

| Please write clearly in | n block capitals. |
|-------------------------|--------------------------------|
| Centre number | Candidate number |
| Surname | |
| Forename(s) | |
| Candidate signature | I declare this is my own work. |

A-level PHYSICS

Paper 3 Section B

Medical physics

Monday 17 June 2024

Morning

Materials

For this paper you must have:

- · a pencil and a ruler
- · a scientific calculator
- a Data and Formulae Booklet
- a protractor.

Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer all questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- Show all your working.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 35.
- You are expected to use a scientific calculator where appropriate.
- A Data and Formulae Booklet is provided as a loose insert.

| Time allowed: The total time for |
|----------------------------------|
| both sections of this paper is |
| 2 hours. You are advised to |
| spend approximately |
| 50 minutes on this section. |

| For Examiner's Use | | |
|--------------------|------|--|
| Question | Mark | |
| 1 | | |
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| TOTAL | | |

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Section B

Answer all questions in this section.

| 0 1. 1 A human eye has a far point of 6 | .0 m |
|---|------|
|---|------|

State the name of this defect of vision.

[1 mark]

0 1.2 Calculate the power of the correcting lens required for this eye.

[2 marks]

power = _____ D

0 1.3 An eye with astigmatism requires the following prescription:

$$-4.00$$
 -0.75 $\times 30$

Which row identifies the meaning of each number?

Tick (✓) one box.

[1 mark]

| -4.00 | -0.75 | ×30 | |
|-------------------------|----------|-----------|--|
| axis | cylinder | spherical | |
| cylinder | axis | spherical | |
| spherical | cylinder | axis | |
| cylinder spherical axis | | | |





| | | Do not write |
|---------|---|-----------------|
| 0 2 . 1 | A stadium is full of spectators. The peak sound-intensity level at the centre of the stadium is $110\ dB$. | outside the box |
| | On another occasion the number of spectators in the stadium is reduced by 60% . | |
| | Estimate the peak sound-intensity level at the centre of the stadium. | |
| | You should assume that on both occasions: • the sound intensity produced by each spectator is the same • the spectators are distributed evenly around the stadium. [4 marks] | |
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| | peak sound-intensity level = dB | |
| 0 2 . 2 | Describe the changes to a person's hearing that may result from prolonged exposure to sound at 110 dB. | |
| | [2 marks] | |
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| | | 6 |
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| | | 1 |

Turn over ▶



| 0 3.1 | Name the two types of optical fibre bundle used in an endoscope. Go on to discuss whether the optical fibres in either of these bundles require cladding. [4 marks] |
|-------|---|
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| 0 3.2 | Modal and material dispersion can cause problems in fibre-optic communications. Discuss why the methods used to reduce modal and material dispersion are not |
| | required in an endoscope. In your answer you should: • describe the methods used to reduce dispersion in an optical fibre used for |
| | communication • explain why the methods are not required in an endoscope • explain how using these methods in an endoscope would affect its function. [6 marks] |
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10





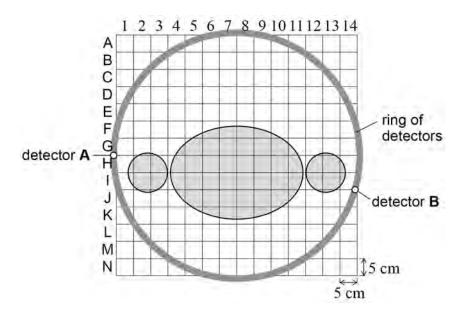
| 0 4 | Fluorine-18 has a biological half-life of 6.0 hours. |
|-------|--|
| 0 4.1 | Explain what is meant by this statement. [2 marks] |
| | [2 marks] |
| | |
| | |
| | |
| | In a PET scan, fluorine-18 is used as a tracer and is injected into the person being scanned. |
| 0 4.2 | The physical half-life of fluorine-18 is 110 minutes. |
| | Calculate the percentage of fluorine-18 that remains in the person 4.0 hours after it is injected. |
| | [3 marks] |
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| | percentage = % |
| 0 4.3 | Name the particles emitted when a fluorine-18 nucleus decays. [1 mark] |
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0 4. **4 Figure 1** shows the cross-section of a body inside a ring of detectors during a PET scan.

The side of each square represents 5 cm.

Figure 1



One of the products from the fluorine-18 decay goes on to produce two new particles. These particles travel in opposite directions in the plane shown in **Figure 1**. The particles are then detected by the detectors labelled **A** and **B**. Detector **A** detects a particle 0.79 ns before detector **B**.

Determine the square in **Figure 1** in which the particles were produced. You should identify the square with a letter and a number, eg B5.

[4 marks]

square =

10



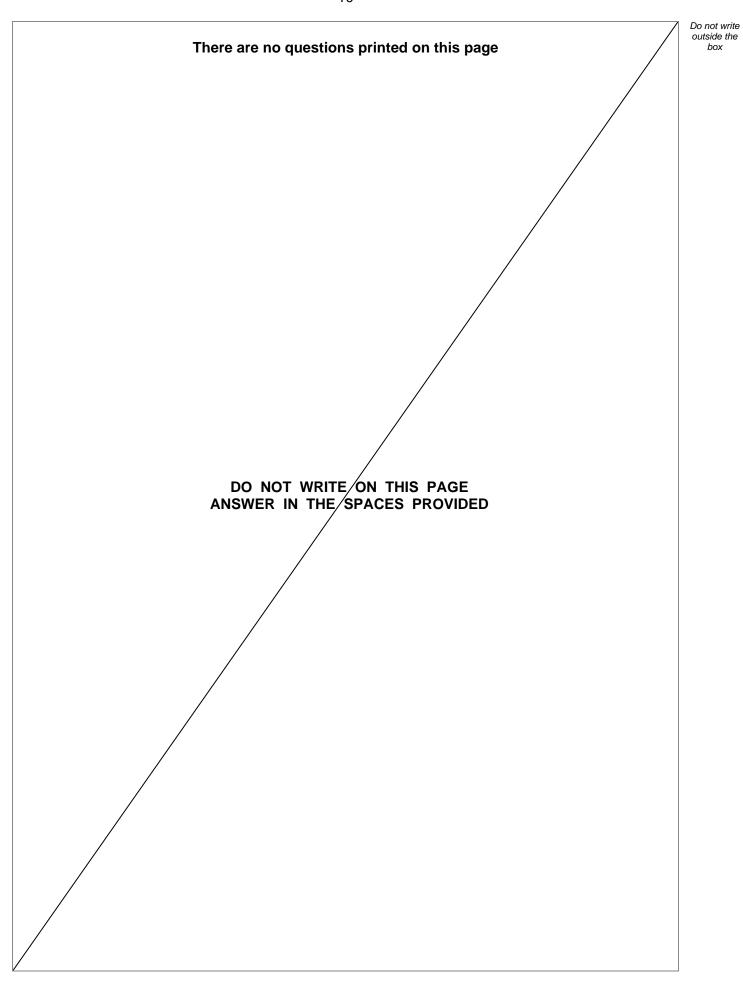


| Figure 2 shows a transducer used in a medical ultrasound scanner. Figure 2 backing material piezoelectric crystal (quartz) (with electrodes front and back) co-axial cable gradient and back) plastic membrane acoustic absorber Explain why a backing material is used. [2 marks] | | |
|---|----------|---|
| backing material piezoelectric crystal (quartz) (with electrodes front and back) co-axial cable ultrasound beam plastic membrane acoustic absorber Explain why a backing material is used. | 5 . 1 | Figure 2 shows a transducer used in a medical ultrasound scanner. |
| co-axial cable ultrasound beam plastic membrane acoustic absorber Explain why a backing material is used. | | Figure 2 |
| plastic membrane acoustic absorber Explain why a backing material is used. | | (with electrodes front and back) |
| Explain why a backing material is used. | co-axiai | plastic membrane |
| [2 marks] | | Explain why a backing material is used. |
| | | [2 marks] |
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|-------|---|-----------|------------------------------------|
| 0 5.2 | A beam of ultrasound is transmitted from muscle into bone. Calculate the percentage of the incident intensity that is transmitted. acoustic impedance of bone = $5.3 \times 10^6~kg~m^{-2}~s^{-1}$ density of muscle = $1100~kg~m^{-3}$ speed of ultrasound in muscle = $1600~m~s^{-1}$ | [3 marks] | Do not write outside the box |
| | | | |
| | percentage = | % | 5 |
| | END OF QUESTIONS | | |







| Question number | Additional page, if required. Write the question numbers in the left-hand margin. |
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