H

Monday 19 May 2014 – 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

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. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- 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 **20** 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

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

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

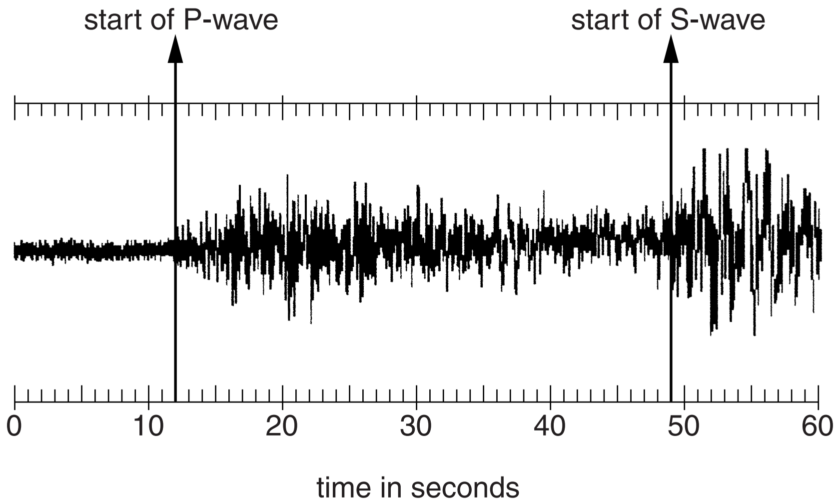
Radioactive materials

$$\text{energy} = \text{mass} \times [\text{speed of light in a vacuum}]^2$$

Answer **all** the questions.

1 This question is about earthquakes.

(a) The diagram shows the record at a detector of an earthquake.



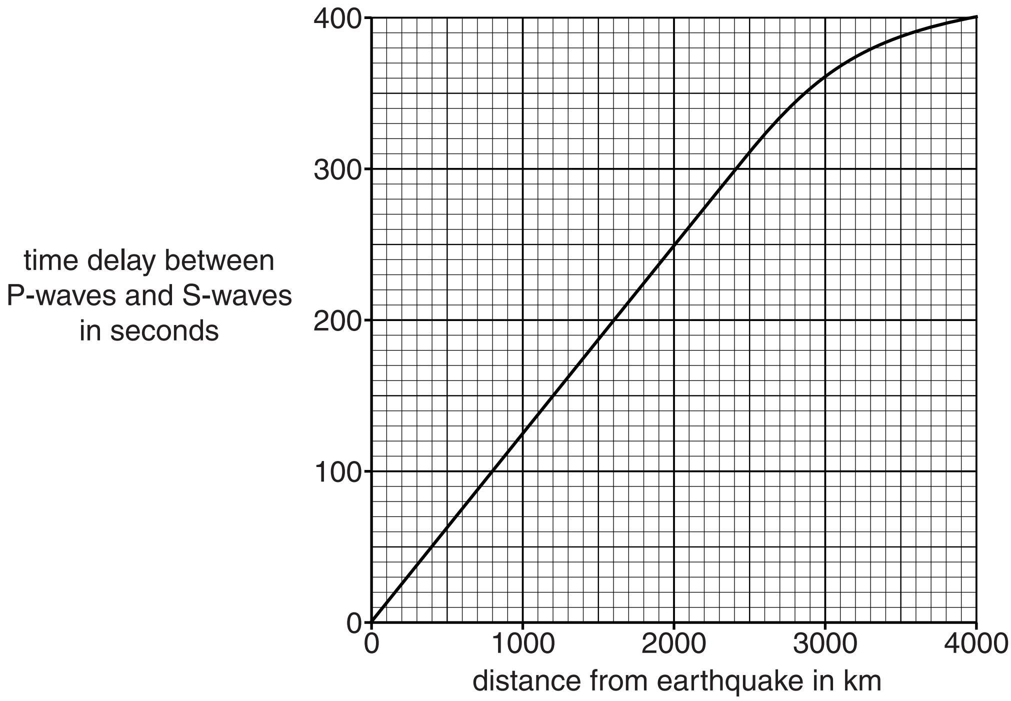
Earth scientists estimate the distance from an earthquake to the detector using the rule:

1 second of time delay between the arrival of the P-waves and the arrival of the S-waves corresponds to a distance of 8 km.

(i) Use the diagram to find the distance between the earthquake and the detector.

answer = ... **[2]**

(ii) The graph shows the actual time delay for different distances from the earthquake.



Use the graph to show that the '8 km for every second of delay' rule works much better at a distance of 2000 km than at a distance of 4000 km.

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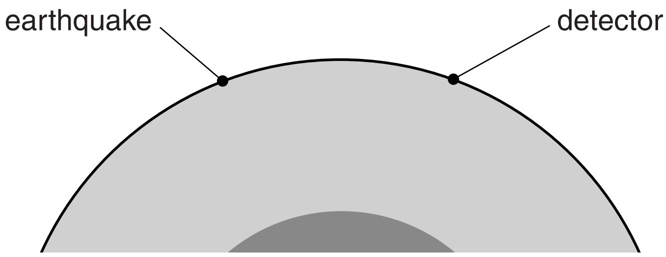
(b) The line on the graph curves because the S-waves and P-waves are both changing in speed as they pass through the Earth.



Use your knowledge of the structure of the Earth to suggest and explain why the graph in **(a)(ii)** curves.

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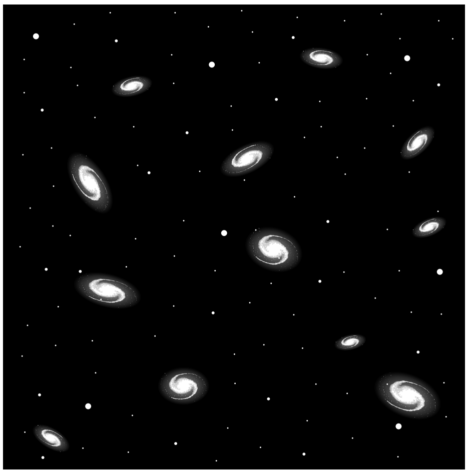
.... **[2]**

[Total: 6]

Question 2 begins on page 6

2 Astronomers first made observations of distant galaxies using telescopes on the Earth. Accurate observations were very difficult to make.



As improved observations of distant galaxies became possible, discoveries were made about their distances and speeds. These discoveries changed our understanding of the Universe.

Suggest how the improvements in observations were made, and explain the new scientific ideas which followed.

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

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[Total: 6]

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Question 3 begins on page 8

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3 This question is about objects which orbit the Sun.

(a) The table has data on some planets in our solar system.

Planet	Diameter of planet (km)	Orbital radius (millions of km)	Speed (km/s)
Earth	12800	150	30
Mars	6780	230	24
Jupiter	143000	780	13
Saturn	120000	1430	9.5
Uranus	50800	2870	6.7

(i) Which of the following statements correctly describe the relationships **shown by the data** in the table?

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

Bigger planets travel slower than smaller ones. ☐

Planets closer to the Sun travel faster. ☐

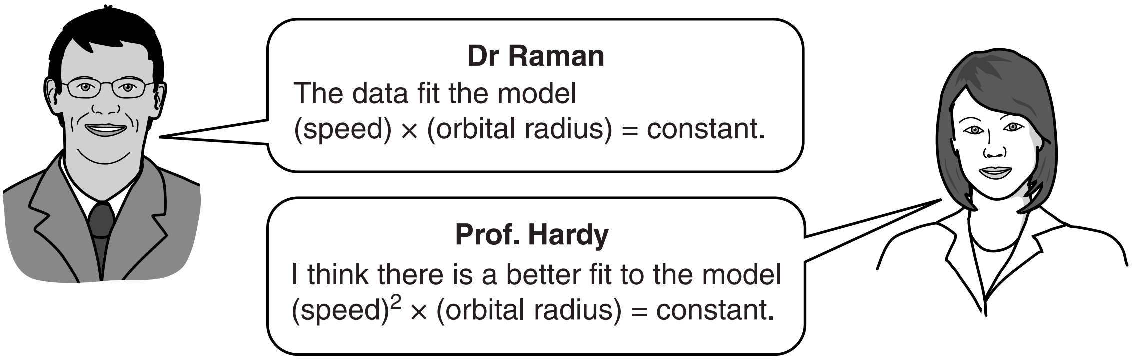
The biggest planets are more than 1000 million km from the Sun. ☐

The diameter of a planet is inversely proportional to its speed. ☐

There is a correlation between orbital radius and speed. ☐

[2]

(ii) Two mathematicians have studied the data to find the relationship between orbital radius and planetary speed.
They discuss different mathematical models.



Use the data for the Earth and Uranus to complete the table below for each of the models.

	Dr Raman's model	**Prof. Hardy's model**
constant for Earth		135 000
constant for Uranus	19 229	

[2]

(iii) Discuss whether or not your table shows which mathematician has the better model.

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(b) An astronomer observes a new object in the night sky. She thinks it may be an asteroid or a comet.
Describe the differences between a comet and an asteroid.

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[Total: 8]

4 This question is about global warming.

(a) Some of the statements below are true and some are false.

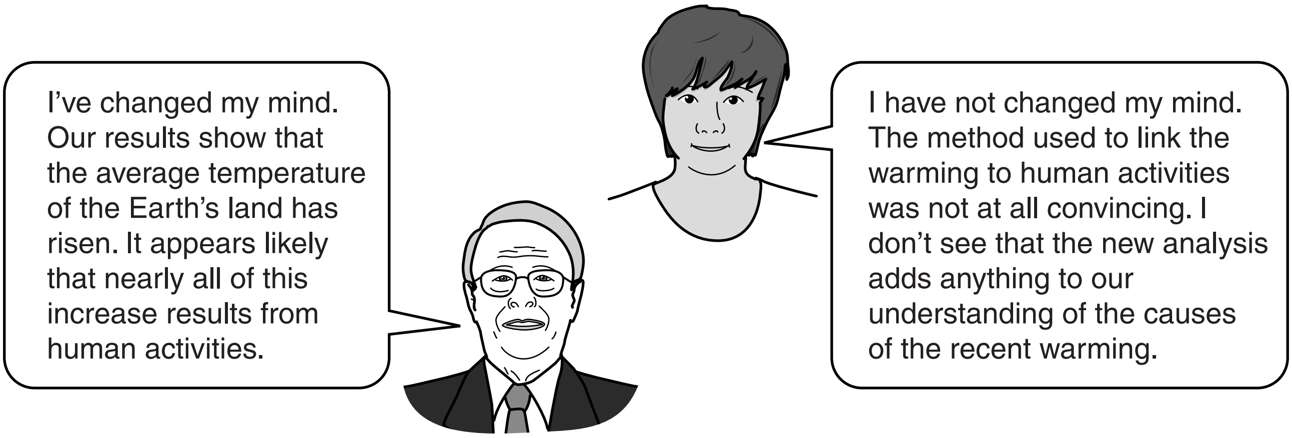
Put a tick (✓) in the correct box after each statement.

	true	**false**
The atmosphere does not absorb infrared radiation.		
The Earth emits infrared radiation.		
The Sun does not emit infrared radiation.		
The Sun emits radiation equally at all frequencies.		
Water vapour is a greenhouse gas.		

[2]

(b) An independent project was set up to analyse all the data available related to global warming. Scientists in this group did not believe that global warming has been caused by human activity.

The leader of this project recently said that the new analysis had made him change his mind. Another scientist in the project said that she had not changed her mind.



Explain what is meant by *global warming caused by human activity* and suggest reasons why experienced scientists have different opinions about this issue.

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

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[Total: 8]

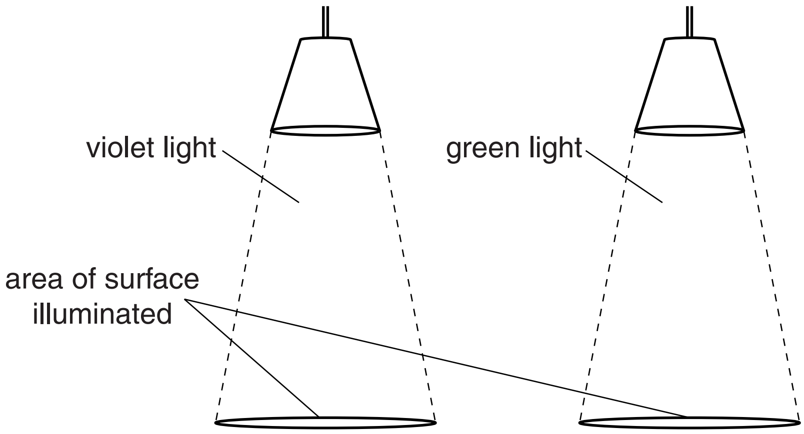
5 (a) Some of the statements below are true, and some are false.

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

	true	**false**
A vacuum will transmit radiation.		
Doubling the distance between a source of radiation and a detector will double the intensity.		
Increasing the frequency of radiation increases the energy of its photons.		
The only radiation which can heat a surface is infrared.		
X-ray radiation has the highest frequency in the electromagnetic spectrum.		

[2]

(b) The diagram shows two lamps giving out coloured light.



The energy of photons is measured in units called eV.

The table shows the energy of photons of these two colours of light.
Each surface is lit up with the **same intensity** over the same area.

Colour of light	Energy of each photon in eV	Number of photons per second
violet	3.0	5.0×10^{18}
green	2.5	

Calculate the number of photons per second of green light reaching the surface.
Explain your answer.

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[Total: 5]

6 The Sun gives out a lot of ultraviolet radiation. This can damage living cells.

(a) Describe how the Earth's atmosphere helps to protect us against this damage.

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(b) People love to sunbathe in sunny weather even though they know it can be dangerous.
Suggest reasons why people are still happy to sunbathe.

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[Total: 4]

7 The table shows the amount of computer storage needed for four different examples of digital information.

Digital information	Size in MB (millions of bytes)
old digital photograph	0.2
modern digital photograph	5
3 minute song	3.1
3 minute video	36

Computers made 20 years ago could store less than 1000 MB. Using information in the table, suggest why typical modern computers are built to store 1TB (a million MB) of information.

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[Total: 3]

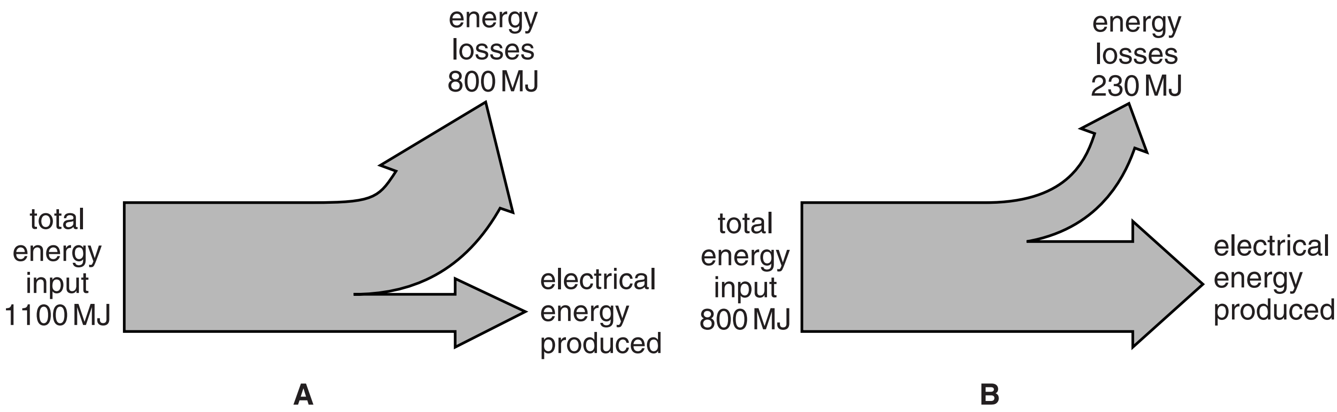
8 **(a)** The boxes below give types of energy sources used by power stations together with some of their disadvantages.

For each **energy source**, put a tick (✓) in **each** box describing its **disadvantages**.

Energy source	**Possible disadvantage**		
	generates greenhouse gases when working	power station needs to pay for fuel	cannot be used in all countries
biofuel			
coal			
hydroelectricity			

[2]

(b) The Sankey diagrams below show the energy transfers in 1 second in two different power stations **A** and **B**.



The statements below are true for power station **A**, or true for power station **B**, or true for **both**, or true for **neither**.

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

	true for A	**true for B**	**true for neither**
It generates more than 600 MW of electrical power.			
It has an efficiency of more than 60%.			
Energy losses in one minute are more than 1×10^{10} J.			
The total energy input in one minute $>$ 50 000 MJ.			

[3]

[Total: 5]

9 An old fridge works for 24 hours a day, every day of the year.
It has a current of 0.63 A from the 230 V mains.

(a) Which of the following values is the energy in kilowatt hours transferred in a year, written to two significant figures?
Assume that a year is 9000 hours.

Put a (ring) around the correct value in kWh.

1300 **3200** **1 300 000** **3 200 000**

[1]

(b) A modern fridge rated A++ has one-eighth of the power rating of the old fridge in **(a)**.

Calculate the money saved in a year when the old fridge is replaced by the modern fridge.
Cost of one kilowatt hour = 16 p

money saved = £ .... **[2]**

(c) The modern fridge costs less money to use, but there are other factors to consider before replacing the old one.
Suggest and explain **one** reason why it may **not** be a good idea to replace the old fridge.

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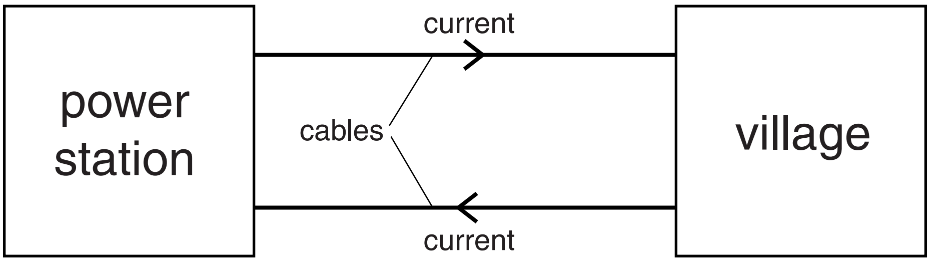
[Total: 5]

10 The diagram shows a small village being supplied by electricity from a power station.



(a) Not all of the energy transferred by the power station reaches the village. Some of the energy heats up the cables.

The power station could transfer the energy at 250 V or at 2500 V.

For the arrangement shown in the diagram, the power that heats up the cables is given by the equation

power wasted in heating cables in W = 0.2 × (current in A)^2

Use this information to complete the table below.

Power produced at power station in W	**Voltage generated in V**	**Current produced in A**	**Power wasted in heating cables in W**	**Power delivered to village in W**
100 000	250	400	....	....
100 000	2500	40	....	....

[2]

(b) Explain why electricity is distributed through the National Grid at voltages as high as 400 000 V.

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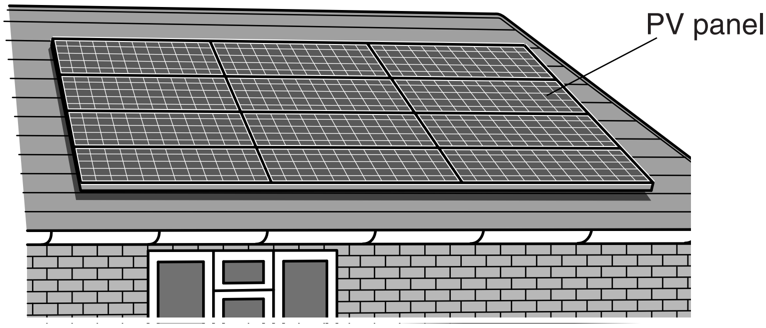
[Total: 4]

11 Many house-owners are putting sets of photovoltaic (PV) panels on their roofs to generate electricity during daylight. The panels work best if the roof used is facing south.



The data about the type of PV panel shown in the diagram are given in the table.

size of one panel (m × m)	1.5 × 0.8
average daily energy output of one panel (kWh)	0.6
cost per panel	£200

A family needs about 24 kWh of electricity per day, averaged out over the winter and the summer.

This family has decided to fit 12 panels on their roof to provide their energy needs throughout the year.

Discuss the advantages and disadvantages of fitting these panels to their roof.

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

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[Total: 6]

END OF QUESTION PAPER

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