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Centre number

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Candidate number

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Surname _____

Forename(s) _____

Candidate signature _____

A-level PHYSICS

Paper 3
Section B Medical physics

Monday 3 June 2019 Afternoon

Materials
For this paper you must have:

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

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.

- 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.



Section B

Answer **all** questions in this section.

0 1

Car drivers must be able to

- read a speedometer from a distance of 50 cm
- read a number plate from a distance of 20.5 m.

A driver has an unaided far point of 55 cm and an unaided near point of 25 cm.

0 1 . 1

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

[1 mark]

Astigmatism	
Hypermetropia	
Myopia	



0 1 . 2

Figure 1 shows the position of a number plate at a distance of 20.5 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

Without corrective lens

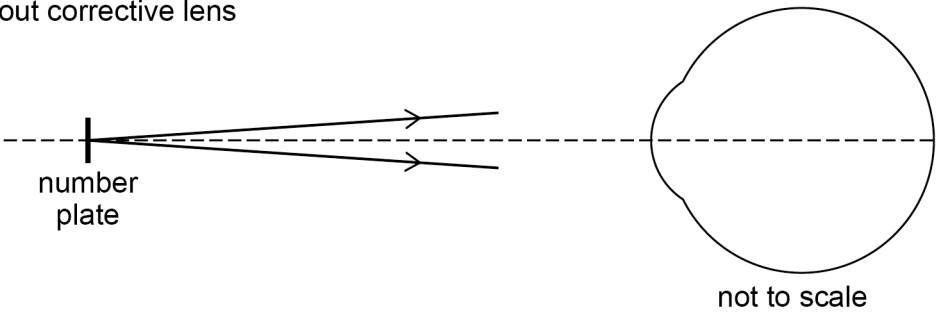
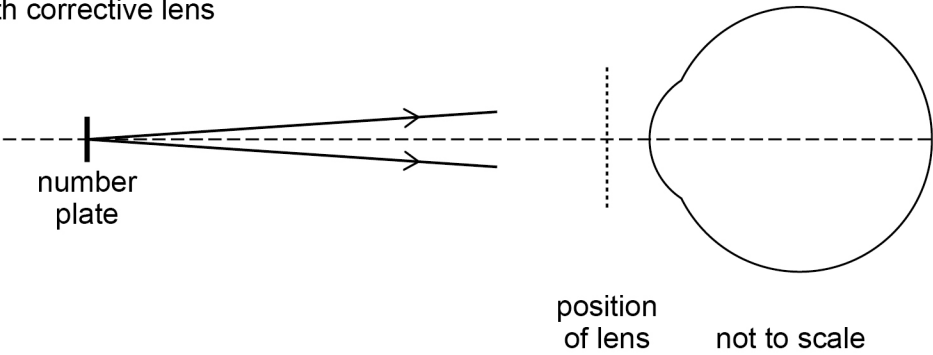


Figure 2

With corrective lens



Question 1 continues on the next page

Turn over ►



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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** = $+1.95\text{D}$

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

[5 marks]

10



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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 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 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 dB at the position of customer **Q** and 42 dB at the position of customer **R**.

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

[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]

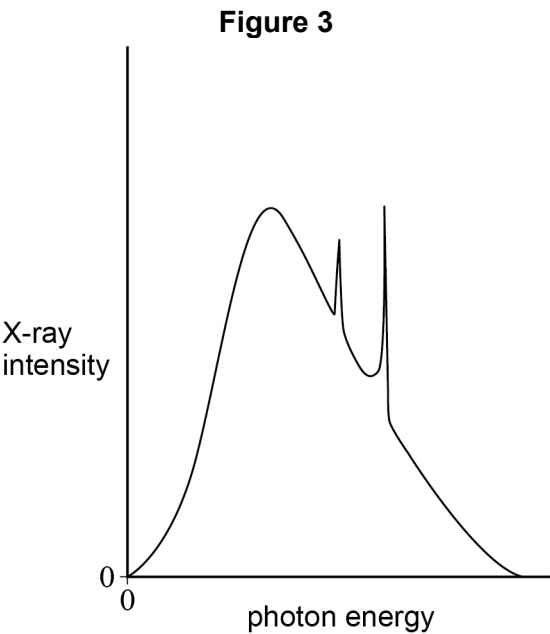
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0 3

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



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 _____



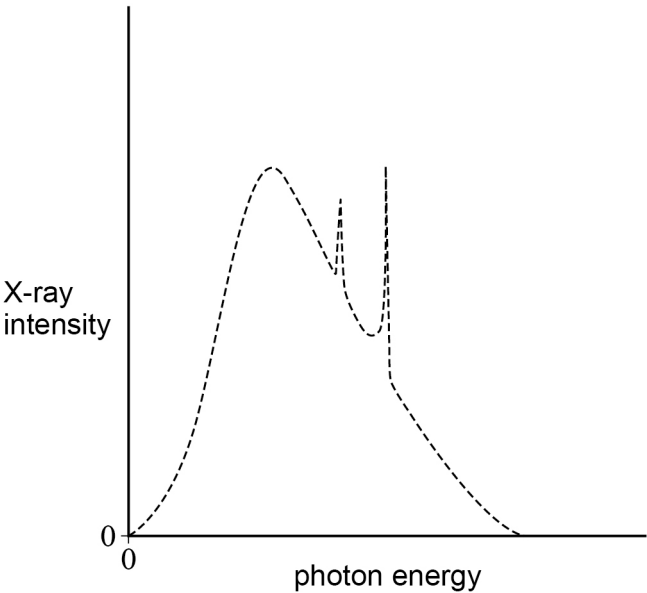
0 3 . 2

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

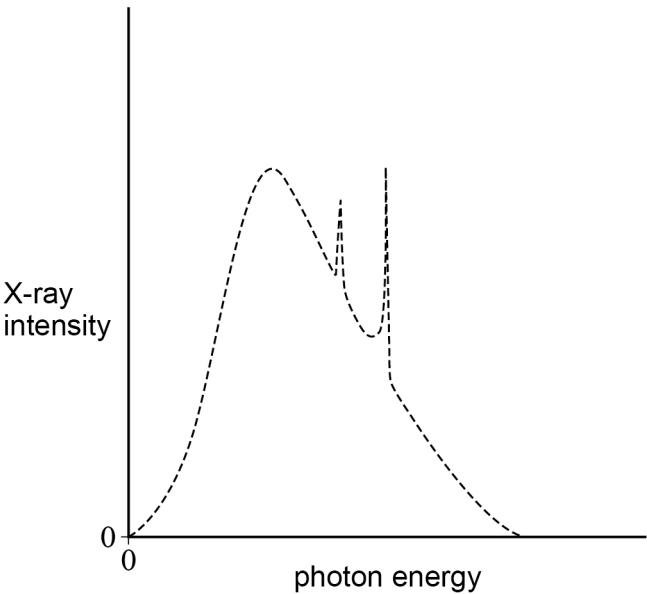
In the medical X-ray machine, the X-rays produced with the initial anode pd are now passed through an aluminium filter.

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



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 m s^{-1} .

Figure 6

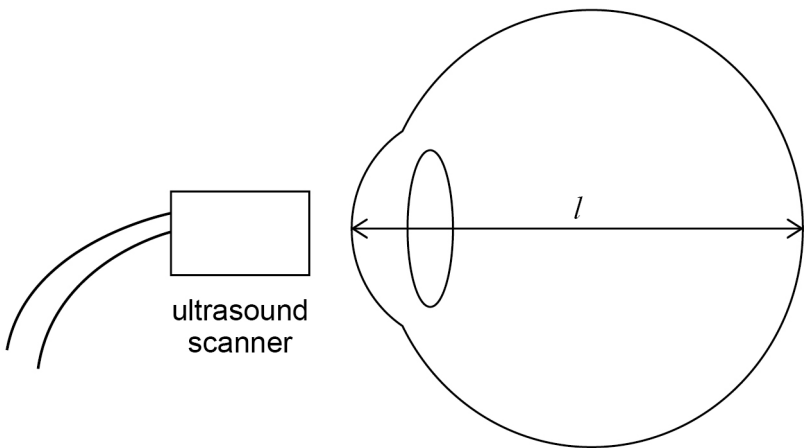
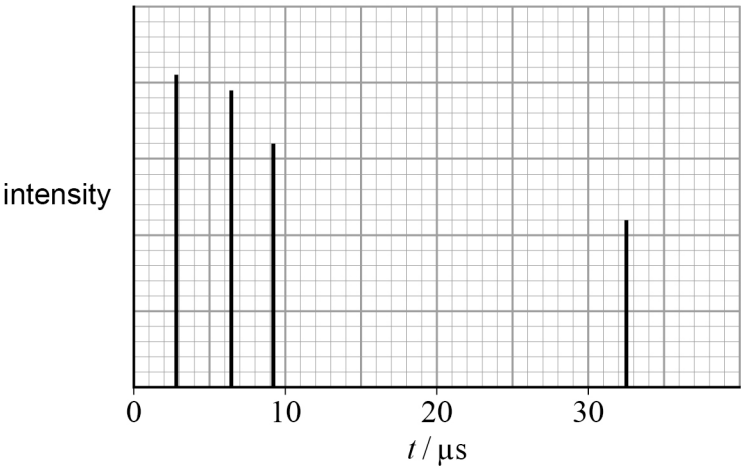


Figure 7



Calculate l .

[3 marks]

$l =$ _____ m



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END OF QUESTIONS



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