Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

A-level PHYSICS

Paper 3
Section B Medical physics

Monday 3 June 2019 Afternoon

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.
- 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	
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 Car drivers must be able to

- read a speedometer from a distance of $50\ \text{cm}$
- read a number plate from a distance of $20.5\ \text{m}$.

A driver has an unaided far point of $55\ \text{cm}$ and an unaided near point of $25\ \text{cm}$.

0 1 . 1 Identify the driver's eye defect.
Tick (✓) **one** box.

[1 mark]

Astigmatism	
Hypermetropia	
Myopia	

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0 1 . 2 **Figure 1** shows the position of a number plate at a distance of $20.5\ \text{m}$ in front of the driver's unaided eye.

Figure 2 shows the same situation and the position of a corrective lens.

Complete both ray diagrams to show how and where the image of the number plate is formed in each case.
Add a suitable lens to **Figure 2**.

[4 marks]

Figure 1

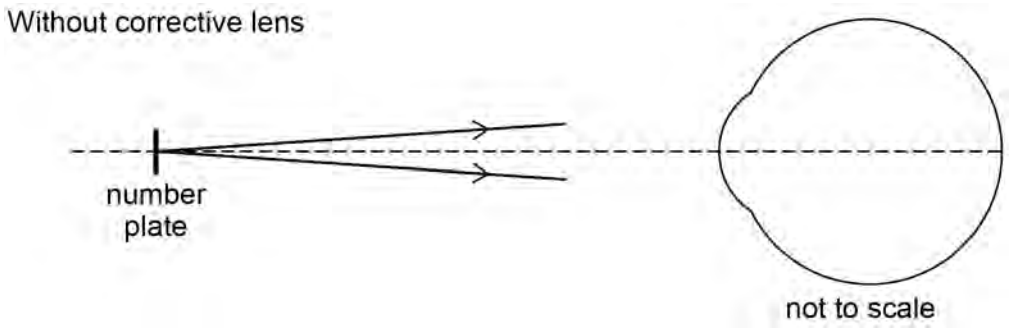
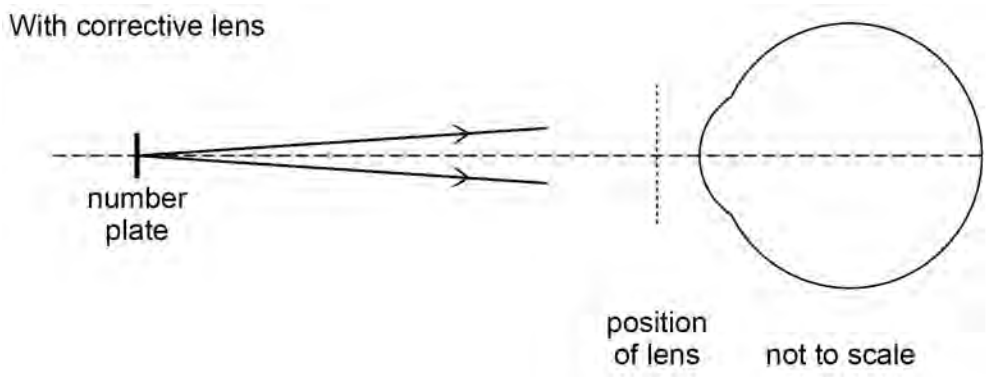


Figure 2



Question 1 continues on the next page

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0 1 . 3 An optician considers the use of **three** different lenses, **A**, **B** and **C**, for use by the driver when driving.

Power of **A** = −2.18D
Power of **B** = −1.77D
Power of **C** = +1.95D

Deduce which lens is suitable.
Support your answer with calculations.

[5 marks]

10

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Turn over for the next question

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0 2 Three customers, **P**, **Q** and **R**, are sitting in a café listening to music from a loudspeaker.
Customer **P** is $11\ \text{m}$ from the loudspeaker. At the position of customer **P**, the sound intensity is $3.4 \times 10^{-8}\ \text{W m}^{-2}$.

0 2 . 1 Customer **P** moves to a distance of $7.0\ \text{m}$ from the loudspeaker.

Calculate the sound intensity at the new position of customer **P**.
Assume that the loudspeaker is a point source.

[2 marks]

sound intensity = _____ W m^{-2}

0 2 . 2 The sound intensity level is $65\ \text{dB}$ at the position of customer **Q** and $42\ \text{dB}$ at the position of customer **R**.

Calculate the ratio $\frac{\text{sound intensity at the position of } \mathbf{Q}}{\text{sound intensity at the position of } \mathbf{R}}$.

[2 marks]

ratio = _____

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0 2 . 3 Customer **Q** perceives the loudness of the sound differently to customer **R**.

Discuss whether the use of intensity level or intensity is more appropriate to compare the perceived loudness.

[2 marks]

0 2 . 4 Customers **P**, **Q** and **R** move to the same distance from the loudspeaker.

Customer **P** is 80 years old and has hearing loss due to her age.
Customer **Q** is 35 years old and has hearing loss due to working in an extremely noisy environment.
Customer **R** is 35 years old and has no hearing loss.

The hearing defects of **P** and **Q** affect their perception of the music being played.

Describe how their perceptions are different from that of **R**.

[3 marks]

9

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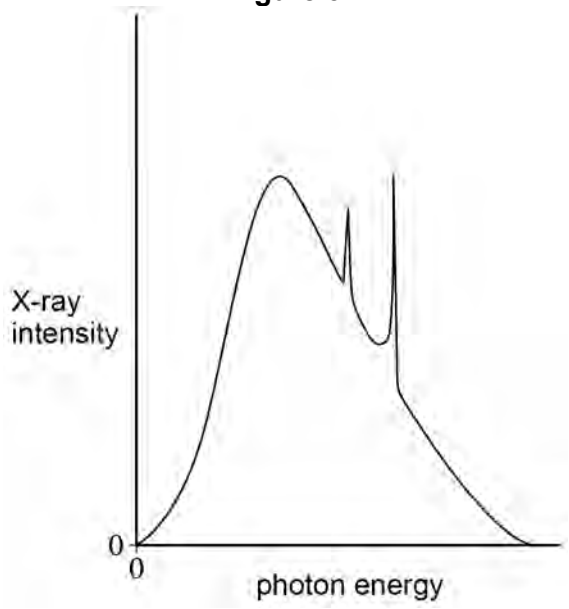
0 3 **Figure 3** shows the X-ray spectrum produced in a medical X-ray machine at a particular anode potential difference (pd).

Figure 3



0 3 . 1 In an X-ray tube, electrons collide with a tungsten target.

Explain how the continuous spectrum and the characteristic spectra are produced by these electron collisions.

[4 marks]

Continuous spectrum _____

_____

_____

_____

_____

_____

_____

Characteristic spectra _____

_____

_____

_____

_____

_____

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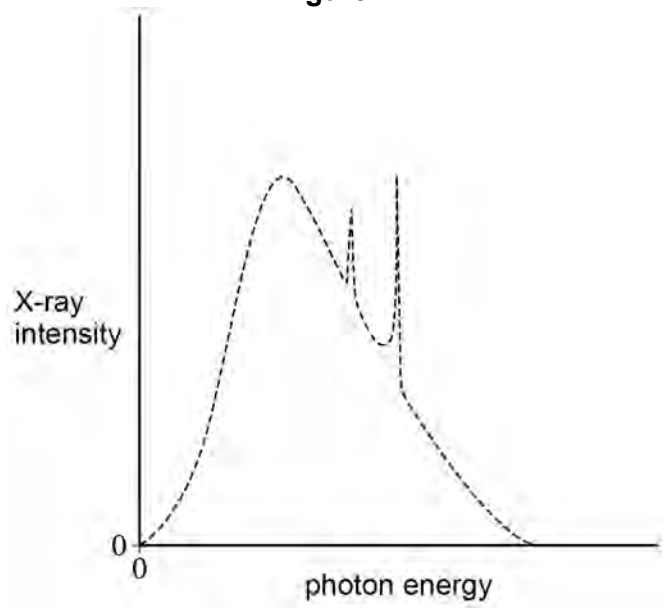
0 3 . 2 The dashed line on **Figure 4** shows the X-ray spectrum for the initial anode pd.

Sketch on **Figure 4** the X-ray spectrum produced when the anode pd is increased.

[2 marks]

Figure 4

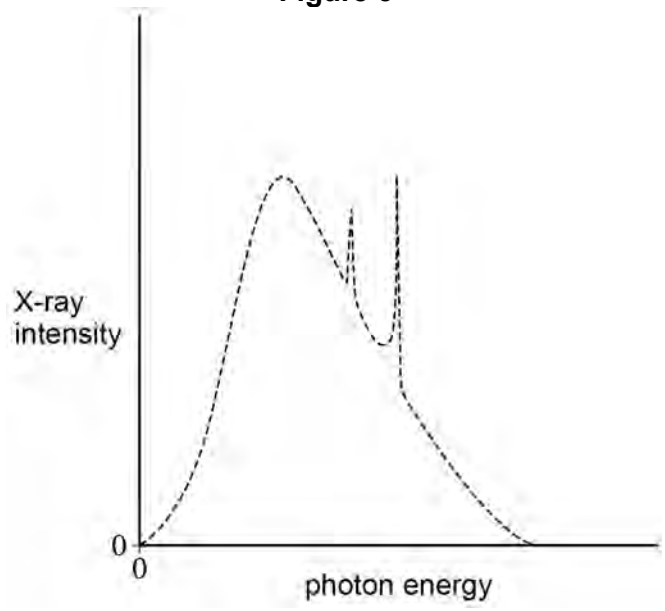


0 3 . 3 In the medical X-ray machine, the X-rays produced with the initial anode pd are now passed through an aluminium filter.
The dashed line on **Figure 5** shows the X-ray spectrum for the initial anode pd.

Sketch on **Figure 5** the X-ray spectrum of the X-rays that emerge from the filter.

[1 mark]

Figure 5



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0 4 Ultrasound is commonly used in medical procedures.

0 4 . 1 An ultrasound A-scan is used to find the length l of an eye as shown in **Figure 6**. **Figure 7** shows the simplified A-scan for the eye. A short pulse of ultrasound is transmitted at time $t = 0$

The average speed of ultrasound in the eye = $1560\ \text{m s}^{-1}$.

Figure 6

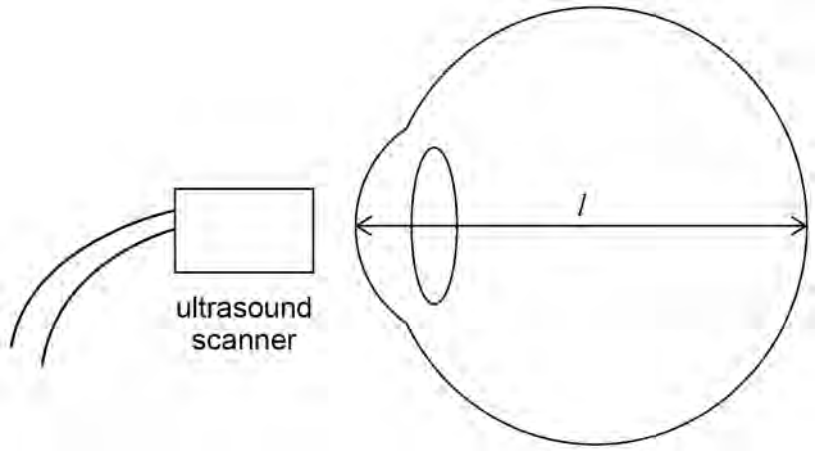
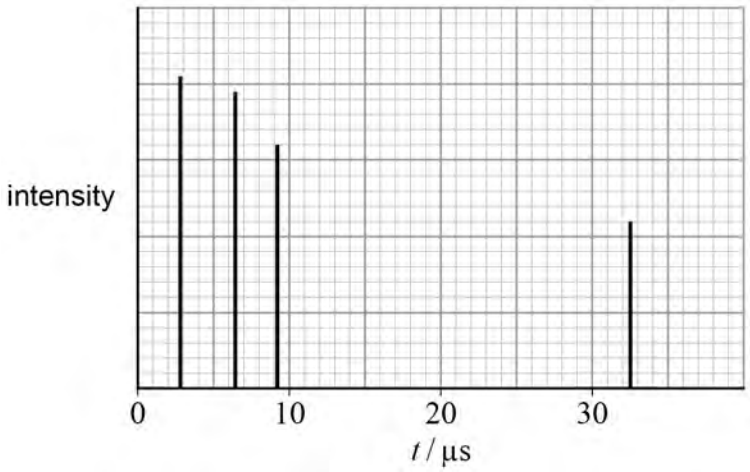


Figure 7



Calculate l.

[3 marks]

l = _____ m

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0 4 . 2 Amniocentesis is a procedure where a tube is inserted into a uterus to remove some cells and fluid from around a foetus. For the procedure to be carried out safely the positions of the needle, foetus and placenta must be determined accurately.

Discuss whether an A-scan or a B-scan should be used for amniocentesis.

In your answer, you should:

- outline the differences between an A-scan and a B-scan
- describe the advantages and disadvantages of each type of scan
- explain why your chosen scan should be used for this procedure.

[6 marks]

Question 4 continues on the next page

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