Surname _____

Forename(s) _____

Centre Number _____

Candidate Number _____

Candidate Signature _____

I declare this is my own work.

A-level

PHYSICS

Paper 3

Section B Medical physics

7408/3BB

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.

[Turn over]

JUN247408 3BB01

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On the front of this book, write your surname and forename(s), your centre number, your candidate number and add your signature.

MATERIALS

For this paper you must have:

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

[Turn over]

INSTRUCTIONS

- **Use black ink or black ball-point pen.**
- **Answer ALL questions.**
- **You must answer the questions in the spaces provided. Do not write 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.**

DO NOT TURN OVER UNTIL TOLD TO DO SO

SECTION B

Answer ALL questions in this section.

0 1 . 1

A human eye has a far point of $6.0\ \mathrm{m}$.

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 ×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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[Turn over]

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

[Turn over]

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

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[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]

[Turn over]

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]

[Turn over]

[Turn over]

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]

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 = _____ %

[Turn over]

0 4 . 3

Name the particles emitted when a fluorine-18 nucleus decays. [1 mark]

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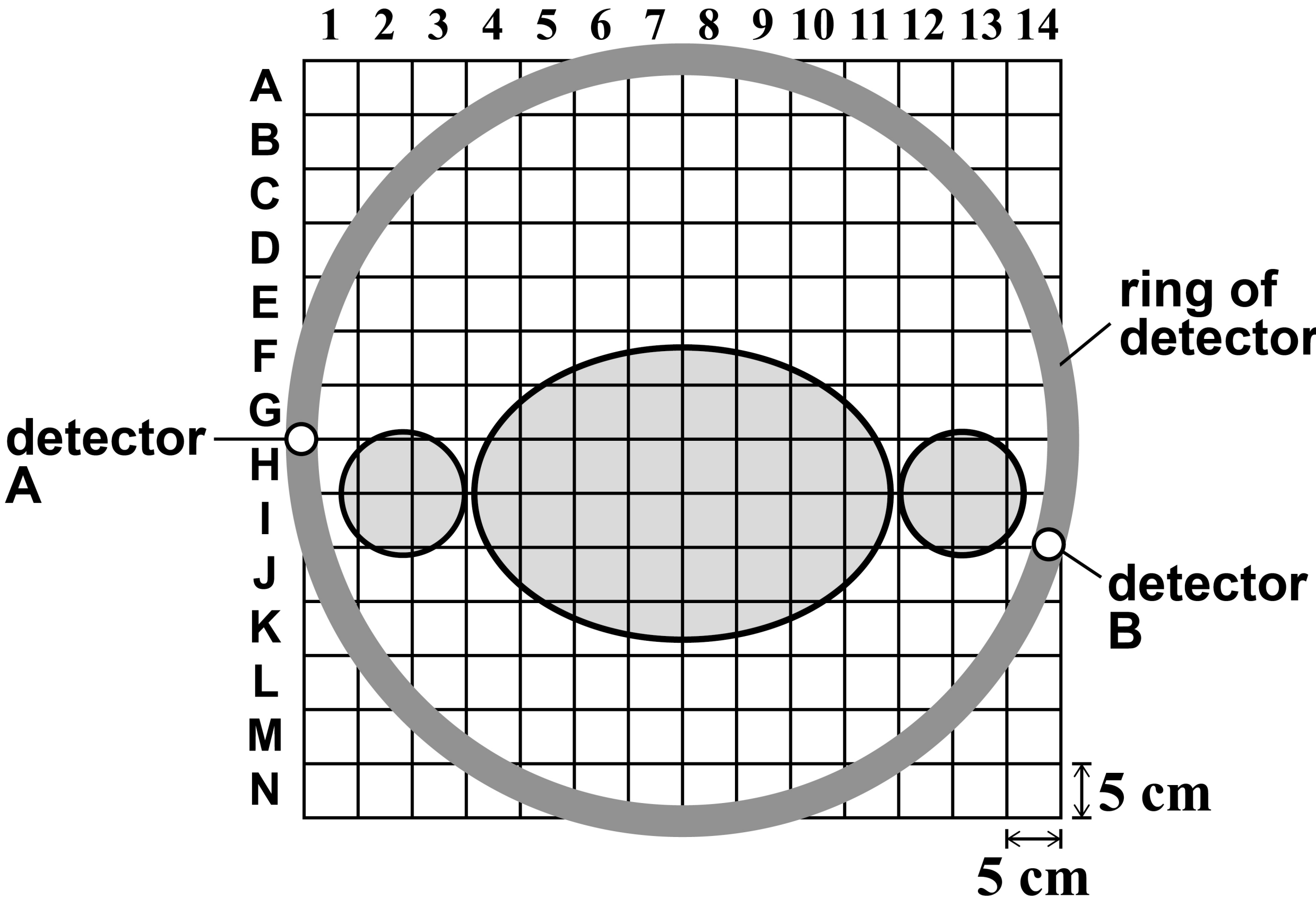
[Turn over]

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 $5\ \text{cm}$.

FIGURE 1


1 2 3 4 5 6 7 8 9 10 11 12 13 14
A
B
C
D
E
F
G
H
I
J
K
L
M
N
ring of detectors
detector A
detector B
5 cm
5 cm

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, on page 25.

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 = _____

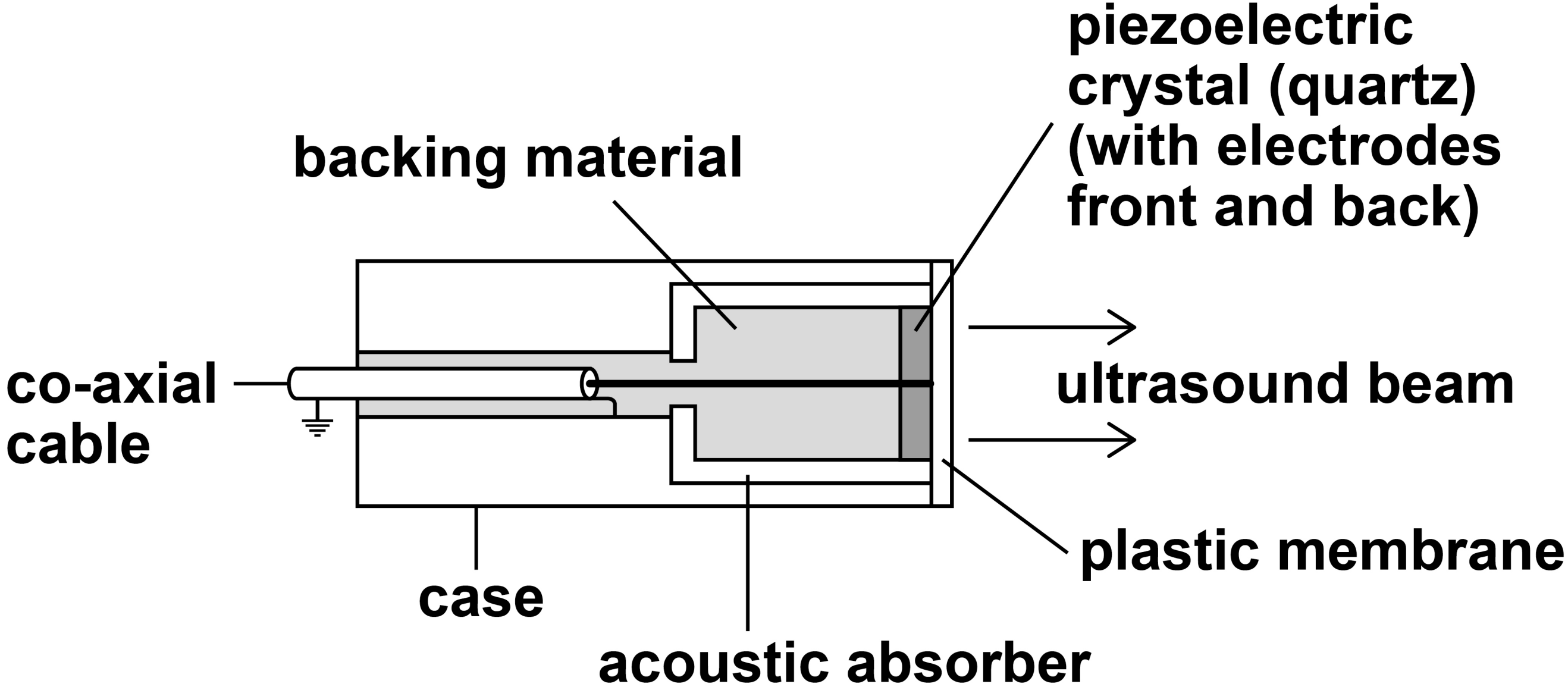
[Turn over]

10

0 5 . 1

FIGURE 2 shows a transducer used in a medical ultrasound scanner.

FIGURE 2



2 9

Explain why a backing material is used. [2 marks]

2

[Turn over]

6

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 = _____ %

END OF QUESTIONS

5

Additional page, if required.

Write the question numbers in the left-hand margin.

Additional page, if required.

Write the question numbers in the left-hand margin.

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