OCR
Oxford Cambridge and RSA

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Friday 23 June 2017 – 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. 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 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 **12** pages. Any blank pages are indicated.

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TWENTY FIRST CENTURY SCIENCE EQUATIONS

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

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

Observing the Universe

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

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

speed of recession = Hubble constant × distance

pressure × volume = constant

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

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

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

Answer **all** the questions.

1 A group of scientists and business people are deciding whether to build a space telescope or a telescope on a high, dry mountain.

The telescope is to observe infrared light.
Infrared light is absorbed by water in the atmosphere.

The group have the following information about estimated costs.

Building optics for space telescope.	£3500 million
Launching the telescope into space.	£80 million per tonne
Mass of space telescope to be launched.	6.5 tonnes
Other costs for space telescope.	£4000 million
Building a high mountain based telescope and observatory.	£1100 million

Suggest which type of telescope the group should build.

Use your knowledge and the data above to justify your conclusion.

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.... **[6]**

[Total: 6]

2 Sam has a telescope with a motor and computer controls.

(a) Sam inputs two numbers to tell the telescope where to point.

What are these two numbers?

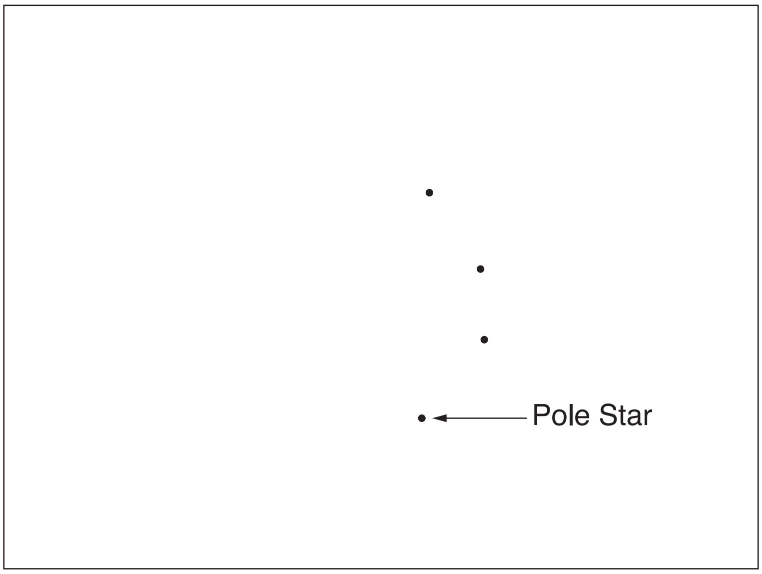
Put a (ring) around the correct answer.

angles **distances** **parallax** **heights** **[1]**

(b) Sam takes a photograph of the constellation of Ursa Minor and the Pole Star.

He knows the stars are faint so he sets the camera to take a picture over 6 hours. The stars show as lines on his photograph.

Draw the lines Sam saw on his photograph.



[4]

(c) Use words from the list to complete the following sentence about 'retrograde' motion.

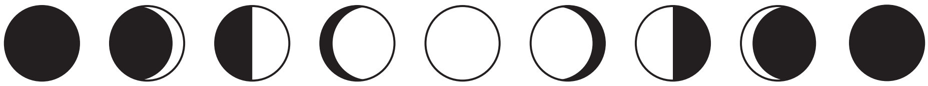
You may use each word once, more than once or not at all.

backwards **faster** **forwards** **galaxies** **planets** **slower** **stars** **Sun**

Retrograde motion is when .... appear to move ....

compared to their usual motion against the fixed .... **[3]**

(d) The Moon shows a cycle of phases.



Explain why we see the different phases and why the cycle repeats.
Use diagrams in your answer.

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.... **[3]**

(e) The Moon takes 27.3 days to orbit the Earth once.
The period of one cycle of the Moon's phases is 29.5 days.

Explain why these two periods are different.

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.... **[3]**

[Total: 14]

3 Astronomical telescopes make use of reflection, refraction and diffraction.

Describe and explain how these processes are used in astronomical telescopes.

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.... **[6]**

[Total: 6]

4 Tom and Gemma have made some measurements of a star.

(a) They want to publish their findings in a peer reviewed scientific journal.

Give an **advantage** of a peer reviewed scientific journal.

....

.... **[1]**

(b) Tom measured the temperature and size of the star. Gemma measured the parallax angle of the same star.

Describe each method of finding the distance to the star, and state and explain factors which limit their accuracy.

The actual distance to the star is 8 parsecs.

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.... **[6]**

[Total: 7]

5 As satellites orbit the Earth they are sometimes eclipsed by the Earth.

This means that the temperature of the satellite can change.

(a) A satellite stores some gas in a constant volume cylinder to act as a propellant.

(i) What will happen to the gas in the cylinder when the satellite moves out of shadow and into the sunlight?

Put (rings) around the correct answers.

Temperature of gas	**Pressure of gas**	**Volume of gas**
increases	increases	increases
decreases	decreases	decreases
stays the same	stays the same	stays the same

[2]

(ii) Explain why this happens.
Use ideas about particles in your answer.

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.... **[3]**

(b) When in the dark, the propellant gas is kept at a temperature of 250 K and the pressure is 1000 Pa. The volume of the container of the propellant gases is fixed.

Calculate the pressure when the temperature increases by 50 °C.

pressure = ... Pa **[3]**

[Total: 8]

6 Stars spend a large part of their lifetime on the main sequence.

Mass of star in solar masses	Surface temperature in K	Time spent on main sequence in millions of years
25	35 000	3
15	30 000	15
3	11 000	500
1.0	6 000	10 000
0.5	4 000	200 000

(a) (i) How can we tell these values must be based on theoretical calculations and not direct measurements?

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.... **[2]**

(ii) This statement is about the data in the table.

There is a correlation between the mass and the time spent on the main sequence, which is an inverse proportionality relationship.

Is this statement correct?
Justify your answer.

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.... **[4]**

(b) (i) What is happening in the core of a star when it is on the main sequence?

.... **[1]**

(ii) Stars leave the main sequence when the hydrogen in the core is used up.
Higher mass stars spend less time on the main sequence than lower mass stars.
Suggest why.

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.... **[3]**

[Total: 10]

7 **(a)** The luminosity of the star, Sirius A, is 9.9×10^{27} W.

(i) Calculate the mass converted to energy each second in Sirius A.
Speed of light = $3.0 \times 10^{8}\,\text{m}\,\text{s}^{-1}$.

mass = ... kg **[4]**

(ii) Sirius A is expected to spend about 2 billion years (2×10^{9} years) on the main sequence.

How much energy will Sirius A have radiated in that time? Give the units in your answer.
(1 year = 3.2×10^{7} seconds)

energy = ... units .... **[3]**

(b) Helium was first discovered in the Sun.

Which two statements explain how an element can be found in the Sun?

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

The Sun's line spectra is specific to an element.	☐
Elements can absorb specific frequencies of light.	☐
The luminosity of the Sun depends on the electromagnetic radiation emitted.	☐
The peak frequency of the Sun's radiation depends on the temperature of the Sun.	☐
The pattern of absorption lines in the Sun's spectrum depends on the elements present.	☐

[2]

[Total: 9]

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).