diagram is a drawing made in 1787. It shows a section through rock layers.



In 1787, people believed that the Earth was only a few thousand years old.

Hutton thought that the distorted layers of rock were evidence that the Earth must be very much older than people believed.

Describe how sedimentary rocks are formed and explain how the drawing supports Hutton's theory that the Earth is very old.

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

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[Total: 6]

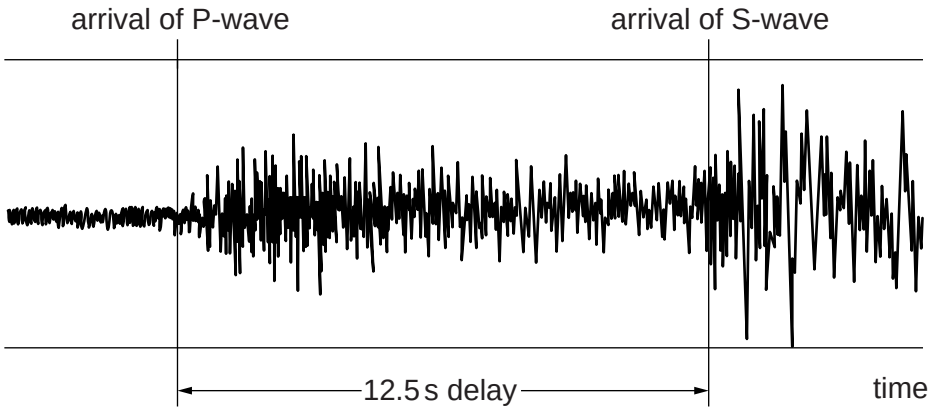
2 An earthquake happened 100 km away from town **A**.

(a) The P-waves arrived at town **A** 12.5 s later.

(i) Calculate the speed of the P-waves.

speed = ...km/s **[1]**

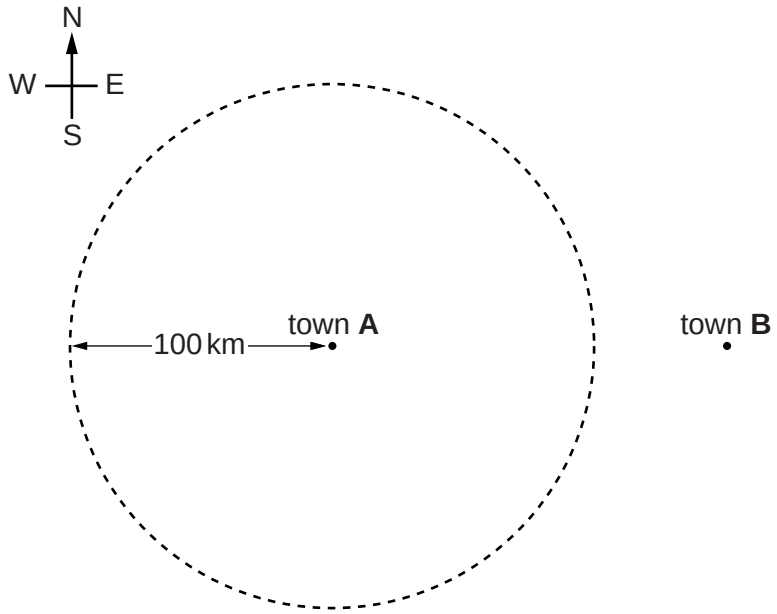
The diagram shows the earthquake detector trace in town **A**.



(ii) Calculate the speed of the S-waves.
Show your working.

speed = ...km/s **[2]**

(b) Below is a map showing town **A** and another town, **B**, which is 150 km due east of town **A**.



(i) The dotted line on the map is a circle of radius 100 km centred on town **A**.
The earthquake which caused the trace in **2(a)** was close to the surface of the Earth.

Explain why the earthquake must be somewhere on this line, but it is not possible to say where.

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

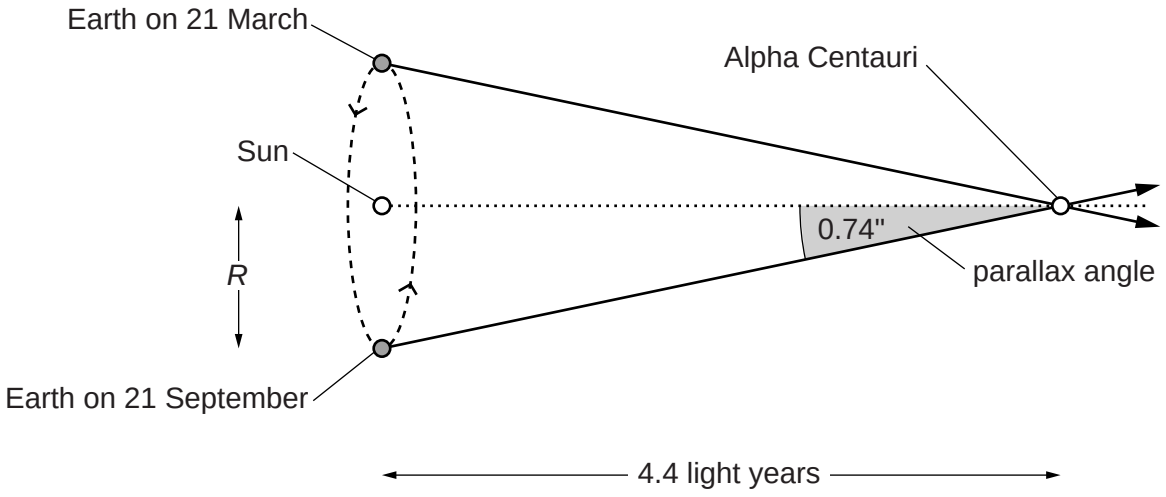
(ii) An earthquake detector in town **B** also recorded the earthquake. The trace in town **B** also had a delay of 12.5 s between the arrival of P-waves and S-waves.

Mark with an **X** on the diagram to show where the earthquake may have taken place. **[2]**

[Total: 7]

3 The nearest bright star to our Sun is Alpha Centauri, which is 4.4 light years away. This star seems to move, relative to very distant stars, by an angle of 1.48 seconds of arc (1.48") between 21 March and 21 September, as shown in the diagram below. *R* is the radius of the Earth's orbit.

The parallax angle of the star is half the angle it seems to move through in 6 months. For Alpha Centauri this is 0.74".



not to scale

(a) Explain the problems in trying to draw this diagram to scale.

(an angle of 1° = 60 × 60 = 3600")

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(b) The parallax angle of a star is **inversely proportional** to the distance to the star.

(i) Write down the distance to a star with a parallax angle of 0.37" (half the value shown in the diagram above).

distance = ... light years **[1]**

(ii) Calculate the parallax angle of the star Gliese 667, which is 22 light years away. Show your working clearly.

parallax angle = ... seconds of arc **[2]**

(c) Gliese 667 has been found to have a number of planets similar to Earth. It is quite possible that there is life on these planets.

Explain why it may be very difficult to discover if life exists on these planets.

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[Total: 7]

4 This question is about the greenhouse effect and global warming.

(a) The Sun emits radiation with a principal frequency of 600 THz, which corresponds to yellow visible light of wavelength 500 nm.

Which two of the following statements, taken together, **explain** the greenhouse effect?

Put ticks (✓) in the boxes next to the **two** correct statements.

Carbon dioxide gas absorbs infrared radiation.	☐
Green plants reduce the amount of atmospheric carbon dioxide.	☐
The Earth emits radiation of principal wavelength longer than 500 nm.	☐
Continued global warming will result in more extreme weather events.	☐
Cutting down forests makes the amount of atmospheric carbon dioxide rise.	☐

[2]

(b) Most scientists believe that recent global warming is due to human activity, but some are not convinced.

Here are some reasons for doubting whether global warming is really caused by humans. Some of these are scientific reasons, and some are not.

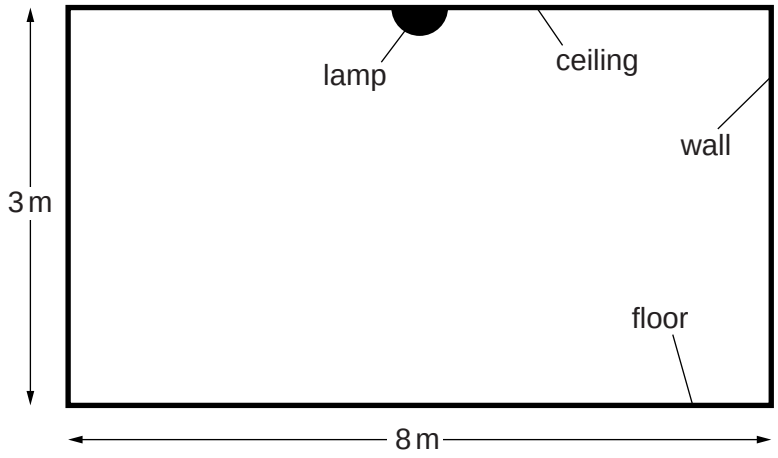
Put a tick (✓) in the correct box after each statement.

	scientific reason	**not a scientific reason**
The Earth's temperature has always varied a lot.	☐	☐
The Earth can never be affected by human activity.	☐	☐
Changes in the Sun's activity have changed the Earth's climate in the past.	☐	☐
Computer models cannot give evidence that human activities cause global warming.	☐	☐
Scientists who support global warming are mostly interested in making themselves famous.	☐	☐

[3]

[Total: 5]

5 Michael designs an office with a square floor area of 8 m by 8 m, and a ceiling height of 3 m. He wants to light the office with a single lamp in the centre of the ceiling, as shown below.



side view

To satisfy planning regulations, Michael needs to select a lamp power that will give an intensity of at least 150 lux everywhere in the office. This should include the furthest corners of the room, which are 6.4 m from the lamp. The light intensity in lux from a lamp of power *P* varies with distance in m according to this formula

$$\text{intensity in lux} = \frac{20 \times P}{(\text{distance in m})^2}$$

Suggest why planning regulations require a minimum light intensity, explain why the light intensity varies with distance from the lamp and calculate a suitable power for the lamp.

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

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[Total: 6]

6 The table shows typical wavelengths of different parts of the electromagnetic spectrum.

Name of region	Typical wavelength (m)
radio waves	5.0
microwave	0.1
infrared	5.0×10^{-5}
visible light	5.0×10^{-7}
ultraviolet	1.0×10^{-7}
X-rays	1.0×10^{-10}
gamma rays	1.0×10^{-12}

(a) Very short wavelength radiation can be hazardous.

Which **two** of the following statements, put together, can explain this?

Put ticks (✓) in the two correct boxes.

Very short wavelength radiation has very high frequency. ☐

Radiation of wavelength greater than 1cm can cause cancer. ☐

The energy of a photon is directly proportional to its frequency. ☐

Long wavelength radiation is not absorbed by living organisms. ☐

Very short wavelength radiation is absorbed by the atmosphere. ☐

[2]

(b) Explain the process by which very short wavelength radiation damages living cells.
Use appropriate scientific terms in your answer.

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

[Total: 5]

7 Here are some statements about methods of communicating information by analogue signals and by digital signals.

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

	true for digital only	**true for analogue only**	**true for both**
The information can be stored and processed by computers.	☐	☐	☐
The signal can be superimposed on an electromagnetic wave.	☐	☐	☐
The signal can carry both images and sound.	☐	☐	☐
The signal consists of a series of 0s and 1s.	☐	☐	☐
Noise will always distort the information carried by the signal.	☐	☐	☐

[4]

[Total: 4]

8 A 230V mains-powered electric drill draws a current of 2.5A.

(a) Calculate the power of the drill when it is in use.

power = ... W **[2]**

(b) Another electric drill has a power rating of 600W. Calculate the number of joules of energy transferred when this drill is in use for 5 minutes.

energy = ... J **[2]**

(c) Calculate the energy transferred by the 600W drill when used for 5 minutes in kWh.

energy = ... kWh **[2]**

[Total: 6]

9 The table below shows data about three different power stations.

Power station	Primary fuel	Efficiency (%)	Output voltage (kV)	Output power (MW)
A	coal	33	24	1400
B	gas	42	28	1100
C	uranium	33	22	1200

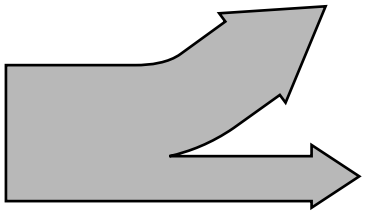
(a) For each statement below, put a tick (✓) in the **one** correct box.

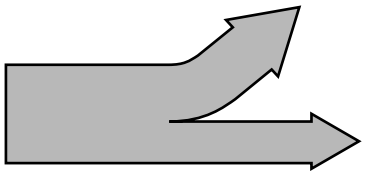
	Power station A	Power station B	Power station C
The power station produces the least carbon dioxide.	☐	☐	☐
The generator produces the largest current.	☐	☐	☐
The energy produced each second from the primary fuel is smallest.	☐	☐	☐

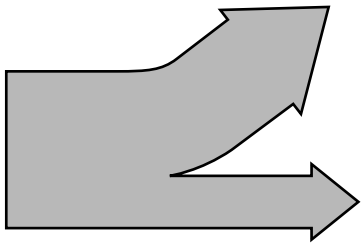
[2]

(b) The three Sankey diagrams below describe these three power stations. The three diagrams are drawn to the same scale.

In the space under each diagram, write the letter (**A**, **B** or **C**) for that power station.







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[2]

[Total: 4]

10 Nuclear fuel rods used by nuclear power stations consist of radioactive uranium sealed inside tubes of zirconium metal, which is not radioactive.

When the fuel has provided as much energy as possible, the used fuel rods, containing the waste, are sent to reprocessing centres. At these centres, the radioactive waste is removed from the zirconium tubes, stored securely and eventually made safe for disposal.

(a) Workers working with the radioactive materials in nuclear fuel and nuclear waste might be at risk from irradiation or from contamination.

Put a tick (✓) in the **one** correct box for each row.

	At risk from irradiation only	**At risk from contamination only**	**At risk from both**	**At risk from neither**
Workers at the power station	☐	☐	☐	☐
Workers at the reprocessing centre	☐	☐	☐	☐

[2]

(b) Give **two** reasons why irradiation is usually less hazardous than contamination.

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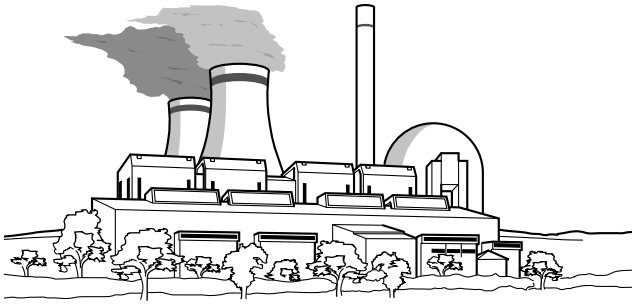
[Total: 4]

11 Over the next 50 years, it is predicted that the worldwide demand for electricity will increase greatly, particularly in developing countries where the population is increasing and more people are moving into cities.



Discuss the implications of these predictions in terms of the sustainability of primary energy sources and the environmental effects of their use.

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

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[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).