

Physics
UNIT: 4PH1
PAPER: 2PR

Total Marks

Friday 14 June 2024 – Afternoon

Time: 1 hour 15 minutes

In the boxes below, write your name, centre number and candidate number.

Surname					
Other names					
Centre Number					
Candidate Number					

YOU MUST HAVE

Ruler, calculator, Equation Booklet (enclosed)

YOU WILL BE GIVEN

Diagram Booklet, Formulae Booklet

INSTRUCTIONS

Answer ALL questions.

Answer the questions in the spaces provided in this Question Paper or in the separate Diagram Booklet – there may be more space than you need.

Show all the steps in any calculations and state the units.

INFORMATION

The total mark for this paper is 70.

The marks for EACH question are shown in brackets – use this as a guide as to how much time to spend on each question.

There may be spare copies of some diagrams.

ADVICE

Read each question carefully before you start to answer it.

Write your answers neatly and in good English.

Try to answer every question.

Check your answers if you have time at the end.

Answer ALL questions.

Some questions must be answered with a cross in a box ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

1 This question is about stars.

Look at the diagram for Question 1 in the Diagram Booklet. It shows an incomplete Hertzsprung-Russell (H-R) diagram.

**(a) Label the axes on the diagram.
(2 marks)**

(b) There are three shaded areas on the diagram.

State the name of the shaded area that contains the Sun.

(1 mark)

(continued on the next page)

1 continued.

**(c) Which star is a white dwarf?
(1 mark)**

☐ **A**

☐ **B**

☐ **C**

☐ **D**

**(d) At a standard distance from the Earth, which star is brighter than the Sun and has a greater surface temperature than the Sun?
(1 mark)**

☐ **A**

☐ **B**

☐ **C**

☐ **D**

(Total for Question 1 = 5 marks)

2 This question is about nuclear fission and nuclear fusion.

- (a) Look at the table for Question 2(a) in the Diagram Booklet. It gives some statements about nuclear fission, or nuclear fusion, or both nuclear fission and nuclear fusion.**

Place ticks (✓) in the table to show which statements are about nuclear fission and which statements are about nuclear fusion.

(3 marks)

- (b) Nuclear fission reactors use control rods and a moderator.**

Describe the function of the control rods and the function of the moderator in a nuclear fission reactor.

(2 marks)

Answer space continues on the next page.

2(b) continued.

control rods

moderator

(Total for Question 2 = 5 marks)

- 3 A sample of liquid gallium is allowed to cool in a laboratory.**

The liquid gallium freezes to become a solid.

- (a) Look at the diagram for Question 3(a) in the Diagram Booklet. Complete the diagram by drawing the arrangement of particles in a liquid and the arrangement of particles in a solid.**

The first particle in each box has been drawn for you.

(4 marks)

(continued on the next page)

3 continued.

(b) The initial temperature of the sample of liquid gallium is 80°C

The freezing temperature of gallium is 30°C

The final temperature of the solid gallium is 20°C

Look at the graph for Question 3(b) in the Diagram Booklet. Complete the graph to show how the temperature of the gallium changes during the time that it cools to 20°C

**Add appropriate values to the temperature axis.
(3 marks)**

(Total for Question 3 = 7 marks)

4 Look at the photograph for Question 4 in the Diagram Booklet. It shows transmission cables used for long-distance transmission of electricity.

(a) Look at the diagram for Question 4(a) in the Diagram Booklet. It shows a power station and a school.

**Add to the diagram by drawing the structures needed to efficiently transfer energy from the power station to the school using electricity.
(3 marks)**

(continued on the next page)

4 continued.

- (b) Explain how the amount of current in the transmission cables increases the efficiency of the transmission of electricity.
(3 marks)**

(Total for Question 4 = 6 marks)

- 5 Look at the diagram for Question 5 in the Diagram Booklet. It shows the collision between two balls, **A** and **B**.

The masses and velocities of both balls are shown before and after the collision.

Ball **B** is stationary before the collision.

- (a) When the balls collide, ball **B** applies a force on ball **A**, which causes the velocity of ball **A** to change.

Ball **A** also applies a force on ball **B** during the collision.

Describe how the force applied on ball **A** compares with the force applied on ball **B** during the collision.
(2 marks)

Answer space continues on the next page.

5(a) continued.

(continued on the next page)

5 continued.

- (b) Calculate the momentum of ball **A** before the collision.
(2 marks)

momentum of ball **A** before collision

= _____ kg m/s

(continued on the next page)

Turn over

5 continued.

- (c) Show that the velocity, v , of ball **B** after the collision is about 0.6 m/s
(4 marks)**

(continued on the next page)

Turn over

5 continued.

- (d) A collision is considered elastic if the total kinetic energy before the collision is equal to the total kinetic energy after the collision.**

Using data from the diagram, deduce whether this collision is elastic.

(4 marks)

(Total for Question 5 = 12 marks)

Turn over

6 This question is about generating electricity from renewable energy resources.

(a) Look at the photographs for Question 6(a) in the Diagram Booklet. Photograph 1 shows a solar farm in the United Kingdom and photograph 2 shows a geothermal power station in Iceland.

Discuss the advantages and disadvantages of generating electricity using solar power and geothermal resources.

(4 marks)

Answer space continues on the next page.

6(a) continued.

(continued on the next page)

6 continued.

- (b) A student investigates how the amount of light affects the output voltage of a solar cell.**

Look at the image for Question 6(b) in the Diagram Booklet. It shows how the student sets up their equipment.

- (i) The student varies the distance between the solar cell and the lamp and measures the output voltage of the solar cell at each distance.**

Look at the table for Question 6(b)(i) in the Diagram Booklet. The student's results are shown.

(continued on the next page)

6(b)(i) continued.

**Draw a table showing the student's results.
(3 marks)**

(continued on the next page)

Turn over

6(b) continued.

- (ii) Give a control variable for the student's investigation.
(1 mark)**
-
-

- (iii) The student states that the solar cell could be used as a power source for the lamp.**

They suggest that this would work if

- **the solar cell is connected directly to the lamp**
- **the light from the lamp is used to produce the output power from the solar cell**

(continued on the next page)

6(b)(iii) continued.

**Explain, with reference to the principle of conservation of energy, why the student's suggestion would not work.
(2 marks)**

(Total for Question 6 = 10 marks)

- 7** Look at the diagram for Question 7 in the Diagram Booklet. It shows two students doing an experiment to measure the speed of sound in air.

This is their method.

- both students stand **100 m** away from a large flat wall
- student **A** makes a sound by hitting two blocks of wood together
- the sound waves travel to the wall and reflect back to the students as an echo
- student **A** hits the blocks together again when the echo is heard
- student **A** continues to hit the blocks together every time an echo is heard
- student **B** starts a timer when the blocks are hit together and stops the timer when the blocks have been hit together 20 more times

(continued on the next page)

7 continued.

(a) Give a reason why the students do not stand nearer to the wall.

(1 mark)

(continued on the next page)

7 continued.

(b) The students repeat their method five times.

Look at the table for Question 7(b) in the Diagram Booklet. It shows the students' results.

(i) The students decide that one of their tests shows an anomalous result.

**Circle the anomalous result in the table.
(1 mark)**

**(ii) Suggest a reason for the anomalous result.
(1 mark)**

(continued on the next page)

7(b) continued.

(iii) Calculate the mean time between starting and stopping the timer.

Give your answer to a suitable number of decimal places.

(3 marks)

mean time = _____ s

(continued on the next page)

Turn over

7(b) continued.

- (iv) The speed of sound in air can be calculated using the formula

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

Use the students' results to calculate a value for the speed of sound in air.
(3 marks)

speed of sound = _____ m/s

(Total for Question 7 = 9 marks)

8 Look at the diagram for Question 8 in the Diagram Booklet. It shows a machine that can be used to measure the speed of fast-moving protons.

(a) At the start, the proton is attracted towards a negatively charged plate.

**(i) Give a reason why the proton is attracted to the negatively charged plate.
(1 mark)**

(continued on the next page)

8(a) continued.

- (ii) The proton accelerates at $1.90 \times 10^{11} \text{ m/s}^2$
from rest to a speed of $1.38 \times 10^5 \text{ m/s}$

Show that the time taken for this acceleration is
about $7 \times 10^{-7} \text{ s}$
(3 marks)

(continued on the next page)

Turn over

8 continued.

- (b) The proton passes through a hole in the negatively charged plate and enters an area where there is a magnetic field.**

The magnetic field exerts a force on the proton, as shown in the diagram.

This force causes the proton to follow a circular path without changing speed.

- (i) Give the direction of the magnetic field.
(1 mark)**

(continued on the next page)

8(b) continued.

- (ii) Suggest how increasing the strength of the magnetic field will affect the proton when it is moving in the magnetic field.
(2 marks)**

(Total for Question 8 = 7 marks)

9 An oscilloscope can be used to determine the frequency of a sound wave.

(a) Give the name of the piece of apparatus that must be connected to the oscilloscope to detect the sound wave.

(1 mark)

(b) Look at the diagram for Question 9(b) in the Diagram Booklet. It shows the screen of the oscilloscope and the oscilloscope settings.

A sound wave of frequency 250 Hz is detected.

The sound wave produces a trace on the oscilloscope of amplitude 4 V

Complete the diagram by drawing the trace of this sound wave on the oscilloscope screen.

(5 marks)

(continued on the next page)

9 continued.

- (c) Look at the graph for Question 9(c) in the Diagram Booklet. It shows how the wavelength of sound waves in air varies with their frequency.**

If wavelength and frequency are inversely proportional, then

$$\text{wavelength} \times \text{frequency} = \text{constant}$$

Using the graph, evaluate whether the wavelength of sound waves in air is inversely proportional to their frequency.

(3 marks)

Answer space continues on the next page.

9(c) continued.

(Total for Question 9 = 9 marks)

TOTAL FOR PAPER = 70 MARKS
END OF PAPER