OCR
Oxford Cambridge and RSA

H

Wednesday 24 May 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

* A 1 8 1 0 2 *

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

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

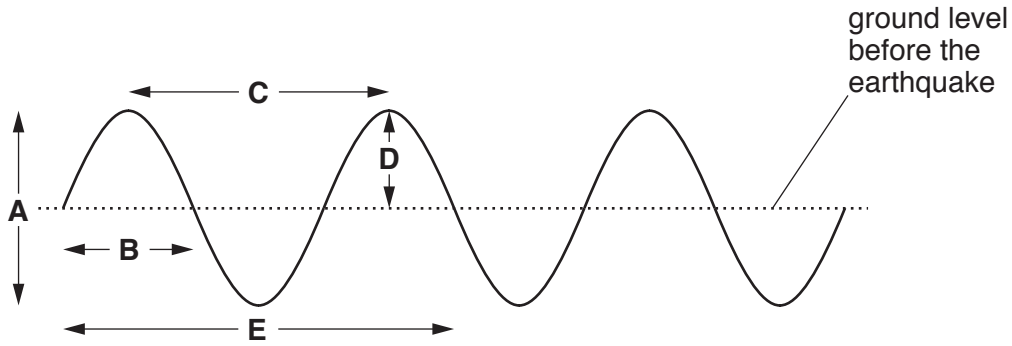
$$\frac{\text{voltage across primary coil}}{\text{voltage across secondary coil}} = \frac{\text{number of turns in primary coil}}{\text{number of turns in secondary coil}}$$

Radioactive materials

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

Answer **all** the questions.

1 The diagram below shows the ground moving when an earthquake wave passes. The dotted line shows the ground level before the earthquake arrived.



The wave diagram has five different arrows labelled **A**, **B**, **C**, **D** and **E**.

(a) Which arrow, **A**, **B**, **C**, **D** or **E**, shows the **amplitude** of the wave?

the amplitude is shown by arrow ..... **[1]**

(b) Which arrow, **A**, **B**, **C**, **D** or **E**, shows the **wavelength** of the wave?

the wavelength is shown by arrow ..... **[1]**

(c) The wave in the diagram has a wavelength of 1 km and a frequency of 2 Hz.

Calculate the speed of the wave in m/s.

Show your working.

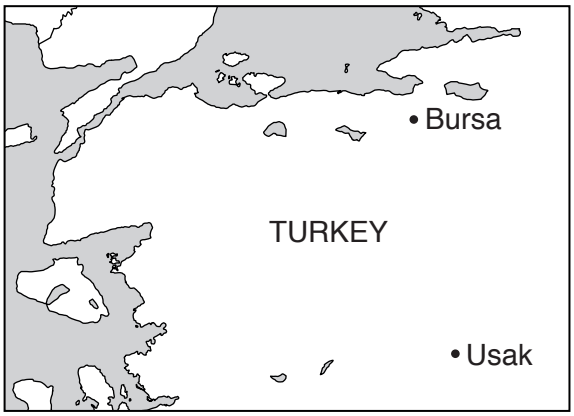
speed = ... m/s **[2]**

[Total: 4]

2 This question is about earthquake waves.

(a) P-waves travel at 8.1 km/s and S-waves travel at 5.1 km/s. A small earthquake occurs in Usak in Turkey.

The waves are detected in Bursa, which is a distance of 169 km away.



Show that the P-waves will arrive at Bursa about 12 seconds before the S-waves.

time difference = ... s **[2]**

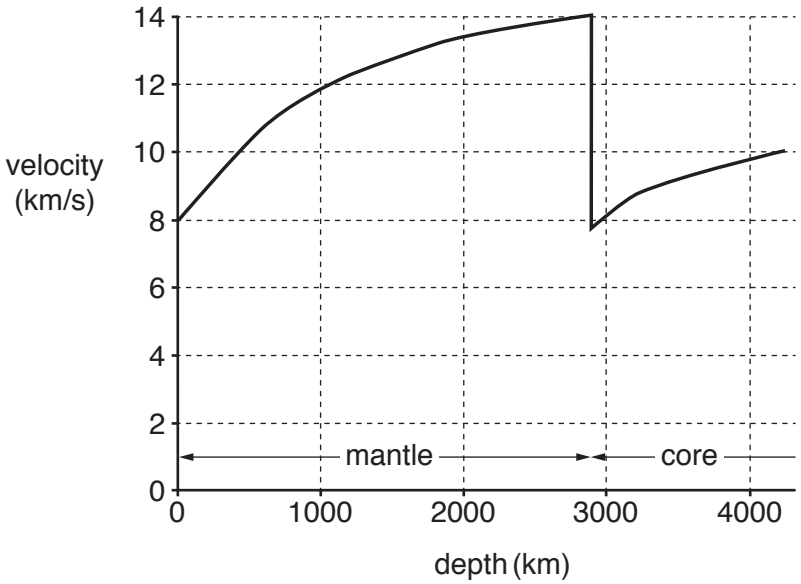
(b) Earthquakes are common in Turkey but are very rare in Britain.

State **one** reason for this.

.....

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

(c) As a P-wave travels deeper into the Earth, its speed changes as shown below.



A P-wave has wavelength of 2000 m when it enters the Earth's mantle.

Explain why the graph shows that its wavelength will be 3500 m just before it enters the Earth's core.

.....

.....

.....

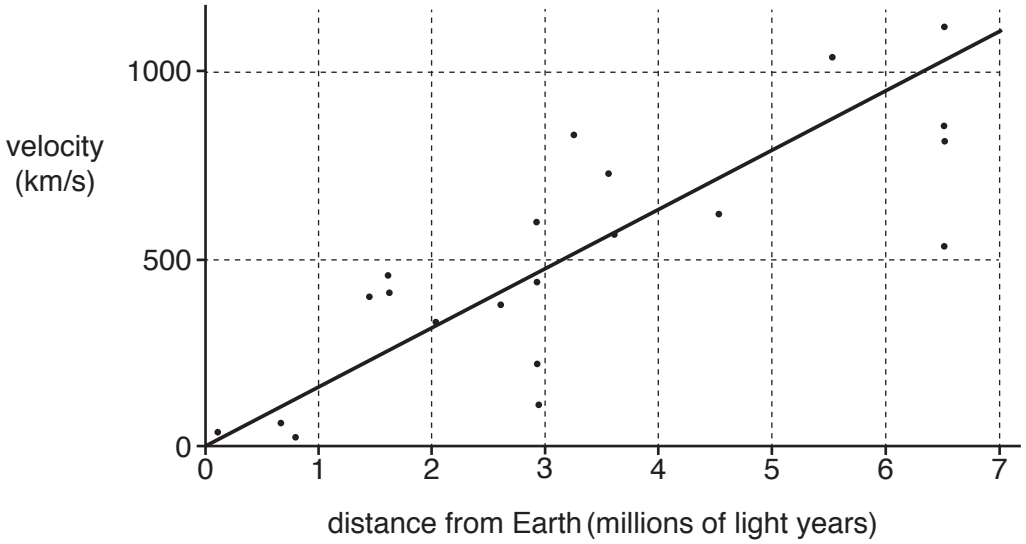
.....

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

[Total: 6]

3 In 1929, the astronomer Edwin Hubble published the results of his observations of galaxies. He found that most were moving away from us, and his results for their velocities are shown in the graph below.

The line shown is Hubble's own best-fit line for the data.



(a) Describe what the graph shows about the relationship between the velocities and distances of galaxies.

.....

.....

.....

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

(b) Explain why other astronomers, seeing these data, were keen to measure the distances and velocities of these and other galaxies themselves.

.....

.....

.....

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

[Total: 4]

4 In 1842, the French philosopher, Comte, said, 'No-one will ever be able to analyse the chemical composition of stars.' Within a decade, the German chemists Bunsen and Kirchhoff discovered that certain frequencies of light acted as 'fingerprints' of the elements present in the source of light.

This was soon applied to stars and it was found that the Sun contains an element not previously known: helium. It is now known that helium is the second most common element in the Universe after hydrogen. These two elements were created in the 'Big Bang'.

The same technique applied to galaxies showed that some of the 'fingerprints' were seen at longer wavelengths than astronomers had expected.

Describe and explain what observations of stars and galaxies have revealed about the nature of the Universe and the elements it contains.

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

.....

.....

.....

.....

.....

.....

.....

.....

.....

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

[Total: 6]

5 The following table shows typical frequencies for some parts of the electromagnetic spectrum. The frequencies are measured in GHz, where 1 GHz = 1×10^9 Hz.

Type of radiation	**Microwave**	**Infrared**	**Visible light**	**Ultraviolet**	**X-ray**
Frequency in GHz	2	1000	550000	30 million	3 thousand million

(a) Here are a number of statements about electromagnetic radiation. Some are true and some are false.

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

	True	**False**
Radiation of greater frequencies than X-rays are emitted by some materials.	☐	☐
Any radiation of frequency greater than 30 million GHz will damage living cells.	☐	☐
Radiation of frequencies less than 1000 GHz cannot be used in communication.	☐	☐
No radiation of frequency greater than 550 000 GHz can penetrate the Earth's atmosphere.	☐	☐

[2]

(b) The speed of light is 3.0×10^8 m/s.

Calculate the typical wavelength of visible light.

Write your answer in nanometres (nm), where 1 nm = 1×10^{-9} m.

Give your answer to **one** significant figure.

wavelength = ... nm **[3]**

[Total: 5]

6 About 100 years ago, Albert Einstein showed that beams of electromagnetic radiation behave like streams of particles (photons) rather than continuous waves.

This discovery allows physicists to explain a range of different observations such as:

- Some parts of the electromagnetic spectrum can cause chemical reactions to take place but others cannot.
- Ultraviolet radiation can cause skin cancer, but visible light cannot.
- When violet light shines on calcium metal, electrons are given off, but this does not happen for red light, even if it is very bright.

Use Einstein's discovery to explain these observations in terms of photons.

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

.....

.....

.....

.....

.....

.....

.....

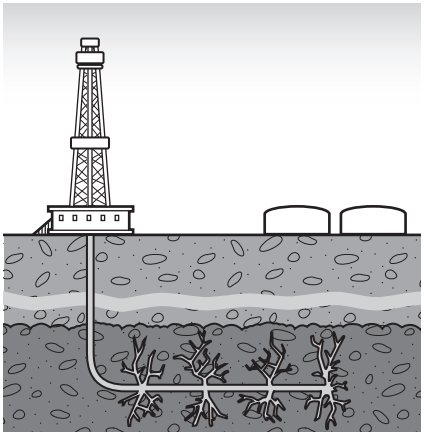
.....

.....

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

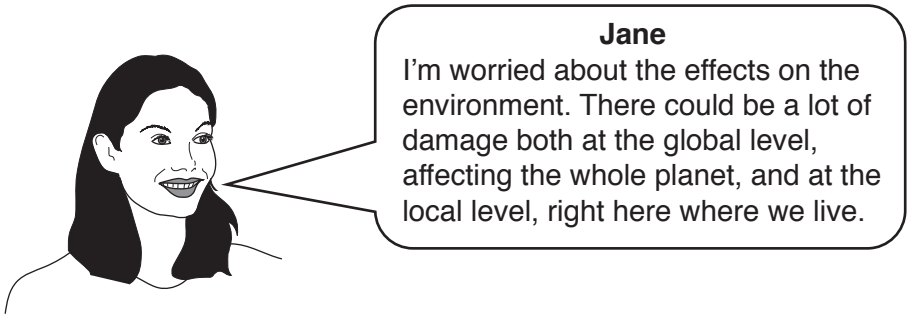
[Total: 6]

7 'Fracking' is a process which is used to extract methane gas, a fossil fuel, for use in power stations. It involves drilling down into rocks, and using high-pressure water to fracture the rocks and drive out the gas.



The Government has suggested that this process could supply much of the energy the country needs. It has been suggested that this could happen in places like National Parks.

Jane is worried about the effects of fracking.



(a) Suggest and explain damage to the environment **at the global level** which could result from using the gas produced in this way.

.....

.....

.....

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

(b) Suggest and explain damage to the environment **at the local level** which could result from introducing fracking.

.....

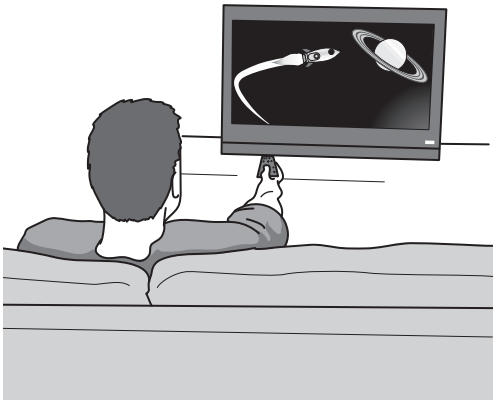
.....

.....

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

[Total: 4]

8 Sam is watching a high-definition (HD) digital television.



(a) HD film needs more bytes of information than standard-definition (SD) film.

Which of the following is a possible explanation for this?

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

Digital images are not affected by noise.	☐
HD signals travel faster than SD signals.	☐
Digital signals consist of a series of 0s and 1s.	☐
HD films have much clearer images than SD films.	☐

[1]

(b) Each byte of digital data is made of 8 **bits**, where a bit is one of the symbols 0 and 1.

Sam is downloading and saving a programme to watch later. The programme contains 720 MB of data. (1 MB = 1 megabyte = 1 000 000 bytes)

(i) Calculate the number of **bits** the programme will need.

number = ... **[2]**

(ii) Sam can download the programme at a rate of 21 megabits per second.

Calculate the time that it will take the whole programme to download.

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

[Total: 5]

9 New providers of electricity are attempting to gain customers who are concerned about the environment.

Here is the advertisement for one provider:

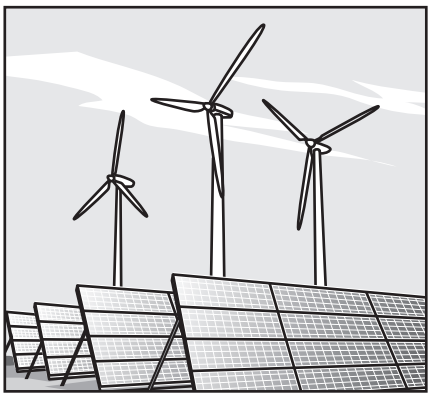
OCR Green Energy – the way forward

Change to our company, and we can guarantee that all your electricity will come from renewable sources – wind, solar, water and biofuel.

Do your bit to combat global warming!

And that's not all – we're cheaper than the big energy suppliers, too!

For more information, see our website www.OCRGreen.com



A householder is thinking about changing to this energy provider.

Discuss the advantages and disadvantages, for the householder and for the country as a whole, of making this change.

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

.....

.....

.....

.....

.....

.....

.....

.....

.....

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

[Total: 6]

10 Electrical appliances which use the 230 V electrical sockets in the house have plugs that are fitted with fuses. In the event of an electrical fault, the fuse 'blows' (melts) and switches off the device.

Each fuse is designed to allow a current which is a bit larger than the maximum current the appliance usually takes. The available fuses are rated at **3 A**, **5 A** and **13 A**.

(a) For each of the following appliances, write down the maximum current which the appliance takes and the fuse which should be used in the plug.

The first one has been done for you.

appliance	maximum power	maximum current	fuse
dish washer	2300 W	10 A	13 A
hair dryer	1.8 kW		
laptop computer	70 W		
vacuum cleaner	800 W		

[3]

(b) The fuse in Jo's kettle 'blows' and she does not have a spare. She replaces the fuse with a thick piece of copper wire.

Explain why this could be extremely dangerous.

.....

.....

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

[Total: 5]

11 Over 600 years ago, it was noticed that men working in silver mines in the Czech Republic often died from 'mountain sickness', which we now know was cancer. It was not until the 20th Century that it was realised that the rocks in the mine were the cause of this damage.

Explain the meaning of *irradiation* and *contamination*, and suggest how they may have caused the damage to these men.

.....

.....

.....

.....

.....

.....

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

[Total: 4]

12 **(a)** A heater draws a current of 10 A from the 230 V mains electricity supply.

Calculate the energy transferred **in kilowatt hours** (kWh) when the heater is left on for 30 minutes.

energy transferred = ... kWh **[3]**

(b) The lamp in a torch draws a current of 0.6 A from a 3.0 V battery.

Calculate the energy transferred **in joules** (J) when the torch is left on for 5 minutes.

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

[Total: 5]

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).