OCR
Oxford Cambridge and RSA

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Wednesday 20 May 2015 – 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

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

Answer **all** questions.

1 Observations of the star Tau Ceti have shown that:

- it is very similar to our Sun
- it is surrounded by a cloud of dust
- it has several planets
- at least five of these planets are as big as the Earth or bigger.

Scientists think that the Tau Ceti system formed in the same way as our solar system.

Draw a labelled sketch of the Tau Ceti system showing how the different parts move, and describe how the different parts may have been formed.

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

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

[Total: 6]

2 Earthquakes close to the coast often produce dangerous water waves called tsunamis.

(a) The table below gives typical data for a tsunami.

Depth of water (m)	Speed (m/s)	Wavelength (m)
7000	260	282 000
4000	200	213 000
2000	140	151 000
200	45	48 000
50	22	23 000
10	10	10 600

(i) A tsunami crossed the Indian Ocean from the earthquake on the coast of Indonesia to Africa. It took 8 hours and 20 minutes to do so. The speed of this tsunami was 180 m/s.

Calculate the distance in km from the Indonesian earthquake to Africa.

distance = ... km **[3]**

(ii) Estimate the depth of the Indian Ocean, which you can assume to be the same at all parts.

depth = ... m

Explain how you decided on this value.

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

(b) It has been suggested that the speed of a tsunami is directly proportional to the depth of the water.

Explain what **directly proportional** means and use the data in the table below to see if the suggestion is true.

Speed (metres per second)	Depth of water (metres)
45	200
10	10

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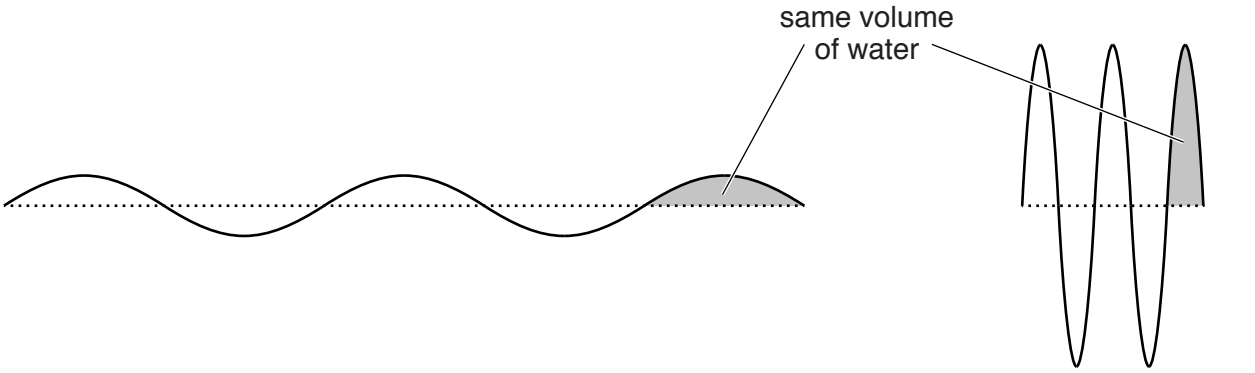
..... **[2]**

(c) The diagram below shows the tsunami waves in mid-ocean and near the land. The volume of water in each 'peak' of the wave stays the same.



tsunami in mid-ocean

tsunami near the land

Explain why a tsunami may not be noticed by a ship in mid-ocean but can cause terrible damage when it strikes the land.

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

[Total: 8]

3 **(a)** Alfred Wegener introduced his theory of Continental Drift in 1912.
Most scientists did not accept his theory.
The following scientific observations had been made by 1912.

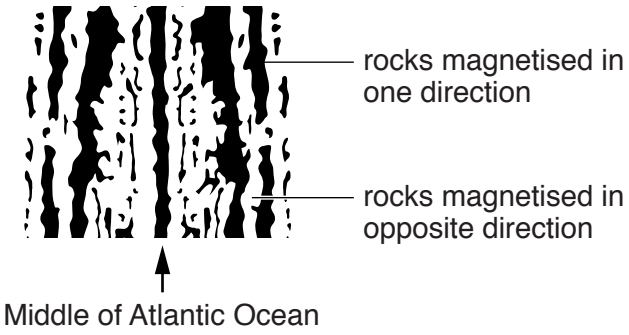
Put a tick (✓) in the **one** correct box after each observation.

Scientific observations in 1912	Supports Wegener	Contradicts Wegener	Neither supports nor contradicts
Fossils of tropical plants are found near the South Pole.			
Humans are found on all continents.			
South America and Africa are separated by the Atlantic Ocean but both have sedimentary rocks.			
The width of the Atlantic Ocean is not changing.			

[3]

(b) In 1963 scientists found an explanation for symmetrical magnetic stripes that had been found on the seafloor in the middle of the Atlantic Ocean. The diagram shows the magnetic stripes.

The darker areas represent rocks magnetised in one direction. The lighter areas represent rocks magnetised in the opposite direction.



The following four facts are all correct.

Which two facts put together best explain the pattern of magnetic stripes?

Put ticks (✓) in the boxes next to those **two** facts.

The Earth's crust lies on top of the mantle.	☐
The Earth's magnetism changes direction about every million years.	☐
The thickness of the seafloor increases as it moves away from the middle.	☐
The seafloor spreads out from the centre.	☐

[1]

[Total: 4]

4 The table gives the mass of some elements.

Element	**Hydrogen**	**Helium**	**Carbon**	**Oxygen**	**Iron**
Mass in atomic mass units	1	4	12	16	56

(a) Which **one** of these elements is used to produce energy in the Sun?

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

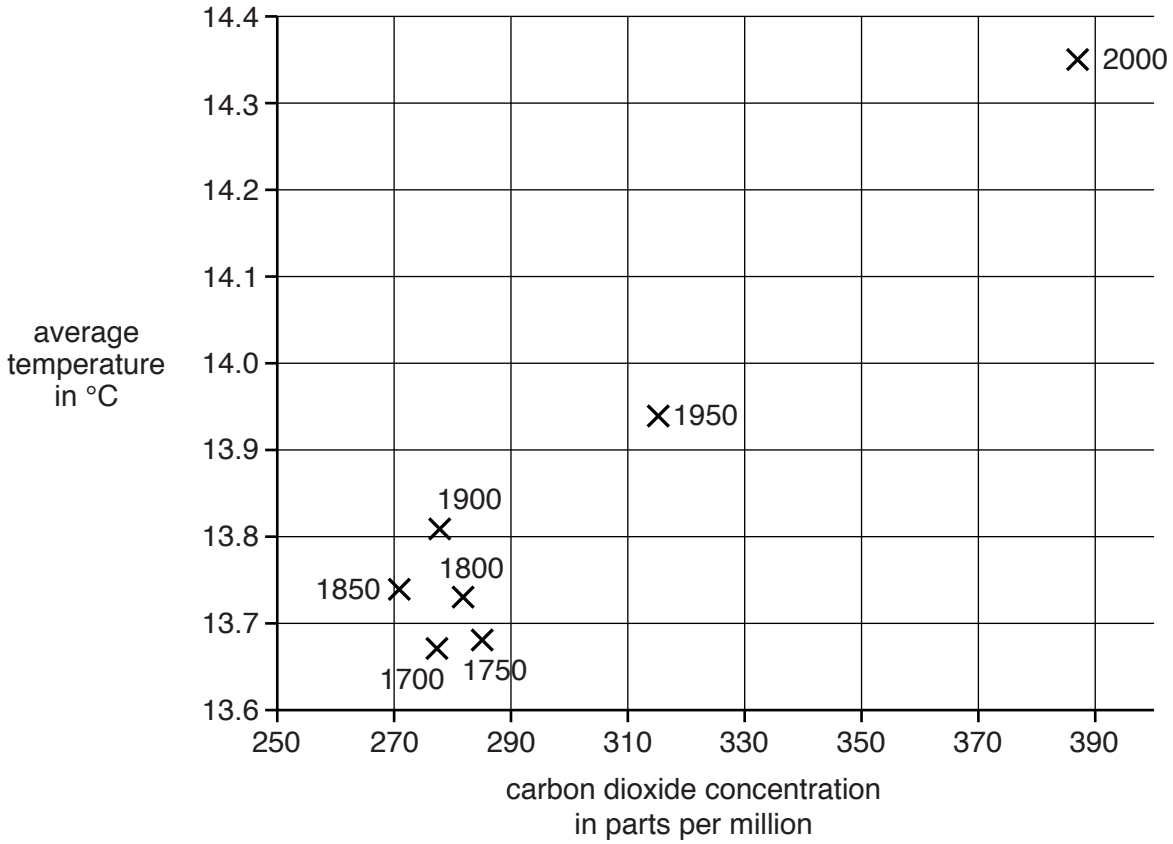
(b) Which **three** of these elements must have been made inside stars?

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

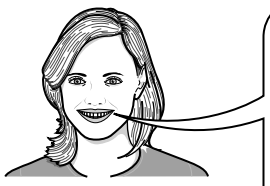
[Total: 2]

5 The graph below shows how the average temperature of the Earth and the concentration of carbon dioxide in the atmosphere have changed over the last 300 years.

Each point is marked with the year the readings were taken.



(a) Five friends have been looking at this graph.



Alice
There is a positive correlation between temperature and carbon dioxide concentration.

Ben
Burning fossil fuels increases the carbon dioxide concentration.

Chandra
Carbon dioxide concentration didn't change much until after 1900.

Debra
I'm worried about the effects of global warming on the environment.

Eddie
Carbon dioxide is a greenhouse gas. It makes the Earth absorb more of the Sun's radiation.

(i) Which two friends are **describing** the data shown in the graph?

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

Alice	☐
Ben	☐
Chandra	☐
Debra	☐
Eddie	☐

[2]

(ii) Which two friends are **explaining** the data shown in the graph?

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

Alice	☐
Ben	☐
Chandra	☐
Debra	☐
Eddie	☐

[2]

(b) The graph opposite, and similar data produced by other scientists, raise concerns about climate change. One such concern is that low-lying land could be flooded.

State and explain **two other** changes that could result from global warming.

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

[Total: 7]

6 **(a)** Digital signals are now used far more often than analogue signals.

Write down **two** advantages of using digital signals.

1 .....

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2 .....

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

(b) Both analogue and digital signals can be sent through the atmosphere or along optical fibres.

The statements below are about these different ways of sending a signal.
Some of them are true for sending through the atmosphere, some are true for using optical fibres, and some are true for both.

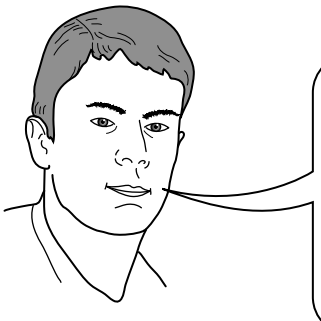
Put a tick (✓) in **each** correct box after each statement. The first statement has been completed for you.

Statement	True for sending through the atmosphere	True for optical fibres
The signals can be digital or analogue	✓	✓
Microwaves can carry the signal.		
Not much of the signal is absorbed by the material it passes through.		
The signal uses photons of less energy than X-ray photons.		
The signal travels at a speed of hundreds of thousands of kilometres each second.		

[2]

[Total: 4]

7 Some people have concerns about the health risks from mobile phones. Other people think there is no risk.



Hugh
I don't believe all these scares about mobile phones. Their power output is less than 1 watt – a kettle is 2000 times more powerful. Mobile phones can help to keep children safe.

The UK Chief Medical Officers strongly advise that children and young people should be encouraged to use mobile phones for essential purposes only and to keep all calls short.

Explain the risks and benefits of allowing children to use mobile phones.

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

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

[Total: 6]

8 A solar farm is planned for West Wales. The data for this project are given below.

Intensity of radiation on the panels	$0.9\,kW/m^2$
Number of solar panels	35 000
Area of each solar panel	$1.2\,m^2$
Efficiency of the solar panels	15%

The project planners claim this solar farm can produce 7.5 MW. Use the data to check if the planners' claim is correct.

Show your working.

[3]

[Total: 3]

9 This question is about electric kettles.

(a) A kettle is plugged into a domestic mains socket. It draws a current of 12 A.

What is the power, in **kilowatts**, of this kettle?

Put a (ring) around the value **nearest** to the power in kilowatts.

3 **12** **230** **3000** **[1]**

(b) It takes 4200 J to raise the temperature of a litre of water by 1 °C.

How much energy is needed to heat up a litre of water from 20 °C to 100 °C?

Put a (ring) around the value, correct to **one significant figure**.

80000 J **300 000 J** **400 000 J** **[1]**

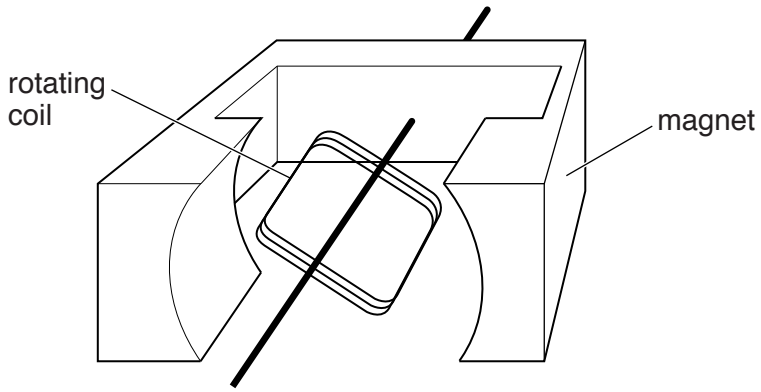
(c) A camping kettle is marked 12 V 170 W. It needs 70 kilojoules to boil the water in it. How long will it take to boil?

Put a (ring) around the nearest value.

0.4 seconds **4 minutes** **7 minutes** **70 minutes** **[1]**

[Total: 3]

10 (a) The simplified diagram shows a generator.



Which one of the following combinations of changes to this generator would be **certain** to result in a larger voltage being generated?

Put a tick (✓) in the box next to the correct combination.

Using a weaker magnet and rotating the coil faster. ☐

Using a stronger magnet and rotating the coil faster. ☐

Using a weaker magnet and rotating the coil slower. ☐

Using a stronger magnet and rotating the coil slower. ☐

[1]

(b) A generator is an important part of any power station.
The block diagram below shows the different parts of a hydroelectric power station.

Complete the diagram by naming parts **A**, **B** and **C**.

[2]

(c) The Three Gorges hydroelectric dam in China generates 2.25×10^{10}W.

It uses 1.0×10^{8}W of that to power the dam itself.

China's electricity consumption is equivalent to an average power of 3.2×10^{12}W.

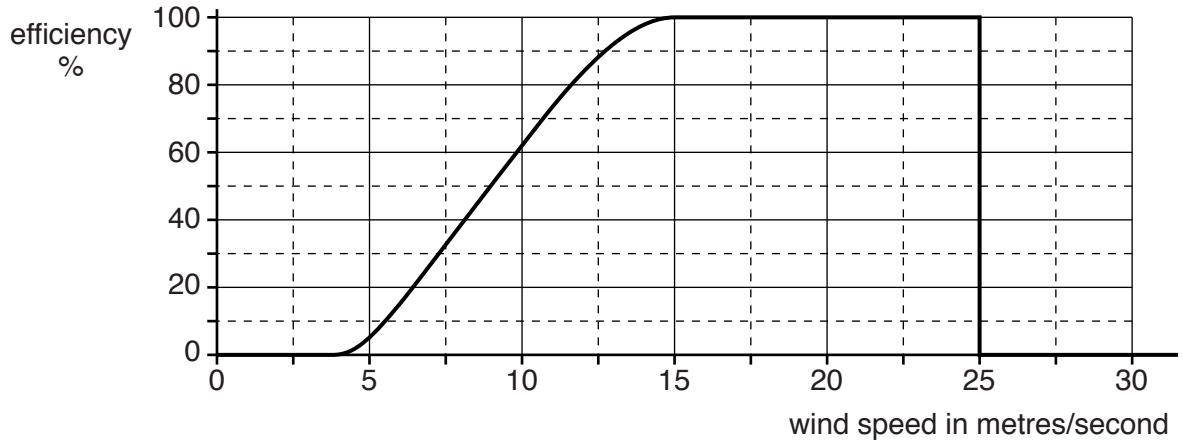
Calculate the percentage of China's electricity requirements that is provided by the Three Gorges dam.

Show your working

percentage = ... % **[2]**

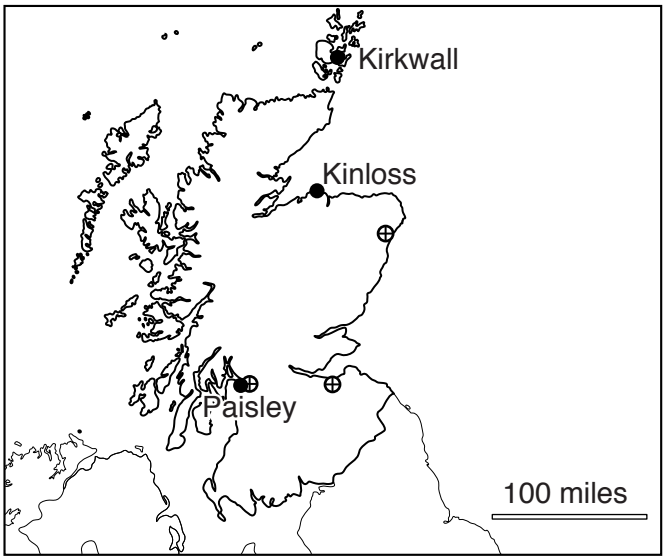
[Total: 5]

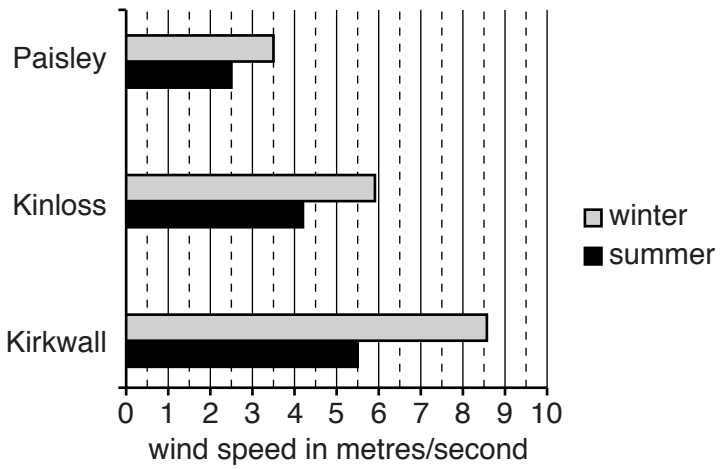
11 Wind turbines are used in wind farms in the UK to generate electricity.
As the following graph shows, the efficiency of a wind turbine depends on the wind speed.



Three locations in Scotland have been studied as possible sites for large wind farms. These places, Paisley, Kinloss and Kirkwall, have been marked (●) on the map of Scotland.

The wind speed for these three places is shown in the bar chart. It shows average wind speed during winter and summer for the three possible wind farm sites.





Another factor to consider is the distance from the wind farm site to the consumers.

Half of all consumers in Scotland live in or near the three largest Scottish cities (marked ⊕ on the map of Scotland).

Use the data to compare the three sites for suitability as locations for a large wind farm.

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

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[Total: 6]

12 About a third of the UK's electricity is produced by burning coal. Two other major sources of energy for producing electricity are the use of nuclear power and burning gas.

(a) For every MWh of electricity generated by burning coal, 0.4 grams of radioactive materials are produced. Much of this waste is present in the flue gases as 'fly ash'.

For every MWh of electricity generated in a nuclear power station, 0.04 grams of radioactive waste are produced. This waste is contained in the 'spent' fuel rods.

The radioactive waste from nuclear power stations is more hazardous than the ash from the coal-burning power stations.

Discuss the different problems associated with the waste produced in coal-burning and nuclear power stations.

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

(b) For every MWh of electricity produced by burning **coal**, 550 kg of carbon dioxide are released. To produce the same amount of electricity by burning **gas**, 180 kg of carbon dioxide are released.

A 1200 MW coal-burning power station is replaced with a gas-burning power station of the same output.

Calculate the reduction in carbon dioxide produced each day (24 h).

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

[Total: 6]

END OF QUESTION PAPER

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