Paper Reference(s) 9PH0/03

Pearson Edexcel Level 3 GCE

Total Marks

Physics

Advanced

PAPER 3: General and Practical Principles in Physics

Tuesday 17 June 2025 – Morning

Time: 2 hours 30 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					

Pearson

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 120.

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

In questions 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 in the spaces provided.

1 A student investigated the variation of current with applied potential difference (p.d.) for a filament bulb. Under normal working conditions the potential difference across the bulb is 3·0 V

(a) Look at the circuit diagram for Question 1(a) in the Diagram Booklet. It shows the circuit the student used.

Comment on the suitability of the student's circuit. (3 marks)

Answer space continues on the next page.

1(a) continued.

(continued on the next page)

1 continued.

(b) When the p.d. across the bulb was 3·0 V, the student recorded a value of 1·29 A for the current.

In his conclusion he stated

This will give an accurate value for the working resistance, as the value of current is precise.

Assess the validity of the student's statement. You do not need to carry out a calculation.
(4 marks)

Answer space continues on the next page.

1(b) continued.

(Total for Question 1 = 7 marks)

2 Look at the diagram for Question 2 in the Diagram Booklet. A transmitter produces microwaves with a frequency of 10·7 GHz

The microwaves are directed towards a metal plate.

A microwave receiver R is placed between the transmitter and the metal plate, as shown.

When R is moved along the line AB, the intensity of microwaves received is observed to increase from minimum to maximum a number of times. The distance between successive minima is about 1·5 cm

Explain these observations. Your answer should include a calculation.

(5 marks)

Answer space continues on the next page.

2 continued.

(Total for Question 2 = 5 marks)

3 Look at Diagram 1 for Question 3 in the Diagram Booklet. A student uses a digital balance. She sets the balance to zero and then places a prism on the balance, as shown.

Look at Diagram 2 for Question 3 in the Diagram Booklet. A uniform metre rule is pivoted at its **5·0 cm** mark. The metre rule is then supported horizontally at the **30·0 cm** mark by the prism, as shown.

(a) (i) The metre rule is in equilibrium.

Explain why the increase in mass recorded by the balance is not equal to the mass of the metre rule.
(2 marks)

Answer space continues on the next page.

3(a)(i) continued.

(continued on the next page)

3(a) continued.

(ii) Calculate the weight of the metre rule.

You should take moments about the pivot.

(4 marks)

Answer space continues on the next page.

3(a)(ii) continued.

_____

_____

_____

Weight of metre rule = _____

(continued on the next page)

3 continued.

(b) The student wants to reduce the percentage uncertainty in the value obtained for the weight of the metre rule.

The student repeated her determination of the weight of the metre rule. She moved the prism towards the centre of gravity of the metre rule before taking moments about the pivot.

Deduce whether the percentage uncertainty in the value obtained for the weight of the metre rule is reduced by the student moving the prism. No calculations are required.
(3 marks)

Answer space continues on the next page.

3(b) continued.

(Total for Question 3 = 9 marks)

4 Two students, A and B, used a cobalt-60 source to investigate the inverse square law for a gamma radiation source. Cobalt-60 is a pure gamma emitter.

(a) The cobalt-60 source was placed in a source holder. A Geiger-Müller (GM) tube was connected to a counter and placed a short distance d away.

(i) Look at Diagram 1 for Question 4(a)(i) in the Diagram Booklet. Student A set up the apparatus as shown.

Look at Diagram 2 for Question 4(a)(i) in the Diagram Booklet. Student B used the same distance d but rotated the GM tube by 90°, as shown.

Both students recorded the count for 2 minutes.

Deduce which set-up will lead to a smaller percentage uncertainty in the count rate.
(3 marks)

Answer space begins on the next page.

4(a)(i) continued.

(continued on the next page)

4(a) continued.

(ii) Explain two modifications to the experimental method which would improve the accuracy of the data.

(4 marks)

Answer space continues on the next page.

4(a)(ii) continued.

(continued on the next page)

4 continued.

(b) Student A suggests that the investigation into the inverse square law for a gamma radiation source could be carried out successfully using a radium-226 source.

Radium-226 emits alpha and beta radiation as well as gamma radiation.

Explain ONE modification that would be necessary if a radium-226 source were to be used.
(2 marks)

Answer space continues on the next page.

4(b) continued.

(Total for Question 4 = 9 marks)

5 **Fuse wire is made of a metal that has a low melting point. The wire melts when the current exceeds a maximum value.**

A student investigated how the cross-sectional area affected the current at which a wire melted. She used wires of the same length and metal, but different diameters.

The student steadily increased the current through each wire and recorded the maximum current through the wire before it melted.

(a) Describe how the student could determine an accurate value for the cross-sectional area of a wire.
(4 marks)

Answer space continues on the next page.

5(a) continued.

(continued on the next page)

5 continued.

(b) (i) Explain why a current in a wire causes the resistance of the wire to change.
(3 marks)

(continued on the next page)

5(b) continued.

(ii) The length of a wire does not affect the value of current at which the wire melts.

Explain why. Assume the wire behaves as a black body.
(2 marks)

(Total for Question 5 = 9 marks)

*6 Air at room temperature was sealed in a closed container. The container was placed in an ice bath and the temperature of the air decreased. The volume of the container remained constant.

Explain what happened to the pressure exerted by the air. In your response you should refer to the momentum of the air molecules.
(6 marks)

Answer space continues on the next 2 pages.

6 continued.

6 continued.

(Total for Question 6 = 6 marks)

7 **Look at the diagram for Question 7 in the Diagram Booklet. A student has 10 identical flat metal discs. One of the discs is shown. Each disc has a diameter d of about $5\,\text{cm}$ and a thickness t of about $2\,\text{mm}$**

The student determined the density of the metal the discs are made from.

She used a half-metre rule to measure d for one of the discs. She used vernier calipers to measure t for one of the discs.

The student then repeated this process for two more discs and calculated average values for d and t of the discs.

(a) Describe improvements to the student's method that would give more accurate values for d and t of the discs.
(4 marks)

Answer space continues on the next 2 pages.

7(a) continued.

7(a) continued.

(continued on the next page)

7 continued.

(b) The student determined the average mass of a disc to be 42·5 g ± 0·5 g

Calculate the density of the material the discs are made from and the percentage uncertainty in this value.
(6 marks)

average diameter of disc = 5·2 cm ± 0·1 cm
average thickness of disc = 1·9 mm ± 0·1 mm

Answer space continues on the next page.

7(b) continued.

Density = _____

Percentage uncertainty = _____

(Total for Question 7 = 10 marks)

8 An object moving through a fluid experiences a drag force due to the viscosity of the fluid.

(a) Look at the diagram for Question 8(a) in the Diagram Booklet. Some liquid chocolate is poured into a mould. Within the chocolate a bubble of air is formed. The bubble has negligible weight and moves upwards at a constant speed, as shown.

Calculate the constant speed at which the air bubble moves upwards in the liquid chocolate.
(5 marks)

radius of air bubble = $6{\cdot}8 \times 10^{-3}\,\mathrm{m}$
density of liquid chocolate = $925\,\mathrm{kg\,m^{-3}}$
viscosity of liquid chocolate = $52{\cdot}6\,\mathrm{Pa\,s}$

Answer space continues on the next page.

8(a) continued.

Speed air bubble moves upwards = _____

(continued on the next page)

8 continued.

(b) The viscosity of a gas increases with temperature.

(i) It is suggested that the relationship between viscosity η and temperature T is of the form

$$\eta = AT^{B}$$

where A and B are constants.

Explain why a graph of log η against log T would give a straight line.
(2 marks)

Answer space continues on the next page.

8(b)(i) continued.

(continued on the next page)

8(b) continued.

(ii) The table shows data for the viscosity of hydrogen gas over a range of temperatures.

T / K	η / mPa s		
123	4·60		
173	6·00		
273	8·30		
373	10·4		
473	12·0		

Look at the grid for Question 8(b)(ii) in the Diagram Booklet. Plot a graph of $\log \eta$ against $\log T$. You should use the columns provided to show any processed data.
(5 marks)

(continued on the next page)

8(b) continued.

(iii) Determine values for A and B. You are not required to state the units of A.
(4 marks)

Answer space continues on the next page.

8(b)(iii) continued.

A = _____

B = _____

(Total for Question 8 = 16 marks)

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9 **A cantilever is a beam fixed at one end.**

Look at the diagram for Question 9 in the Diagram Booklet. A student made a cantilever by clamping a metre rule to a bench and attached a mass M at the free end, as shown.

The student displaced the free end through a small distance. When the free end was released, the cantilever oscillated with simple harmonic motion of period T

(a) The student measured the time for 5 oscillations with an electronic stopwatch. This was repeated twice.

(i) Explain ONE modification to the apparatus which would improve the accuracy of the data the student obtained.
(3 marks)

Answer space continues on the next page.

9(a)(i) continued.

(continued on the next page)

9(a) continued.

(ii) Explain ONE modification to the student's method which would reduce the percentage uncertainty in her measurement of T
(2 marks)

(continued on the next page)

9 continued.

(b) The length of the metre rule overhanging the bench was L. The period of oscillation T is related to L, M and the Young modulus E of the wood of the metre rule by the expression

$$T^2 \propto \frac{ML^3}{E}$$

The student repeated the timing measurements for a half-metre rule.

The half-metre rule had the same added mass M, width and thickness as the metre rule.

The metre rule was made from wood of Young modulus E_1, and the half-metre rule was made from wood of Young modulus E_2

Look at Table 1 for Question 9(b) in the Diagram Booklet. It shows the data that the student collected.

Look at Table 2 for Question 9(b) in the Diagram Booklet. The table gives the Young modulus values of various types of wood.

(continued on the next page)

9(b) continued.

Deduce the type of wood each rule is made from.

(6 marks)

Answer space continues on the next page.

9(b) continued.

(Total for Question 9 = 11 marks)

10 The potential difference (p.d.) from a power pack alternates at a frequency of 50 Hz

The root-mean-square (r.m.s.) value of the output p.d. is measured to be 8·5 V using an a.c. voltmeter.

The output from the power pack is connected to a resistor of resistance 1·5 Ω

(a) Show that the rate of power dissipation in the resistor is about 48 W

(2 marks)

(continued on the next page)

10 continued.

(b) A lab technician used the resistor to heat $1{\cdot}25 \times 10^{-4}\,m^3$ of milk in a beaker.

Calculate the time taken for the milk to increase in temperature by $12\,°C$

(4 marks)

specific heat capacity of milk = $3930\,J\,kg^{-1}\,K^{-1}$

density of milk = $1050\,kg\,m^{-3}$

Answer space continues on the next page.

10(b) continued.

_____

_____

_____

_____

_____

Time = _____

(continued on the next page)

10 continued.

(c) The lab technician used an oscilloscope to determine the supply frequency and check the r.m.s. output p.d. displayed by the voltmeter.

Describe the methods the technician should use. (6 marks)

Answer space continues on the next page.

10(c) continued.

(Total for Question 10 = 12 marks)

11 **Particle accelerators produce beams of high speed charged particles which are used to investigate particle collisions. New particles are created during the collisions.**

(a) **In the Large Hadron Collider (LHC), protons are maintained in a circular path by the force exerted on the protons due to a magnetic field.**

(i) **The magnetic flux density required to maintain the protons in a circular path increases as the kinetic energy of the protons increases.**

Explain why.
(2 marks)

Answer space continues on the next page.

11(a)(i) continued.

(continued on the next page)

11(a) continued.

(ii) Calculate the magnetic flux density required to maintain the protons in the LHC when the protons are travelling at a speed of $3{\cdot}0 \times 10^{7}\,\mathrm{m\,s^{-1}}$

(4 marks)

circumference of LHC = 27 km

Answer space continues on the next page.

11(a)(ii) continued.

_____

_____

_____

_____

_____

Magnetic flux density = _____

(continued on the next page)

11(a) continued.

(iii) A maximum of 13 600 GeV of energy is available to create a new particle.

Calculate the theoretical maximum mass, in kg, of the new particle.
(3 marks)

Maximum mass = _____ kg

(continued on the next page)

11 continued.

***(b) Fifty years ago, fixed-target collision experiments were carried out at the Stanford Linear Accelerator Centre (SLAC). In these experiments, high speed particles were made to collide with a stationary target.**

Currently, colliding beam experiments are carried out at SLAC. In these experiments, high speed particles travelling in opposite directions are made to collide head-on.

For a given total energy in the collision, colliding beam experiments allow particles to be created with a larger mass than could be created in a fixed-target experiment.

Explain why colliding beam experiments allow a new particle with the larger mass to be created. You should consider how the conservation of energy and the conservation of momentum apply to each type of collision.
(6 marks)

Answer space begins and continues on the next 2 pages.

11(b) continued.

11(b) continued.

(Total for Question 11 = 15 marks)

12 **Look at the diagram for Question 12 in the Diagram Booklet. In an experiment to determine the acceleration of free-fall, g, a metal cylinder was dropped from rest down a glass tube. A light gate was positioned close to the outside of the glass tube, as shown.**

The light gate was connected to a data logger that recorded the time t taken for the cylinder to pass the gate.

(a) Look at the table for Question 12(a) in the Diagram Booklet. It shows the data that the student collected.

(i) The student omitted t_1 when calculating the mean time. He justified this by stating that t_1 is an anomalous result.

Another student stated that the correct mean time should use all the data in the table.

Explain who is correct.
(2 marks)

Answer space begins on the next page.

12(a)(i) continued.

(continued on the next page)

12(a) continued.

(ii) Calculate the percentage uncertainty in the mean time t_{mean}
(3 marks)

_____

_____

_____

_____

_____

Percentage uncertainty in t_{mean} = _____

(continued on the next page)

12(a) continued.

(iii) The student used the mean time to calculate the velocity of the metal cylinder as it moved past the light gate.

State the extra measurement the student must have made to calculate this velocity.
(1 mark)

_____

_____

_____

(continued on the next page)

12 continued.

(b) The metal cylinder fell through a distance 0·75 m before reaching the light gate.

(i) Calculate the velocity of the metal cylinder as it reached the light gate.
(2 marks)

_____

_____

_____

_____

_____

Velocity = _____

(continued on the next page)

12(b) continued.

(ii) Explain why a light gate and data logger were used in this experiment rather than a stopwatch. You should refer to your answer to (b)(i).
(3 marks)

Answer space continues on the next page.

12(b)(ii) continued.

(Total for Question 12 = 11 marks)

TOTAL FOR PAPER = 120 MARKS

END OF PAPER