

Please write clearly in block capitals.

Centre number

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Candidate number

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Forename(s)

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Candidate signature

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# A-level PHYSICS

Paper 3

Section B Medical physics

Thursday 29 June 2017

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.

## 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.
- 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.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
<b>TOTAL</b>	



**Section B**

Answer **all** questions in this section.

0	1
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A person suffers from hypermetropia (long sight).  
Use of a spectacle lens of power +2.0D allows the person to just see clearly an object placed 24 cm away from the eye.

0	1	.	1
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Explain why the unaided defective eye cannot form a clearly focused image of the object placed 24 cm from the eye.

**[2 marks]**

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0	1	.	2
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An object is placed 24 cm from the spectacle lens.

Calculate the distance of the image formed from the spectacle lens.  
Give your answer to a suitable number of significant figures.

**[3 marks]**

image distance = \_\_\_\_\_ cm



0 1 . 3

What is the name for the position where the image is formed by the spectacle lens?

Tick (✓) the correct answer.

[1 mark]

The eye's aided far point

The eye's aided near point

The eye's unaided far point

The eye's unaided near point

0 1 . 4

Draw a ray diagram to show how this spectacle lens forms an image of the object placed 24 cm from the spectacle lens.

On your diagram clearly label the object, image and a principal focus of the lens.

Your diagram does not have to be drawn to scale.

[3 marks]

Turn over for the next question

9

Turn over ►





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**0 2 . 2**

The blood vessel called the aorta passes through the abdomen. A second patient with a suspected fault in the wall of the aorta can be given an ultrasound scan or an X-ray of the abdomen.

Suggest, with reasons, which is the better procedure for investigating this suspected fault.

**[2 marks]**

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**Question 2 continues on the next page**

**Turn over ►**



0 2 . 3

When ultrasound travels across a boundary from blood to the wall of the aorta there is a decrease in acoustic impedance across the boundary. This results in 0.0625% of the intensity of the incident ultrasound being reflected at the boundary.

Calculate the acoustic impedance of the aorta wall tissue.

$$\text{acoustic impedance of blood} = 1.64 \times 10^6 \text{ kg m}^{-2} \text{ s}^{-1}$$

**[4 marks]**

acoustic impedance of aorta wall tissue = \_\_\_\_\_  $\text{kg m}^{-2} \text{ s}^{-1}$

**12**

**Turn over for the next question**

**DO NOT WRITE ON THIS PAGE  
ANSWER IN THE SPACES PROVIDED**

**Turn over ►**



0	3
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A patient is going to have a PET scan. A small amount of radioisotope is injected into the patient's bloodstream and the patient is left to relax. The patient then lies on a horizontal table and is moved into the PET scanner. The scanner has many detectors positioned in a vertical circular pattern around the patient.

0	3	.	1
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State what is meant by a radioisotope.

[1 mark]

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0	3	.	2
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The radionuclide used in the PET scan has a physical half-life of 110 minutes. The radionuclide is excreted from the body with a biological half-life of 185 minutes.

Show that the effective half-life of the radionuclide in the body is about 70 minutes.

[1 mark]





0 3 . 3

Discuss what might be a suitable length of time for the patient to relax between injecting the radionuclide and moving the patient into the PET scanner.

**[3 marks]**

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0 3 . 4

The decay of the radionuclide results in the emission of a positron. Two of the detectors, directly opposite to each other, are triggered as they each receive a gamma photon.

Explain the process in which the gamma photons are created.

**[2 marks]**

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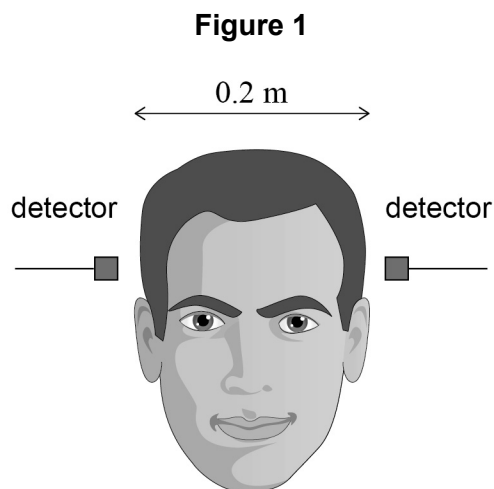
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**Question 3 continues on the next page**

**Turn over ►**

0 3 . 5

**Figure 1** shows the head of a patient that is 0.2 m across, placed centrally between two of the many detectors in a PET scanner.



To determine the position where the gamma photons are produced between the detectors, the scanner measures the short interval of time  $\Delta t$  between the triggering of the first detector and the triggering of the second detector.

Discuss, for the detector positions shown in **Figure 1**, the range of the values of  $\Delta t$  that the scanner must measure to perform a PET scan on the head.

Assume that the speed of the gamma photons in the head is  $3 \times 10^8 \text{ m s}^{-1}$ .

**[2 marks]**

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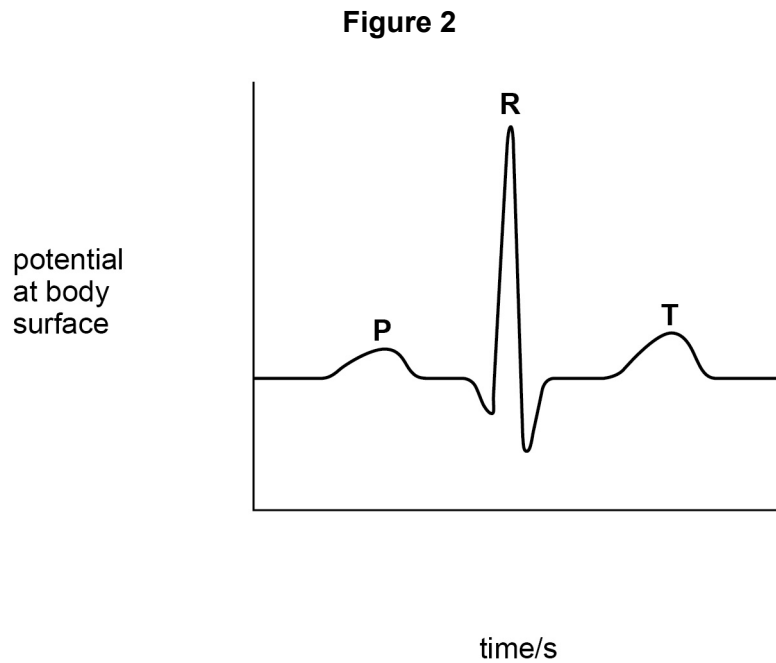


0 4 . 1

**Figure 2** shows an ECG trace for a healthy person.

Complete **Figure 2** by adding a suitable unit and scale to the potential axis, and a suitable scale to the time axis.

[2 marks]



**Question 4 continues on the next page**

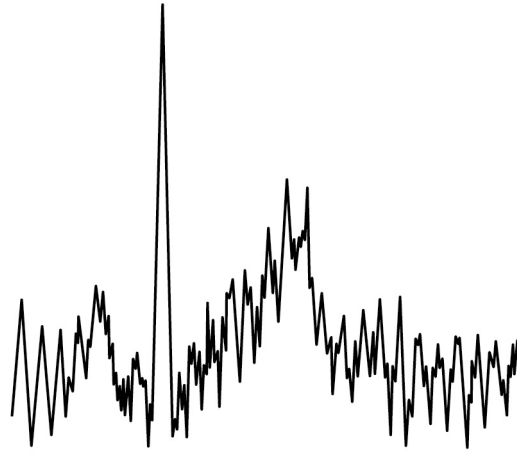
**Turn over ►**



0 4 . 2

**Figure 3** shows a faulty ECG trace which was obtained for another healthy person.

**Figure 3**



Discuss **three** possible reasons why this faulty trace was obtained.

**[3 marks]**

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**5**

**END OF QUESTIONS**

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