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Centre number		Candidate number	
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.

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	
TOTAL	



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 $55~\mathrm{cm}$ and an unaided near point of $25~\mathrm{cm}$.

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 $20.5~\mathrm{m}$ 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

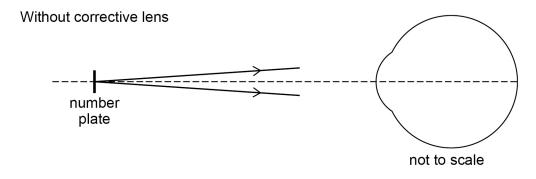
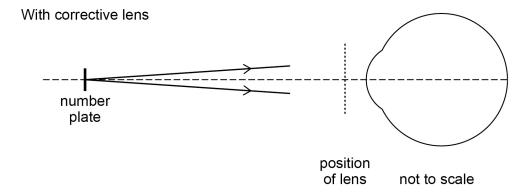


Figure 2



Question 1 continues on the next page





An optician considers the use of **three** different lenses, ${\bf A}$, ${\bf B}$ and ${\bf C}$, for use by the driver when driving.

Power of $\mathbf{A} = -2.18D$ Power of $\mathbf{B} = -1.77D$

Power of C = +1.95D

Deduce which lens is suitable.

Support your answer with calculations.

[5 marks]

10



Turn over for the next question DO NOT WRITE ON THIS PAGE ANSWER IN THE SPACES PROVIDED

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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 $3.4\times10^{-8}~W~m^{-2}$.	
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 $65~\mathrm{dB}$ at the position of customer \mathbf{Q} and $42~\mathrm{dB}$ at the position of customer \mathbf{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 =	



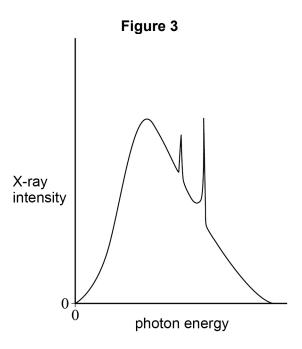
0 2 . 3	Customer Q perceives the loudness of the sound differently to customer R .
	Discuss whether the use of intensity level or intensity is more appropriate to compare the perceived loudness. [2 marks]
	[2 marks]
0 2 . 4	Customers P, Q and R move to the same distance from the loudspeaker.
	Customer 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]
	[o marke]

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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]

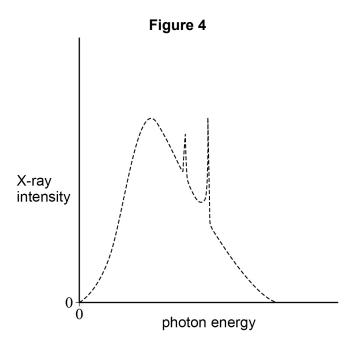
Continuous spectrum	
	—
Characteristic spectra	



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]

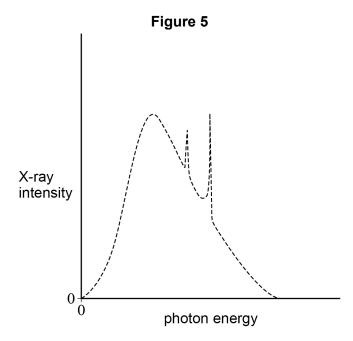


In the medical X-ray machine, the X-rays produced with the initial anode pd are now passed through an aluminium filter.

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]



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0 4

Ultrasound is commonly used in medical procedures.

- 0 4 .
- 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 = $1560 \,\mathrm{m \ s^{-1}}$.

Figure 6

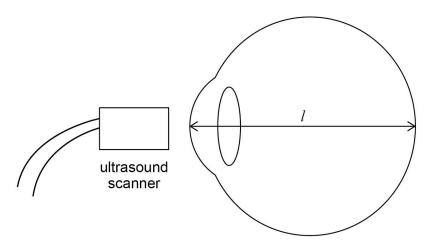
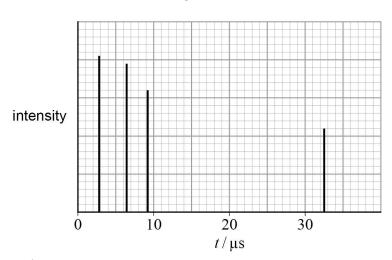


Figure 7



Calculate *l*.

[3 marks]

l = m



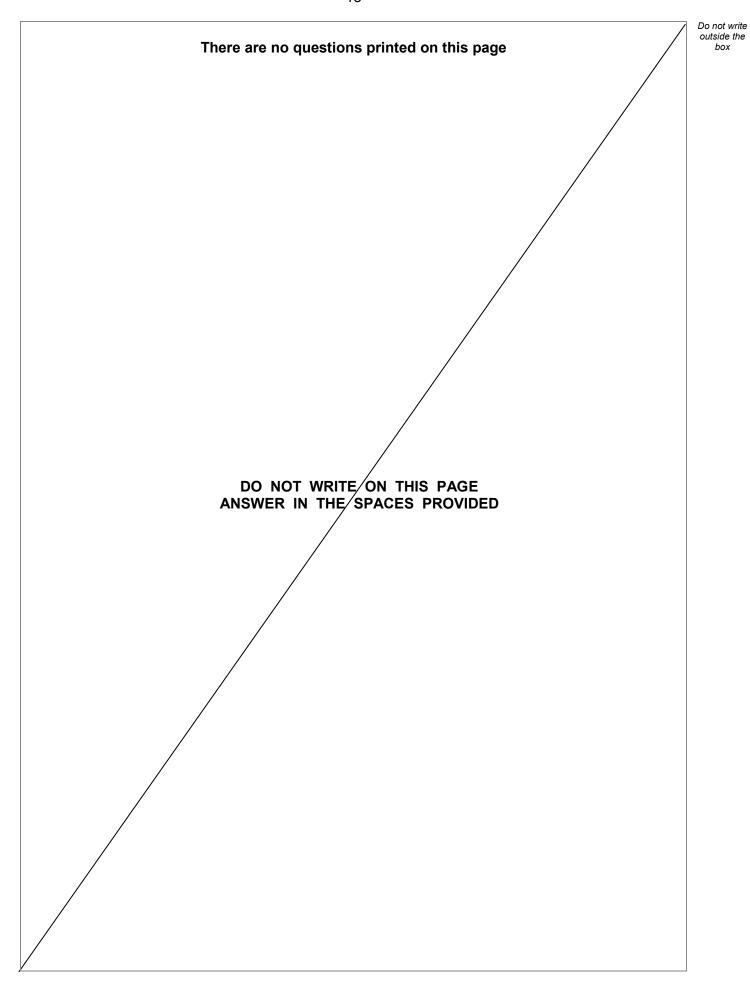
0 4 . 2	Amniocentesis is a procedure where a tube is inserted into a uterus to removells and fluid from around a foetus. For the procedure to be carried out safe positions of the needle, foetus and placenta must be determined accurately.	ely the
	Discuss whether an A-scan or a B-scan should be used for 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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