THIS IS A NEW SPECIFICATION

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RECOGNISING ACHIEVEMENT

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Monday 24 June 2013 – Morning

GCSE TWENTY FIRST CENTURY SCIENCE PHYSICS 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

- Your quality of written communication is assessed in questions marked with a pencil (✎).
- A list of useful relationships is printed on pages two and three.
- 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

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)** A lens works by bending the light rays that pass through it.

Complete the sentences that describe the process of refraction.

Use words from this list.

amplitude **frequency** **power** **speed** **wavelength**

As the light enters the glass of the lens the .... changes.

This results in a change in ....

However, the .... cannot change. **[3]**

(b) Here are some data on five lenses.

All the lenses are made from the same type of glass.

Lens	**Diameter in cm**	**Focal length in mm**
A	10	500
B	20	1000
C	6	1000
D	10	20
E	15	35

(i) Which two lenses would be the **best** to use to make a telescope.

objective lens ....

eyepiece lens .... **[2]**

(ii) Calculate the magnification of a telescope made using the lenses you chose in **(i)**.

magnification = ... **[2]**

(c) Two lenses have exactly the same size and shape.

Suggest how they can have different focal lengths.

.... **[1]**

(d) One problem with using a lens is that light of different wavelengths will produce a spectrum.

Explain how the edge of a lens can produce a spectrum.

Use a diagram to help you explain.

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.... **[2]**

(e) Explain why the aperture of a radio telescope must be much larger than the aperture of an optical telescope.

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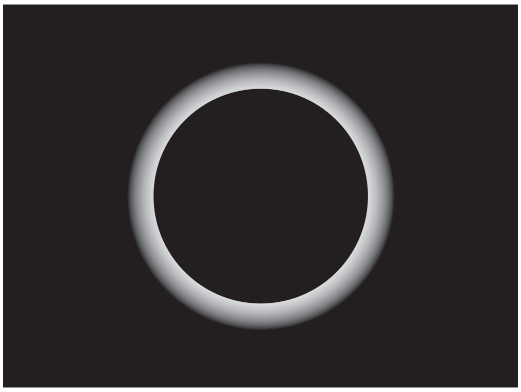
.... **[3]**

[Total: 13]

2 Solar eclipses are rare.



Explain solar eclipses and why they only occur infrequently.

Include diagrams in your answer.

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

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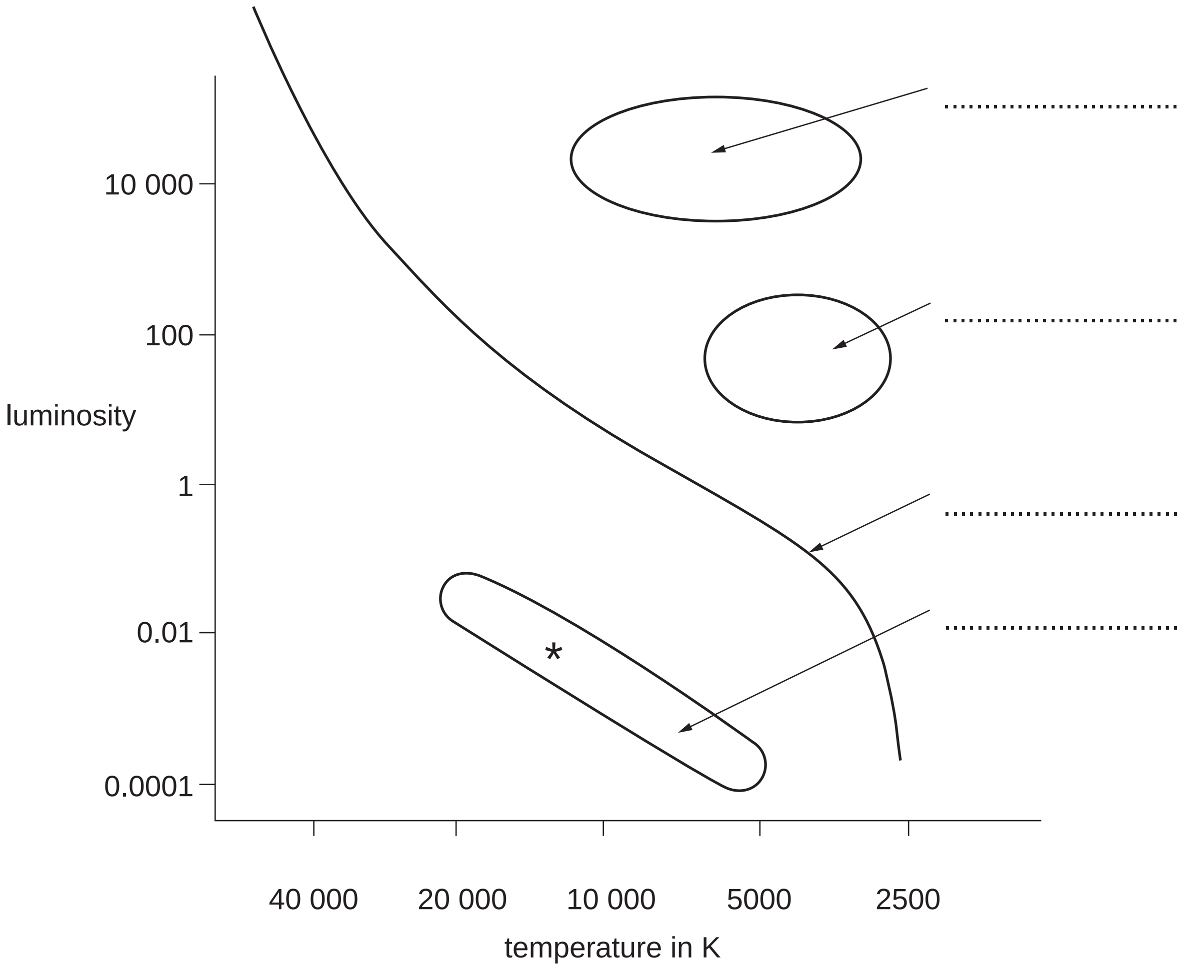
.... **[6]**

[Total: 6]

3 The graph shows a Hertzsprung-Russell diagram.



The luminosity of the Sun is 1.

(a) Complete the labels for the regions on the Hertzsprung-Russell diagram. **[4]**

(b) Put a cross on the Hertzsprung-Russell diagram to show the position of the Sun. **[1]**

(c) At the end of their lives most stars cool down and emit less and less energy.

Draw an arrow on the Hertzsprung-Russell diagram to show the direction the star (*) would move as it cools down and emits less energy. **[2]**

[Total: 7]

4 Scientists often disagree about how to interpret data. Additional data can often help them agree on the conclusion.

The Curtis-Shapley debate was an example of a disagreement. Additional evidence from Edwin Hubble resolved the problem.

Use this example to show how scientists can disagree about how to interpret data, until more evidence resolves the problem.

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

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.... **[6]**

[Total: 6]

5 Look at the data about some galaxies.

Galaxy location	**Distance in millions of light years**	**Speed away from Earth in light years per year**	**Time taken to travel the distance at a constant speed in millions of years**
Ursa Major	990	0.051	19 400
Corona Borealis	1440	0.072	20 000
Bootes	2740	0.131	....
Hydra	3960	0.198	....

(a) Complete the table. Assume that the speeds of each of the galaxies is constant. **[1]**

(b) How well do these data support the idea that the 'big bang' took place approximately 14 000 million years ago?

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.... **[4]**

[Total: 5]

6 Jo is researching a red giant star that is approximately the same mass as the Sun.

(a) Jo knows the surface temperature of the red giant is approximately 3400 K.

What is this temperature in °C?

temperature = ...°C **[2]**

(b) In a red giant the main source of energy is the fusion of helium nuclei in the **core**.

Explain how this shows that the core temperature of the red giant must be higher than the core temperature of the Sun.

....

....

....

.... **[2]**

(c) Which of the following elements are **not** produced by fusion in this low mass red giant?

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

carbon	☐
hydrogen	☐
iron	☐
nitrogen	☐
oxygen	☐

[2]

(d) What is likely to be the next stage in the life of this low mass red giant?

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

blue giant	☐
main sequence	☐
protostar	☐
supernova	☐
white dwarf	☐

[1]

[Total: 7]

7 Read this extract from an article.

> A telescope in Arizona has taken the clearest pictures ever taken from an Earth-based telescope. The images are three times sharper than those from the Hubble Space Telescope. The telescope uses adaptive optics.
>
> Adaptive optics compensate for some of the effects of the atmosphere by gently bending an ultra-thin secondary mirror that corrects the incoming light. This mirror is so thin that it can be bent into different shapes, as controlled by sensors that detect atmospheric distortions.

Suggest how the new adaptive optics affect the balance of advantages and disadvantages of ground-based and space-based telescopes.

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

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.... **[6]**

[Total: 6]

8 At the beginning of the 20th century, scientists could not explain how the Sun produced its energy.

However, the development of Einstein's equation $E=mc^2$ showed that energy could be released when mass is lost during nuclear fusion, where $c = 3 \times 10^8 m/s$.

(a) The luminosity of the Sun is about 3.90×10^{26} J/s.

(i) Use Einstein's equation to calculate the amount of mass lost each second by the Sun.

mass loss per second = ... kg/s **[3]**

(ii) The Sun will be on the main sequence for about 10 billion (10^{10}) years.

Assume that the only loss of mass from the Sun is due to the fusion of hydrogen.

How much mass will the Sun lose while it is on the main sequence?

mass loss = ... kg **[2]**

(b) Most of the energy produced in the Sun is from the fusion of hydrogen into helium by the proton-proton chain.

The proton-proton chain involves three stages.

$$ {}^{1}_{1}H + {}^{1}_{1}H \rightarrow {}^{2}_{1}H + e^{+} $$
$$ {}^{2}_{1}H + {}^{1}_{1}H \rightarrow {}^{3}_{2}He $$
$$ {}^{3}_{2}He + {}^{3}_{2}He \rightarrow {}^{4}_{2}He + {}^{1}_{1}H + {}^{1}_{1}H $$

(i) How many positrons (e^+) are emitted to produce a stable ^{4}He nucleus?

.... **[1]**

(ii) Why is a positron emitted in the first stage and not an electron?

.... **[1]**

[Total: 7]

9 **(a)** This question is about naked eye astronomy.

Which time is the shortest?

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

The time taken for the Moon to return to the same position in the sky. ☐

24 hours. ☐

The time taken for a star to return to the same position in the sky. ☐

The time for the Sun to return to its highest position in the sky. ☐

[1]

(b) How do astronomers describe the position of the Sun, Moon and stars in the sky?

....

....

.... **[2]**

[Total: 3]

END OF QUESTION PAPER

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