OCR
Oxford Cambridge and RSA

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Friday 19 June 2015 – Morning

GCSE TWENTY FIRST CENTURY SCIENCE
PHYSICS A/FURTHER ADDITIONAL SCIENCE A

A183/02 Module P7 (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 useful relationships is printed on pages **2** and **3**.
- 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 EQUATIONS

Useful relationships

The Earth in the Universe

$$\text{distance} = \text{wave speed} \times \text{time}$$

$$\text{wave speed} = \text{frequency} \times \text{wavelength}$$

Sustainable energy

$$\text{energy transferred} = \text{power} \times \text{time}$$

$$\text{power} = \text{voltage} \times \text{current}$$

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

Explaining motion

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

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

$$\text{momentum} = \text{mass} \times \text{velocity}$$

$$\text{change of momentum} = \text{resultant force} \times \text{time for which it acts}$$

$$\text{work done by a force} = \text{force} \times \text{distance moved in the direction of the force}$$

$$\text{amount of energy transferred} = \text{work done}$$

$$\text{change in gravitational potential energy} = \text{weight} \times \text{vertical height difference}$$

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

Electric circuits

$$\text{power} = \text{voltage} \times \text{current}$$

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

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

Radioactive materials

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

Observing the Universe

$$\text{lens power} = \frac{1}{\text{focal length}}$$

$$\text{magnification} = \frac{\text{focal length of objective lens}}{\text{focal length of eyepiece lens}}$$

$$\text{speed of recession} = \text{Hubble constant} \times \text{distance}$$

$$\text{pressure} \times \text{volume} = \text{constant}$$

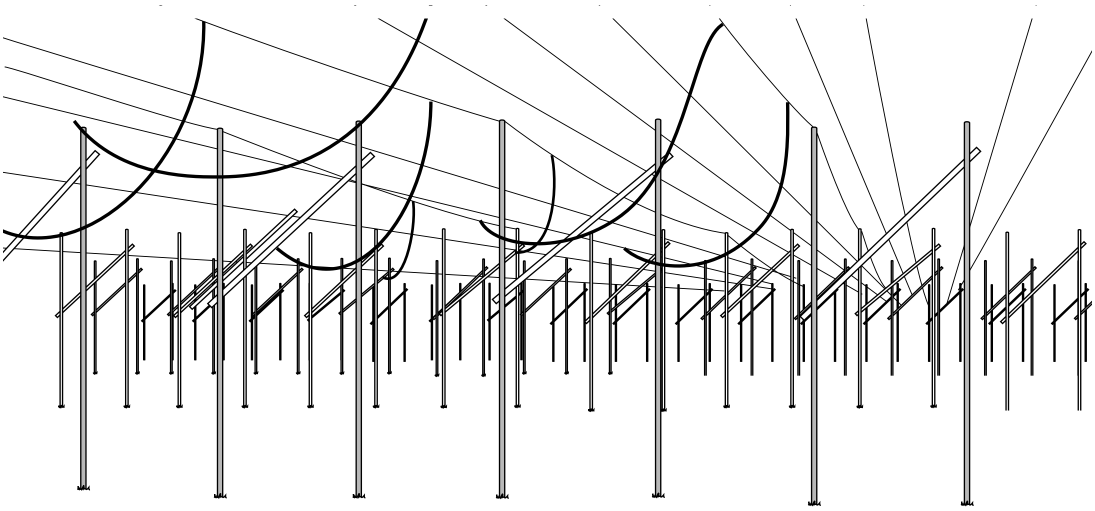
$$\frac{\text{pressure}}{\text{temperature}} = \text{constant}$$

$$\frac{\text{volume}}{\text{temperature}} = \text{constant}$$

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

Answer **all** the questions.

1 The picture shows a radio telescope.



In 1967 a scientist used a radio telescope and recorded a regular series of pulses, one every 1.33 seconds, coming from the sky. She took more readings over a number of nights. The signal came from a location that moved across the sky with the stars.

Observations made with another telescope confirmed the pulses existed, with the same location in the sky and with the same timing.

(a) Why did the scientist repeat the readings over a number of nights?

.... **[1]**

(b) At first the scientist thought the signal might be a fault in the radio telescope.

How could the scientist be sure this was not the explanation for the pulses?

....

.... **[1]**

(c) Some people suggested that this signal was from extraterrestrial life, an alien civilisation.

(i) Would it be a good idea to send a signal back to the alien civilisation?
You should justify your answer by considering the possible **advantages** and **disadvantages**.

....

....

....

....

.... **[3]**

(ii) What evidence of extraterrestrial life have scientists found?

.... **[1]**

(iii) Over the last few years scientists have found objects in space that they think make it much more likely that extraterrestrial life exists.

What objects have scientists found?

....

.... **[1]**

(d) The discovery of other sources giving off the pulses at different intervals led to a different explanation that involved spinning neutron stars.

How are neutron stars formed?

....

.... **[2]**

[Total: 9]

2 Most major astronomical observatories are in very isolated places on high mountains.

(a) Which **two** of the following are examples of places with major optical and infrared astronomical observatories?

Put (rings) around the **two** correct answers.

Canada **Canary Islands** **Chile** **London** **The North Sea**

[2]

(b) Explain why observatories are built on isolated high mountains. You should consider **both** advantages **and** disadvantages of the isolated high location. Suggest, with a justification, an alternative location.

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

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.... **[6]**

[Total: 8]

3 Johannes Kepler found a relationship between the distance from the Sun and the time it takes the planets to orbit the Sun.

The table shows data for some of the planets.

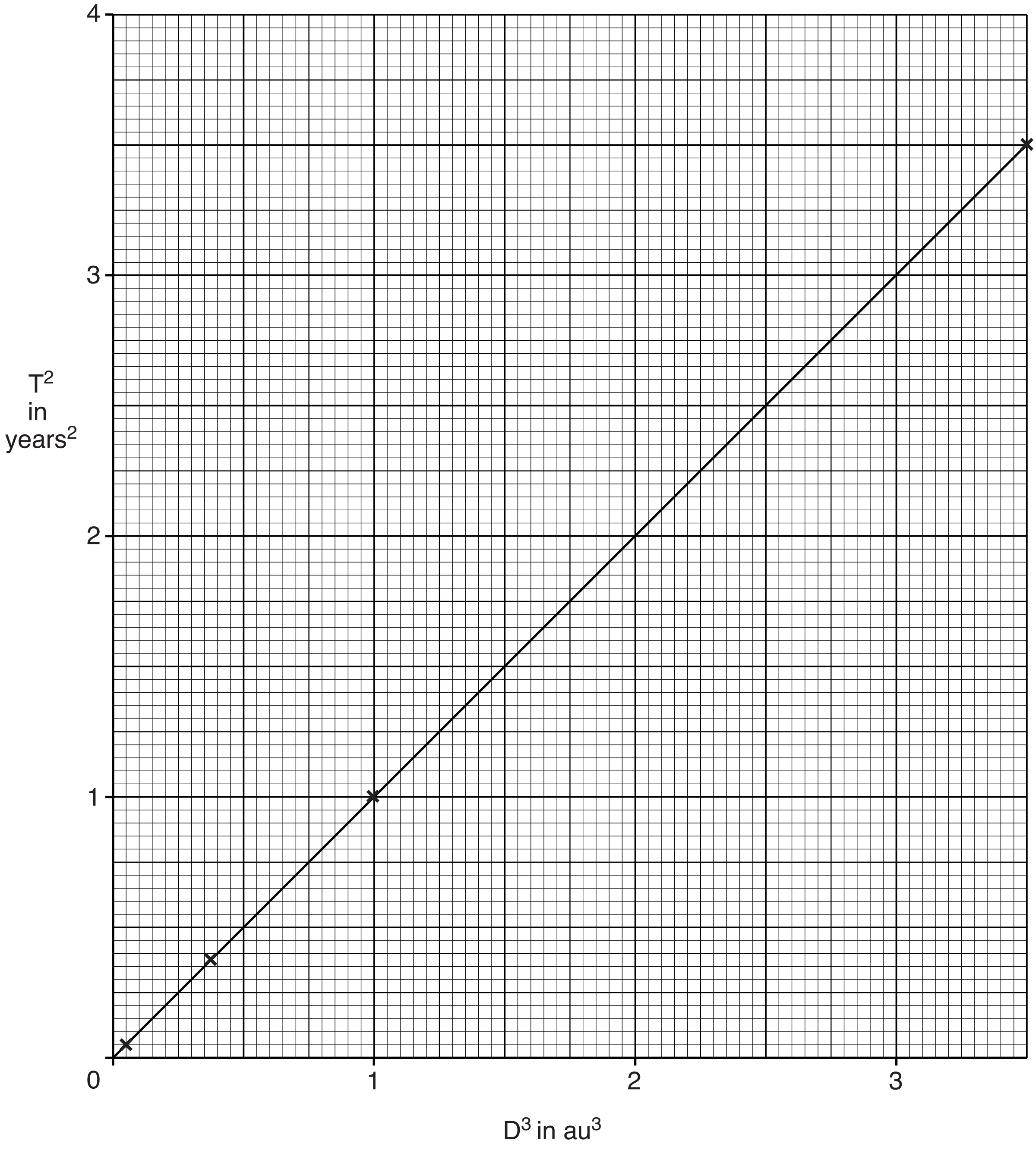
	Distance (D) from Sun in astronomical units (au)	**Time (T) to orbit the Sun in years**
Mercury	0.39	0.24
Venus	0.72	0.62
Earth	1.00	1.00
Mars	1.52	1.88

(a) Plot a graph of this data with distance **(D)** on the horizontal axis.
Include a line of best fit passing through the origin.

[4]

(b) Kepler said that T^2 was directly proportional to D^3.

This is a graph of T^2 against D^3 for the first four planets.



(i) Does this graph support Kepler's relationship?
Justify your answer.

....

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.... **[2]**

(ii) The asteroid Geographos has a mean orbital distance (D) from the Sun of 1.25 au.
Use the graph on the opposite page to find the time (T) it takes for the asteroid Geographos to orbit the Sun.

time to orbit Sun .... years **[3]**

(c) (i) Complete the table for Jupiter. Give your answers to **three** significant figures.

	Distance (D) from Sun in astronomical units (au)	**D^3 in au^3**	**Time (T) to orbit the Sun in years**	**T^2 in $years^2$**
Mercury	0.39	0.05	0.24	0.06
Venus	0.72	0.37	0.62	0.38
Earth	1.00	1.00	1.00	1.00
Mars	1.52	3.50	1.88	3.53
Jupiter	5.22	....	11.90	....
Saturn	9.54	868.00	29.50	870.00

[2]

(ii) Show that Saturn also fits Kepler's relationship.

[2]

(d) Here are some data about the Sun, Moon and stars.

	Distance from Earth	**Time to travel once across the sky**
Moon	380 000 km	27 days
Sun	150 000 000 km	24 hours
Stars	more than 3 light years	23 hours 56 minutes

John says that there must be a causal link between the distance and the time.
Is John correct?
Discuss John's conclusion.

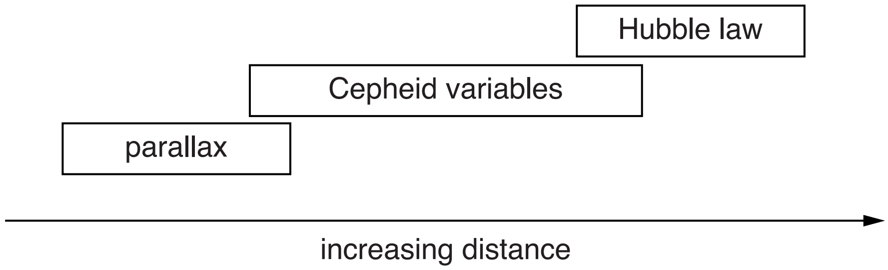
....

....

.... **[2]**

[Total: 15]

4 Astronomers sometimes refer to the ‘ladder of distance’ when talking about measuring the distance to astronomical objects.



Describe the **three** methods of measuring astronomical distances and explain how the Hubble law depends upon the other methods.

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

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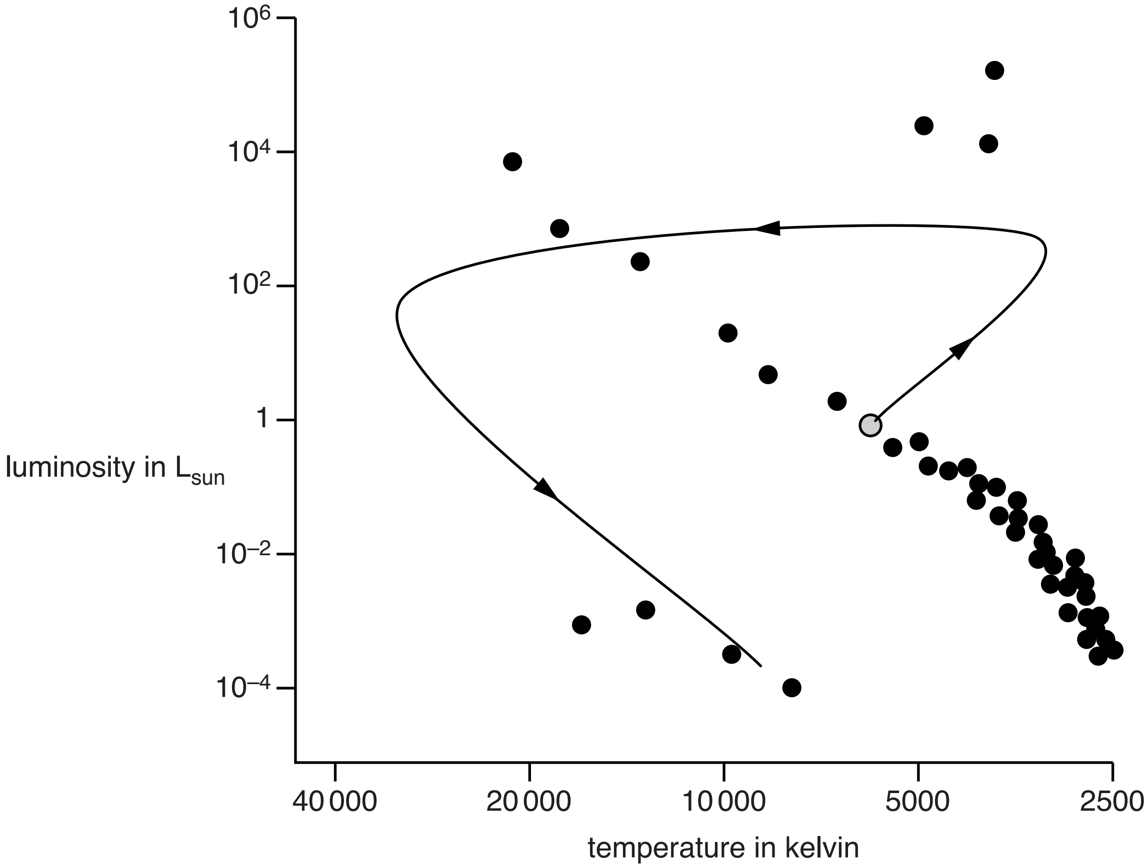
.... **[6]**

[Total: 6]

5 This graph is a Hertzsprung–Russell diagram.

The track on the graph shows most of the life of a star like the Sun.



(a) On the diagram, draw the track of a star with a **much higher** mass than the Sun. **[3]**

(b) Complete the following sentences about stars.
Use words from the list.

carbon **helium** **hydrogen** **iron** **uranium**

Stars with a low mass do not fuse elements with nuclei bigger than ....

These nuclei will fuse when the star is a red giant to form .... and some heavier nuclei like nitrogen and oxygen.

When a high mass star becomes a supernova it has a core that is made up of .... **[3]**

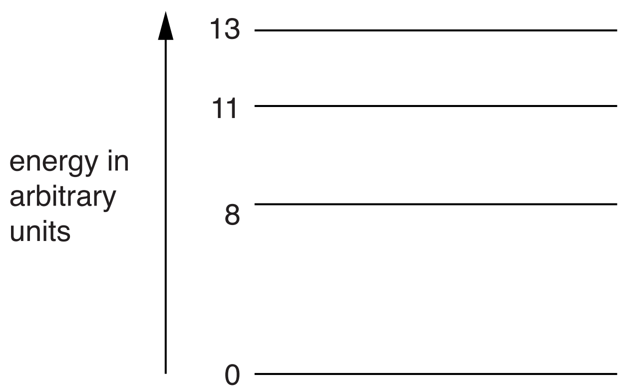
(c) Scientists can use spectral lines in the light from a star to detect the chemical elements in the star.

(i) Which statements explain how an atom can produce line spectra?
Put ticks (✓) in the boxes next to the **three** correct answers.

Electrons fuse with protons to emit energy.	☐
Electrons move between energy levels in an atom.	☐
Photons turn into electrons in atoms.	☐
A photon of a specific energy is emitted.	☐
The energy of the photon determines the frequency of the photon.	☐
The colour of the electron depends upon the photon.	☐
An atom is ionised when an electron is removed.	☐

[3]

(ii) Here is an energy level diagram for an atom.



What are possible energy values for photons that could be absorbed by this atom to form a spectral line?

Put (rings) around your answers.

5 **8** **19** **21** **32**

[2]

(d) Most of the energy produced by a star is from fusion in the core of the star.

(i) Name the **two** main ways that energy is transported to the surface of the star.

1 ....

2 ....

[2]

(ii) What is the name of the part of the Sun that emits radiation from its surface?

.... **[1]**

(iii) The temperature at the Sun's surface has been measured as 5778 K.
What is this temperature in Celsius?

temperature = ... °C **[2]**

[Total: 16]

6 A star forms from a cloud of gas.

Use the relationships between temperature, pressure and volume of a gas to explain how the conditions needed for the fusion of hydrogen come about during the formation of a star.

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

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.... **[6]**

[Total: 6]

END OF QUESTION PAPER

PLEASE DO NOT WRITE ON THIS PAGE