



Surname _____

Other Names _____

Centre Number _____

Candidate Number _____

Candidate Signature _____

I declare this is my own work.

A-level PHYSICS

Paper 3

Section B Medical physics

7408/3BB

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.

At the top of the page, write your surname and other names, your centre number, your candidate number and add your signature.

[Turn over]



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.
- 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.

01

A hospital uses the radioactive isotope technetium-99m as a tracer. Technetium-99m is produced using a Molybdenum-Technetium generator on site at the hospital.

01.1

Explain why the value of the half-life of technetium-99m:

- makes it suitable for use as a tracer**
- means that it must be produced in a generator on site.**

[4 marks]



[Turn over]



0 1 . 2

Technetium-99m emits ONLY gamma rays.

Explain why this makes technetium-99m suitable for use as a tracer. [4 marks]

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

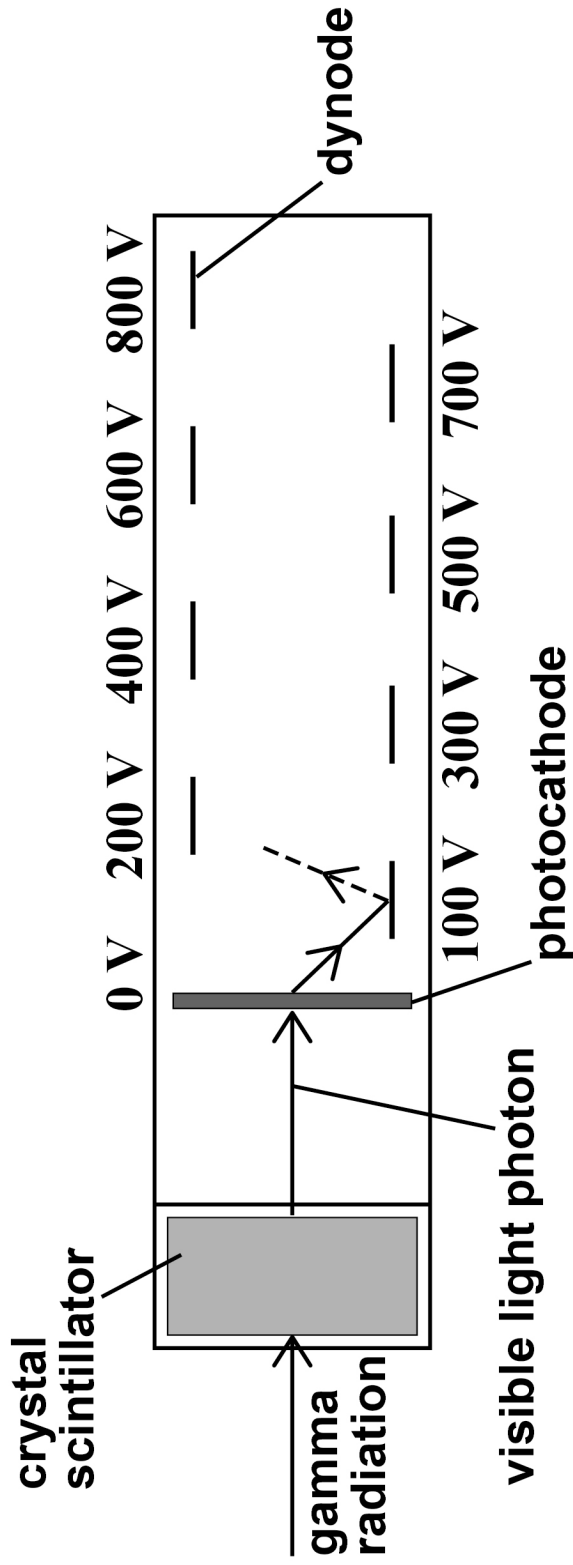
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[Turn over]



A gamma camera can be used to form images when using a tracer. **FIGURE 1** shows a photomultiplier tube from a gamma camera.

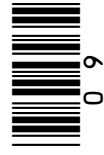
FIGURE 1



At the crystal scintillator, each photon of gamma radiation leads to the emission of one visible light photon.

Describe how the current produced by the photocathode is amplified in the photomultiplier tube. [3 marks]

[Turn over]



01.4

Iodine-131 is a medical tracer that can be detected using a gamma camera.

Iodine-131 has a physical half-life of 8.0 days.

A patient is injected with iodine-131 that has an initial activity of 3.2 GBq. For this patient, the biological half-life is 66 days. For safety reasons, the patient cannot be discharged from hospital until the activity due to the iodine in the patient's body drops to 1.1 GBq.

Determine whether the patient can be safely released from hospital after 10 days. [4 marks]



[Turn over]

15



02

FIGURE 2 shows scanned images of three different human heads.

Each image used **ONE** of the following scanning techniques:

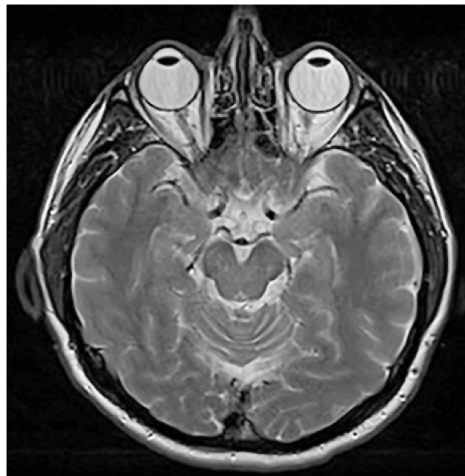
- magnetic resonance (MR)
- CT
- ultrasound
- PET.

FIGURE 2

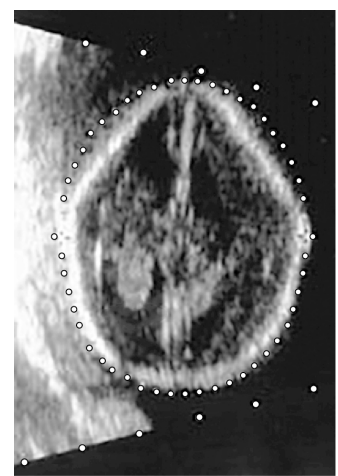
A



B



C



**Identify the scanning technique used for each image.
Go on to explain how the features of each image
enabled you to identify the type of scan. [4 marks]**

A: Scanning technique _____

Explanation _____

B: Scanning technique _____

Explanation _____

C: Scanning technique _____

Explanation _____

[Turn over]



0	3	.	1
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A point source of sound has a power of 17 W.

Calculate, in dB, the intensity level at a distance of 12 m from the source. [3 marks]

intensity level = _____ dB



03.2

The frequency of a sound is increased from 3.0 kHz to 8.0 kHz with no change in intensity.

One change in the sound perceived by a person with normal hearing is an increase in pitch.

Explain ONE other change to the sound perceived by the person as the frequency is increased from 3.0 kHz.
[2 marks]

[Turn over]

5



04

In an X-ray machine, X-rays are emitted from an emission spot on a tungsten target.

FIGURE 3

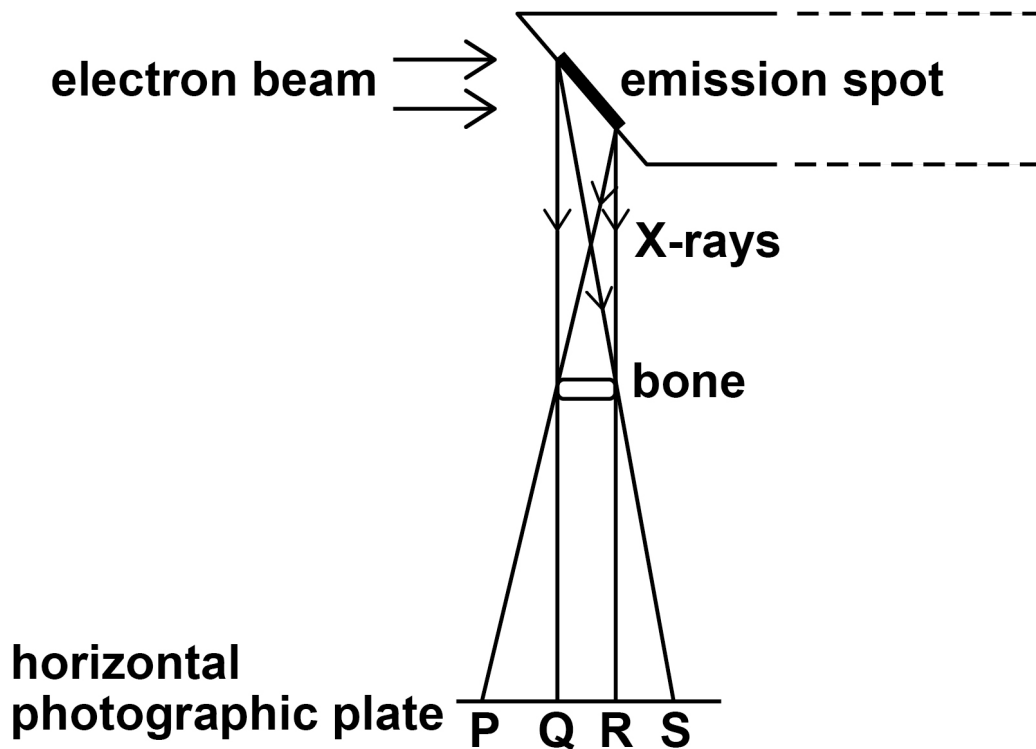


FIGURE 3 shows how a total shadow is produced in the region QR where no X-rays from any part of the emission spot can reach the photographic plate. Partial shadows are formed in regions PQ and RS where X-rays from only part of the emission spot can reach the plate.



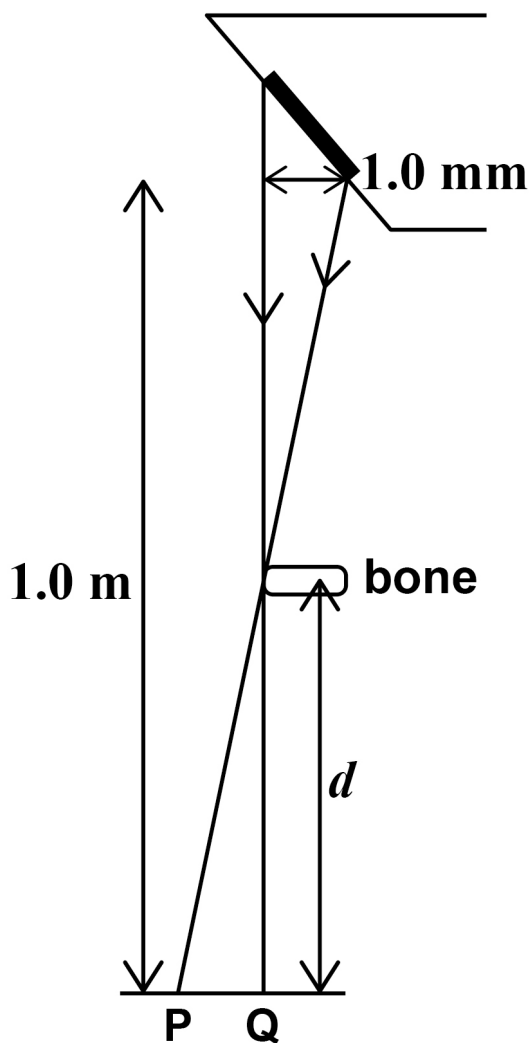
FIGURE 4 shows detail of the formation of edges of the partial shadow PQ.

The bottom of the emission spot is 1.0 m vertically above the plate.

The horizontal distance across the beam is 1.0 mm at the bottom of the emission spot.

FIGURE 4

The diagram is not drawn accurately.



[Turn over]



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To produce a sharp image of a bone, the partial shadow in region PQ must be no more than 0.10 mm wide.

Calculate the maximum distance d between a bone and the plate. [2 marks]

$d =$ _____ m

[Turn over]



04.2

Discuss whether an X-ray image of a chest or an X-ray image of a hand is likely to be sharper when exposed to the same X-ray source. [2 marks]

—
4



0	5	.	1
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Which would be a correct lens prescription for a person with hypermetropia and astigmatism? [1 mark]

Tick (✓) ONE box.

☐

−2.00 +0.50 75

☐

+2.00 −0.50 75

☐

−2.00 +0.50 255

☐

+2.00 −0.50 255

[Turn over]



05.2

A student views an object O and cannot see it clearly unaided.

The student is diagnosed with myopia and is prescribed a suitable correcting lens.

Using the correcting lens, an intermediate image is formed that can be viewed clearly by the student.

The student states that she can see O more clearly because the intermediate image is enlarged.

**Discuss the validity of the student's statement.
In your answer you should:**

- **describe how myopia affects vision**
- **draw a labelled ray diagram of the correcting lens, showing how the intermediate image of O is formed**
- **explain how the correcting lens enables the student to see clearly.**

[6 marks]



Space for diagram

[Turn over]



[illegible]

END OF QUESTIONS

7



Additional page, if required.

Write the question numbers in the left-hand margin.

[illegible]

Additional page, if required.

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Question	Mark
1	
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