AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

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I declare this is my own work.

A-level PHYSICS

Paper 3
Section B Medical physics

Monday 17 June 2024 Morning

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.

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.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
TOTAL	

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.

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Section B

Answer **all** questions in this section.

0 1 . 1 A human eye has a far point of $6.0\ \text{m}$.

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:

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

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	

4

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0 2 . 1 A stadium is full of spectators. The peak sound-intensity level at the centre of the stadium is 110 dB.

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]

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]

_____

_____

_____

_____

6

Turn over ►

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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]

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

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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]

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]

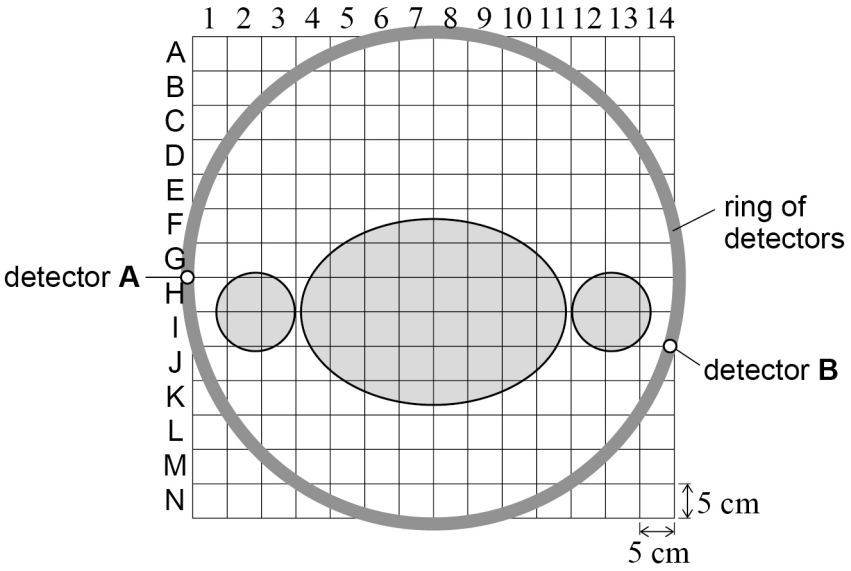
percentage = _____ %

0 4 . 3 Name the particles emitted when a fluorine-18 nucleus decays.

[1 mark]

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

Turn over ►

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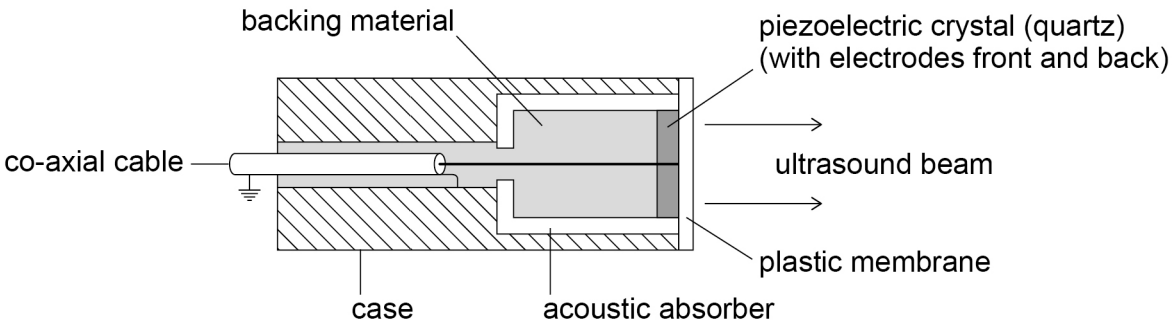
0 5 . 1 **Figure 2** shows a transducer used in a medical ultrasound scanner.

Figure 2



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 = 5.3×10^6 kg m^{-2} s^{-1}
density of muscle = 1100 kg m^{-3}
speed of ultrasound in muscle = 1600 m s^{-1}

[3 marks]

percentage = _____ %

5

END OF QUESTIONS

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ANSWER IN THE SPACES PROVIDED

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

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