

Physics

Advanced

PAPER 2: Advanced Physics II

Monday 9 June 2025 – Morning

Time: 1 hour 45 minutes

Question Paper

THIS DOCUMENT MUST BE RETURNED TO
PEARSON AT THE END OF THE EXAMINATION

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

Surname					
Other names					
Centre Number					
Candidate Number					

YOU MUST HAVE

Scientific calculator and ruler

Data, Formulae and Relationships Booklet (enclosed)

YOU WILL BE GIVEN

Diagram 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.

INFORMATION

The total mark for this paper is 90.

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

(continued on the next page)

INFORMATION continued.

In the question marked with an ASTERISK (*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.

There may be spare copies of some diagrams.

ADVICE

Read each question carefully before you start to answer it.

Try to answer every question.

Check your answers if you have time at the end.

You are advised to show your working in calculations, including units where appropriate.

Answer ALL questions.

All multiple choice questions must be answered with a cross in the box $\boxtimes$ for the correct answer from A to D. If you change your mind about an answer, put a line through the box $\boxtimes$ and then mark your new answer with a cross $\boxtimes$.

1 Which of the following gives the SI base units of stress?

☐ A kg m s^{-2}

☐ B $\text{kg m}^{-1} \text{s}^{-2}$

☐ C N m^{-2}

☐ D Pa

(Total for Question 1 = 1 mark)

2 Which of the following provides evidence for the particle nature of electromagnetic radiation?

- ☐ **A diffraction**
- ☐ **B interference**
- ☐ **C photoelectric effect**
- ☐ **D polarisation**

(Total for Question 2 = 1 mark)

- 3 Look at the diagram for Question 3 in the Diagram Booklet. Light enters a semicircular glass block, as shown. The ray of light reaches the straight edge of the block at an angle of incidence θ

The critical angle for glass is C .

Which of the following statements for light incident at the straight edge of the block is correct?

- ☐ A When θ is greater than C , then no light is reflected.
- ☐ B When θ is greater than C , then no light is transmitted.
- ☐ C When θ is less than C , then no light is reflected.
- ☐ D When θ is less than C , then no light is transmitted.

(Total for Question 3 = 1 mark)

- 4 Scientists believe that our universe is currently expanding. One possible fate is for the universe to reach a maximum size and then start to contract.**

Which of the following descriptions of a universe with this fate is correct?

- ☐ **A a closed universe**
- ☐ **B a critical universe**
- ☐ **C a flat universe**
- ☐ **D an open universe**

(Total for Question 4 = 1 mark)

- 5 **X** and **Y** are identical stars. When viewed from Earth the intensity of star **X** is four times the intensity of star **Y**.

Which of the following explanations is possible?

- ☐ A **X** is twice as far away as **Y**.
- ☐ B **X** is four times as far away as **Y**.
- ☐ C **Y** is twice as far away as **X**.
- ☐ D **Y** is four times as far away as **X**.

(Total for Question 5 = 1 mark)

- 6 Look at the diagram for Question 6 in the Diagram Booklet. A trolley is attached to two springs and set into horizontal oscillation, as shown.

The kinetic energy of the trolley is E_k , and the potential energy of the trolley is E_p

Which row of the table is correct?

	Trolley at equilibrium position	Trolley at maximum displacement
☐ A	E_k is a maximum	E_p is minimum
☐ B	E_k is a maximum	E_p is a maximum
☐ C	E_k is zero	E_p is a maximum
☐ D	E_k is zero	E_p is minimum

(Total for Question 6 = 1 mark)

- 7 A small ball bearing falls slowly through a liquid at terminal velocity. The temperature of the liquid is increased.

Which row of the table shows the change in viscosity of the liquid and the change in terminal velocity of the ball bearing?

	Viscosity of liquid	Terminal velocity of ball bearing
☐ A	increases	increases
☐ B	increases	decreases
☐ C	decreases	increases
☐ D	decreases	decreases

(Total for Question 7 = 1 mark)

- 8 Some rocks contain polonium. The polonium is radioactive, and decays to a stable isotope of lead.**

Look at the graphs for Question 8 in the Diagram Booklet. Which of the graphs shows how the number **N of lead atoms produced from the decay of polonium varies with time?**

☐ **A graph A**

☐ **B graph B**

☐ **C graph C**

☐ **D graph D**

(Total for Question 8 = 1 mark)

- 9 Look at the diagram for Question 9 in the Diagram Booklet. Light from a lamp passes through two polarising filters, P_1 and P_2 , as shown. The light intensity is recorded by a detector.**

The filters initially have their planes of polarisation parallel.

Both filters are rotated in the same direction.

(continued on the next page)

9 continued.

Which row of the table gives the changes that result in the minimum intensity of light at the detector?

	Rotation of P_1 / rad	Rotation of P_2 / rad
☐ A	$\frac{\pi}{4}$	$\frac{\pi}{2}$
☐ B	$\frac{\pi}{4}$	π
☐ C	$\frac{\pi}{2}$	π
☐ D	$\frac{\pi}{2}$	$\frac{3\pi}{2}$

(Total for Question 9 = 1 mark)

- 10** Look at the diagram for Question 10 in the Diagram Booklet. It shows how displacement varies with distance for two waves, **X** and **Y**, at a particular instant. The waves are travelling to the right.

Which of the following statements describes the phase relationship between the two waves?

- ☐ **A** **X** leads **Y** by 90°
- ☐ **B** **X** leads **Y** by 180°
- ☐ **C** **Y** leads **X** by 90°
- ☐ **D** **Y** leads **X** by 180°

(Total for Question 10 = 1 mark)

- 11 A spectral line with wavelength 655.88 nm is detected on Earth from the Triangulum Galaxy. The wavelength of this spectral line measured using a laboratory source is 656.28 nm**

Calculate the velocity of the Triangulum Galaxy relative to the Earth.

(3 marks)

Answer space continues on the next page.

11 continued.

Magnitude of velocity = _____

Direction = _____

(Total for Question 11 = 3 marks)

- 12 Look at the diagram for Question 12 in the Diagram Booklet. The image from the cover of a music album is represented.**

White light enters the prism at an angle of incidence of 45° . The light disperses and splits into a spectrum of colours as it enters the prism.

In this image the angle of refraction for violet light at the first boundary is 22° . The angle between the red light and the violet light is 11°

Evaluate whether the angle between the red light and the violet light is accurate.

(4 marks)

$$\frac{\text{speed of violet light in prism}}{\text{speed of red light in prism}} = 0.99$$

Answer space continues on the next page.

12 continued.

(Total for Question 12 = 4 marks)

13 A teacher demonstrated the photoelectric effect by illuminating a zinc plate with electromagnetic radiation.

When ultraviolet radiation of wavelength 320 nm was incident upon the zinc plate, electrons were emitted from the zinc surface.

When visible light of wavelength 420 nm was incident upon the zinc plate, no effect was observed.

Explain these observations. Your answer should include calculations.

(5 marks)

work function of zinc = 3.74 eV

Answer space continues on the next page.

13 continued.

[illegible]

(Total for Question 13 = 5 marks)

Turn over

- *14 Look at Diagram 1 for Question 14 in the Diagram Booklet. Air molecules are trapped in a container by a piston, as shown.**

Look at Diagram 2 for Question 14 in the Diagram Booklet. The position of the piston is adjusted so that the volume available to the air molecules is reduced. The temperature of the air stays constant.

Explain how the pressure exerted by the air changes. You should refer to the motion of the air molecules. (6 marks)

Answer space continues on the next 2 pages.

14 continued.

[illegible]

Turn over

14 continued.

(Total for Question 14 = 6 marks)

- 15 A pulsar is a rotating neutron star. The pulsar emits electromagnetic radiation as it rotates.

Scientists have recently detected the highest ever energy gamma ray photons received from a pulsar.

- (a) The energy of one of these gamma ray photons was determined to be $2.0 \times 10^{13} \text{ eV}$

Calculate the wavelength of these gamma rays.
(4 marks)

Answer space continues on the next page.

15(a) continued.

Wavelength = _____

(continued on the next page)

15 continued.

- (b) The pulsar is estimated to be travelling away from the Earth with a velocity of 750 m s^{-1}**

State why this motion away from the Earth does not significantly affect the wavelength of radiation received at the Earth.

(1 mark)

(Total for Question 15 = 5 marks)

- 16 The closest distance from the eye where light from an object can be brought to a focus is known as the near point distance. The near point distance for a human eye is taken to be 25 cm**

A long-sighted eye has a near point distance greater than 25 cm. This may cause problems with focusing on near objects.

A converging lens can be used to correct this problem. The converging lens forms an image of a near object at the actual near point distance of the long-sighted eye.

- (a) State the type of image formed by the converging lens when used to correct a long-sighted eye.**
(1 mark)
-
-

(continued on the next page)

16 continued.

(b) The near point distance for a long-sighted eye is 65 cm

Calculate the power, in dioptries, of the converging lens required.

(3 marks)

Power of converging lens = _____ D

(continued on the next page)

Turn over

16 continued.

- (c) A diverging lens can also be used to correct problems with eyesight.**

Look at the axes for Question 16(c) in the Diagram Booklet. Draw a ray diagram on the axes to show the formation of the image of a distant object by a diverging lens. F marks the position of each principal focus of the lens.

(3 marks)

(Total for Question 16 = 7 marks)

17 The asteroid Bennu is in an approximately circular orbit around the Sun. Scientists consider that Bennu may collide with Earth within the next century.

(a) In 2060 Bennu will be 7.49×10^8 m from the Earth.

(i) Show that the mass of Bennu is about 7.8×10^{10} kg

mean radius of Bennu = 245 m

average density of Bennu = 1260 kg m^{-3}

(3 marks)

17(a) continued.

(ii) Calculate the magnitude of the force **F**
between Bennu and Earth in 2060.

mass of Earth = 5.98×10^{24} kg

(2 marks)

F = _____

(continued on the next page)

17 continued.

- (b) The orbital time of Bennu around the Sun is 1.17 years.**

Calculate the mass of the Sun.

**average distance of Bennu from the Sun =
 $1.70 \times 10^{11} \text{ m}$**

mass of Bennu = $7.8 \times 10^{10} \text{ kg}$

1 year = $3.15 \times 10^7 \text{ s}$

(4 marks)

Answer space continues on the next page.

Turn over

17(b) continued.

Mass of Sun = _____

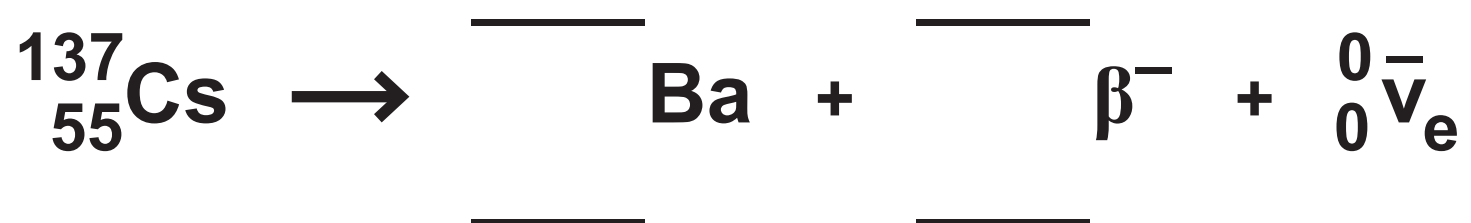
(Total for Question 17 = 9 marks)

- 18 Glaciers are massive bodies of slowly moving ice. Over time, a fine sediment forms on the surface of a glacier. The sediment contains radioactive isotopes.

Caesium-137, ^{137}Cs , is a common radioisotope found in the sediment.

- (a) Complete the following nuclear equation to represent the decay of caesium.

(2 marks)



18 continued.

(b) The concentration of ^{137}Cs on a Norwegian glacier was investigated.

half-life of $^{137}\text{Cs} = 9.5 \times 10^8 \text{ s}$

(i) The activity of ^{137}Cs was determined to be $2.5 \times 10^4 \text{ Bq}$ per kg of sediment.

Calculate the number of atoms of ^{137}Cs in 1 kg of sediment.

(3 marks)

Answer space continues on the next page.

18(b)(i) continued.

Number of atoms of ^{137}Cs = _____

(continued on the next page)

18(b) continued.

(ii) Calculate the time taken for 10% of the ^{137}Cs atoms to have decayed.

(2 marks)

Time taken = _____

(Total for Question 18 = 7 marks)

Turn over

- 19 Look at the photograph for Question 19 in the Diagram Booklet. It shows a giant ice sculpture of the Elizabeth Tower (Big Ben). The ice sculpture was installed in St Pancras station in London in 2009.**

Look at the diagram for Question 19 in the Diagram Booklet. The ice sculpture can be approximated as a regular cuboid, as shown.

- (a) Show that the mass of the ice sculpture is about $2.2 \times 10^5 \text{ kg}$**

**density of ice = 920 kg m^{-3}
(2 marks)**

Answer space continues on the next page.

19(a) continued.

(continued on the next page)

19 continued.

- (b) (i) Look at the diagram for Question 19(b)(i) in the Diagram Booklet. It is claimed that 1% of the ice would melt if the ice sculpture were in direct sunlight continuously for 12 hours. Assume that radiation, of intensity I , from the Sun is directly incident upon the top of the sculpture, as shown.**

Deduce whether this claim is correct.

initial temperature of ice sculpture = -20°C

intensity of the Sun = 1350 W m^{-2}

specific heat capacity of ice =

$2.09 \times 10^3\text{ J kg}^{-1}\text{ K}^{-1}$

specific latent heat of ice = $3.34 \times 10^5\text{ J kg}^{-1}$

(6 marks)

Answer space continues on the next 2 pages.

19(b)(i) continued.

[illegible]

Turn over

19(b)(i) continued.

(continued on the next page)

19(b) continued.

- (ii) Give TWO reasons why your analysis of the situation may be incorrect.
(2 marks)**

(Total for Question 19 = 10 marks)

20 Look at the photograph for Question 20 in the Diagram Booklet. It shows the Petronas Twin Towers in Kuala Lumpur, which are the world's tallest twin buildings.

(a) Each tower is supported by 16 cylindrical concrete columns.

Calculate the stress at the base of each cylindrical concrete column.

mass of each tower = 3.0×10^8 kg

diameter of each column = 2.4 m

(5 marks)

Answer space continues on the next page.

20(a) continued.

Stress at the base of each column = _____

(continued on the next page)

20 continued.

(b) Tall buildings sway in the wind. The design of the Petronas Towers permits safe movement of the towers.

(i) The towers were designed to permit a maximum horizontal displacement of 0·90 m at the top of the towers. The natural frequency of each tower is 0·17 Hz

Calculate the maximum velocity at the top of one of the towers when the tower is oscillating at its natural frequency.

(3 marks)

Answer space continues on the next page.

Turn over

20(b)(i) continued.

Maximum velocity at the top of the tower =

(continued on the next page)

20(b) continued.

- (ii) The twin towers were linked together to improve the response of the building to strong winds.**

Look at the graph for Question 20(b)(ii) in the Diagram Booklet. It shows how the maximum displacement X varies with the frequency f for a single tower and for two linked towers.

Explain the behaviour of a single tower compared with the behaviour of the linked towers.

(3 marks)

Answer space continues on the next page.

20(b)(ii) continued.

(Total for Question 20 = 11 marks)

21 All objects with a temperature above absolute zero emit a spectrum of electromagnetic radiation.

(a) State what is meant by absolute zero.

(1 mark)

(b) Look at the graph for Question 21(b) in the Diagram Booklet. It shows how the intensity of radiation emitted by the Earth varied with wavelength in 2020.

Explain the differences between this graph and a graph representing the emission of radiation by the Earth in 2050. Assume that the average global temperature increases over time.

(4 marks)

Answer space begins on the next page.

21(b) continued.

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

21 continued.

- (c) At the end of the 19th century, Wien investigated the radiation emitted by hot objects and formulated a law.**

The table shows data for some stars.

Star	$\lambda_{\text{max}}/\text{nm}$	T / K
Bellatrix	132	21 500
Rigel	245	11 600
Sirius	287	9910

Deduce whether Wien's law is confirmed by this data.
(3 marks)

Answer space continues on the next page.

Turn over

21(c) continued.

(continued on the next page)

21 continued.

- (d) Look at the Hertzsprung–Russell diagram for Question 21(d) in the Diagram Booklet. It shows part of the main sequence of stars. The star Sirius A is marked on the diagram.**

On a website it states that the radius of Sirius A is twice the radius of the Sun.

**Deduce whether this statement is correct.
(5 marks)**

radius of the Sun = 6.96×10^8 m

surface temperature of the Sun = 5800 K

Answer space continues on the next page.

21(d) continued.

(Total for Question 21 = 13 marks)

TOTAL FOR PAPER = 90 MARKS

END OF PAPER