

Centre No.						Paper Reference						Surname	Initial(s)	
Candidate No.						6	P	H	0	5	/	1	Signature	

Paper Reference(s)

6PH05/1

Edexcel GCE

Physics

Unit 5: Physics from Creation to Collapse

Sample Assessment Material

Time: 1 hour 35 minutes

Examiner's use only

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Team Leader's use only

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Question Number	Leave Blank
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19	
Total	

Materials required for examination

Nil

Items included with question papers

Nil

Instructions to Candidates

In the boxes above, write your centre number, candidate number, your surname, initial(s) and signature. Check that you have the correct question paper.

Answer ALL the questions in Section A and Section B. Write your answers in the spaces provided in this question paper.

Some questions must be answered with a cross in a box (⊗). If you change your mind, put a line through the box (⊗) and then mark your new answer with a cross (⊗).

Information for Candidates

The marks for individual questions and the parts of questions are shown in round brackets: e.g. (4).

The total mark for this paper is 80. There are 19 questions in this paper.

There are 20 pages in this question paper. Any blank pages are indicated.

Advice to Candidates

Quality of written communication will be taken into account in the marking of your responses to Questions 18 and 19. These questions are indicated with an asterisk. Quality of written communication includes clarity of expression, the structure and presentation of ideas and grammar, punctuation and spelling.

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Turn over

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SECTION A

Answer **ALL** the questions in this section.

For each question, select one answer from A to D and put a cross in the box (☒). If you change your mind, put a line through the box (☒) and then mark your new answer with a cross (☒).

1. A valid set of units for specific heat capacity is

- A $\text{kg J}^{-1} \text{K}^{-1}$
- B kg J K^{-1}
- C $\text{kg}^{-1} \text{J K}^{-1}$
- D $\text{kg J}^{-1} \text{K}$

Q1

(Total 1 mark)

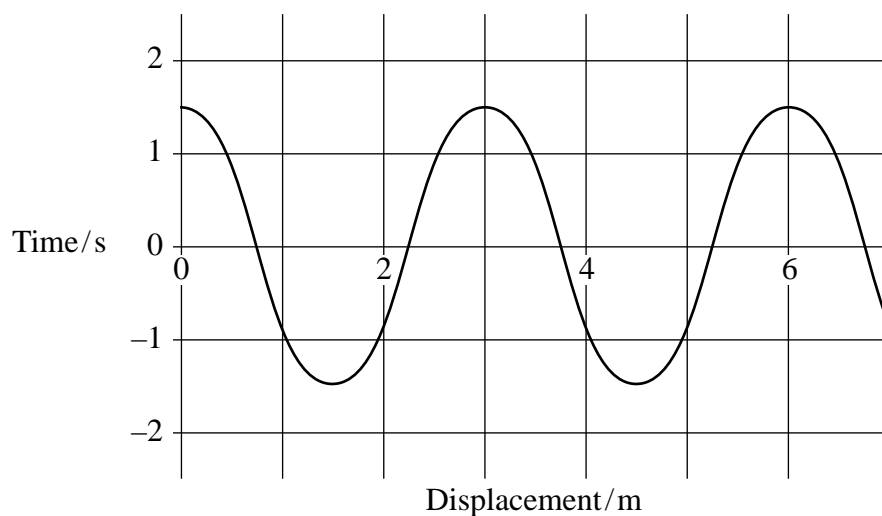
2. The gravitational field strength on the surface of the Earth is g . The gravitational field strength on the surface of a planet of twice the radius and the same density is

- A $4g$
- B $2g$
- C g
- D $g/4$

Q2

(Total 1 mark)

3. A child is playing on a swing. The graph shows how the displacement of the child varies with time.



The maximum velocity, in m s^{-1} , of the child is

- A $\pi/2$
- B π
- C 2π
- D 3π

Q3

(Total 1 mark)

4. Cosmic background radiation is a remnant of the big bang and appears to pervade the universe. It has a maximum wavelength in the microwave region of the electromagnetic spectrum. This can be calculated to correspond to a temperature of about 3 K. This calculation is based on the assumption that

- A the universe is spherical
- B the universe is expanding
- C space can be regarded as a black body
- D space is a vacuum

Q4

(Total 1 mark)

5. A student is asked: "What is meant by background radiation?"
She writes: "It is the radiation produced by the rocks in the ground."
This answer is

- A correct
- B incorrect – rocks do not produce radiation
- C incomplete
- D incorrect – this radiation would not be ionising

Q5

(Total 1 mark)

6. A car driver notices that her rear view mirror shakes a lot at a particular speed. To try to stop it she sticks a big lump of chewing gum on the back of the mirror.

Which one of the following statements is correct?

- A The mirror no longer shakes a lot because it is heavily damped.
- B The mirror stills shakes a lot at the same speed as before because the chewing gum does not change the damping.
- C The mirror shakes a lot at a different speed because the chewing gum changes the damping.
- D The mirror shakes a lot at a different speed because the chewing gum has changed the resonant frequency of the mirror.

Q6

(Total 1 mark)

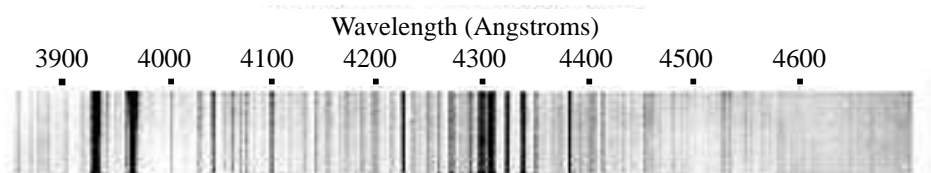
7. The x -axis of a Hertzsprung-Russell diagram is $\log T$. This is because

- A the range of temperatures of the surfaces of stars is large
- B the temperatures of the surfaces of stars are all very large numbers
- C the scale has to start with the hottest stars
- D the diagram would be impossible to interpret if $\log T$ was the y -axis

Q7

(Total 1 mark)

8. The spectrum of visible light from the Sun contains a number of dark lines known as Fraunhofer lines.



This is due to

- A polarisation caused by the atmosphere
- B absorption of light by atoms
- C refraction of light by telescopic lenses
- D the Doppler effect because atoms are moving very fast

(Total 1 mark)

Q8

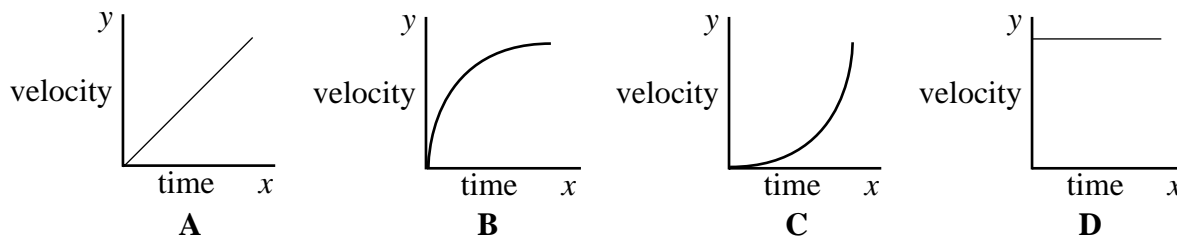
9. All quasars show large red shifts in the light received from them. This shows that they

- A have large diameters
- B are moving towards us at very high speeds
- C have a low temperature
- D are far away from earth

(Total 1 mark)

Q9

10. A space rocket takes off vertically from the surface of the Earth. Assuming the thrust remains constant which graph best represents the variation of velocity of the rocket with time if the universe expands forever it can be described as



- A
- B
- C
- D

(Total 1 mark)

Q10

TOTAL FOR SECTION A: 10 MARKS

SECTION B

Answer ALL the questions in this section.

11. An ideal gas is contained in a volume of $2.0 \times 10^{-3} \text{ m}^3$.

(a) Explain why the internal energy of an ideal gas is only kinetic.

.....

(2)

(b) The pressure of the gas is $1.2 \times 10^5 \text{ Pa}$ and its temperature is $27 \text{ }^\circ\text{C}$. Calculate the number of molecules of gas within this container.

Number of molecules =

(2)

(Total 4 marks)

Q11

12. Smoke detectors contain an alpha emitting source.

(a) Describe how you would determine whether this radioactive source emits alpha particles only.

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(4)

(b) State why smoke detectors do not provide a radiation risk in normal use.

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(1)

(Total 5 marks)

Q12

13. Two stars in the night sky appear equally bright to an observer. The Ancient Greeks thought that all stars were the same distance from the Earth. State and explain **two** reasons why these two stars do not need to be the same distance from the observer.

Reason One

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(2)

Reason Two

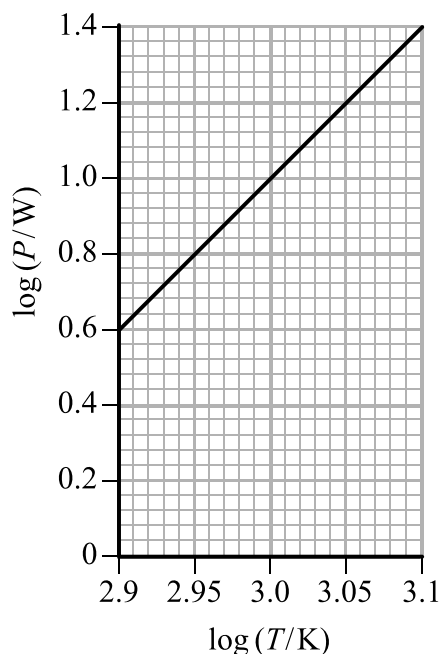
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(2)

(Total 4 marks)

Q13

14. The graph shows how the logarithm of the electrical power P supplied to a filament lamp varies with the logarithm of the temperature T of the filament.



(a) P is related to T by a power law: $P = k T^n$

Use the graph to determine n .

$n = \dots\dots\dots$
(2)

(b) A student suggests that this relationship is predicted by the Stefan-Boltzmann law.

Comment on this statement.

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(2)

Q14

(Total 4 marks)

15. The Hubble constant is thought to be about $70\,000\text{ m s}^{-1}\text{ Mpc}^{-1}$.

(a) Give one reason why the value of this constant is uncertain.

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(1)

(b) State how an estimate of the age of the Universe can be calculated from the Hubble constant.

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(1)

(c) Explain how the ultimate fate of the Universe is associated with the Hubble constant.

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(3)

(Total 5 marks)

Q15

16. Potassium-40 (${}_{19}\text{K}$) is unstable.

(a) Calculate the binding energy per nucleon for potassium-40.

Nuclear mass of potassium-40 = 39.953548 u

Mass of one neutron = 1.008 665 u

Mass of one proton = 1.007 276 u

Binding energy per nucleon =
(6)

(b) Explain what is meant by the random nature of nuclear decay.

.....

 (1)

(c) Scientists have worked out the age of the Moon by dating rocks brought back by the Apollo missions. They use the decay of potassium-40 to argon-40. The half-life of potassium-40 is 1.3×10^9 years.

(i) Show that the decay constant of potassium-40 is about $5 \times 10^{-10} \text{ y}^{-1}$.

.....

(1)

(ii) In one rock sample the scientists found $0.84 \mu\text{g}$ of argon-40 and $0.10 \mu\text{g}$ of potassium-40.

Calculate the age of the rock sample in years.

Age of rock =

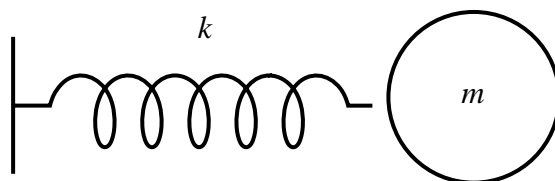
(4)

(Total 12 marks)

Q16

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17. Certain molecules such as hydrogen chloride (HCl) can vibrate by compressing and extending the bond between atoms. A simplified model ignores the vibration of the chlorine atom and just considers the hydrogen atom as a mass m on a spring of stiffness k which is fixed at the other end.



(a) (i) Show that the acceleration of the hydrogen atom, a , is given by $a = -\frac{kx}{m}$ where x is the displacement of the hydrogen atom.

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(2)

(ii) Hence derive the equation $T = 2\pi\sqrt{\frac{m}{k}}$ for the period of natural oscillations of the hydrogen atom.

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(2)

(b) Infrared radiation is used in chemical analysis.

Compared to other radiations, infrared radiation of wavelength $3.3 \mu\text{m}$ is strongly absorbed by hydrogen chloride gas. As a result of this absorption, the amplitude of oscillations of the hydrogen atoms significantly increases.

(i) What name is given to this phenomenon?

.....

 (1)

(ii) State the condition for it to occur.

.....

 (1)

(iii) Calculate the frequency of infrared radiation of wavelength $3.3 \mu\text{m}$.

Frequency =
 (2)

(iv) Hence calculate the stiffness of the hydrogen chloride bond.

Mass of hydrogen atom = $1.67 \times 10^{-27} \text{ kg}$

Stiffness =
 (3)

(Total 11 marks)

Q17

*18. (a) A planet of mass m orbits a star of mass M . The radius of orbit is r . By considering the force required for circular motion in this situation, show that the period T of the orbit is given by $T^2 = \frac{4\pi^2 r^3}{GM}$.

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(3)

(b) Measurements have shown that star HD70642 has a planet which orbits the star with a period of about 6 years. The radius of the orbit is about 3× the radius of the Earth’s orbit around the Sun.

(i) Use the formula in (a) to determine a value for the ratio $\frac{\text{mass of star HD70642}}{\text{mass of Sun}}$.

$$\frac{\text{mass of star HD70642}}{\text{mass of Sun}} = \dots\dots\dots (3)$$

(ii) Because of the presence of the planet, the star HD70642 does not remain at rest. Instead, the planet and star both orbit around their common centre of mass. Explain why the orbiting speed of the star is very small in comparison to the speed of the planet.

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(2)

(c) Astronomers discovered the planet by observing the “Doppler Wobble” effect. As the planet orbits the star, light from the star undergoes a Doppler shift in its frequency. Explain why this method is likely to only detect **very large** planets.

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(3)

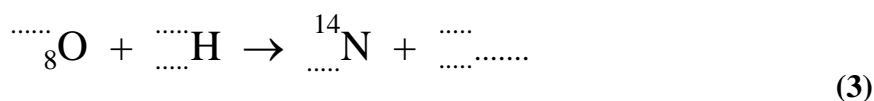
Q18

(Total 11 marks)

***19.** Read the following passage and answer the questions that follow.

A nova is a sudden brightening of a star. Novae are thought to occur on the surface of a white dwarf star which is paired with another star in a binary system. If these two stars are close enough to each other, hydrogen can be pulled from the surface of the star onto the white dwarf. Occasionally, the temperature of this new material on the surface of the white dwarf may become hot enough for the hydrogen to fuse to helium. This causes the white dwarf to suddenly become very bright. In a nova, this hydrogen fusion occurs by the “CNO” process, where helium-4 is produced by a series of steps in which protons react with various isotopes of Carbon, Nitrogen and Oxygen. Novae are used by astronomers as standard candles.

(a) Complete the equation which shows a typical part of the CNO process.



(b) What is a white dwarf? Suggest why hydrogen fusion in the white dwarf is likely to be the CNO process.

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(3)

- (c) The temperature required for these processes is 10^7 K.
 - (i) Calculate the mean kinetic energy, in keV, of the particles involved.

energy of particles = keV
(3)

- (ii) Explain how this temperature arises.

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(2)

- (d) Astronomers use novae as standard candles. Explain what a standard candle is, and suggest what this implies about the processes occurring in a nova.

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(3)

(Total 14 marks)

Q19

TOTAL FOR SECTION B: 70 MARKS
TOTAL FOR PAPER: 80 MARKS

END