Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
TOTAL	

General Certificate of Education
Advanced Level Examination
June 2013

Physics A PHYA5/2B

Unit 5B Medical Physics
Section B

Thursday 20 June 2013 9.00 am to 10.45 am

For this paper you must have:
- a calculator
- a ruler
- a Data and Formulae Booklet (enclosed).

Time allowed
- The total time for both sections of this paper is 1 hour 45 minutes. 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.
- 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 section is 35.
- You are expected to use a calculator where appropriate.
- A *Data and Formulae Booklet* is provided as a loose insert.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use specialist vocabulary where appropriate.

Section B

The maximum mark for this section is 35. You are advised to spend approximately 50 minutes on this section.

1 In the eye, rods and cones are used to detect light incident on the retina.

1 (a) Describe how the rods and cones are distributed over the surface of the retina.

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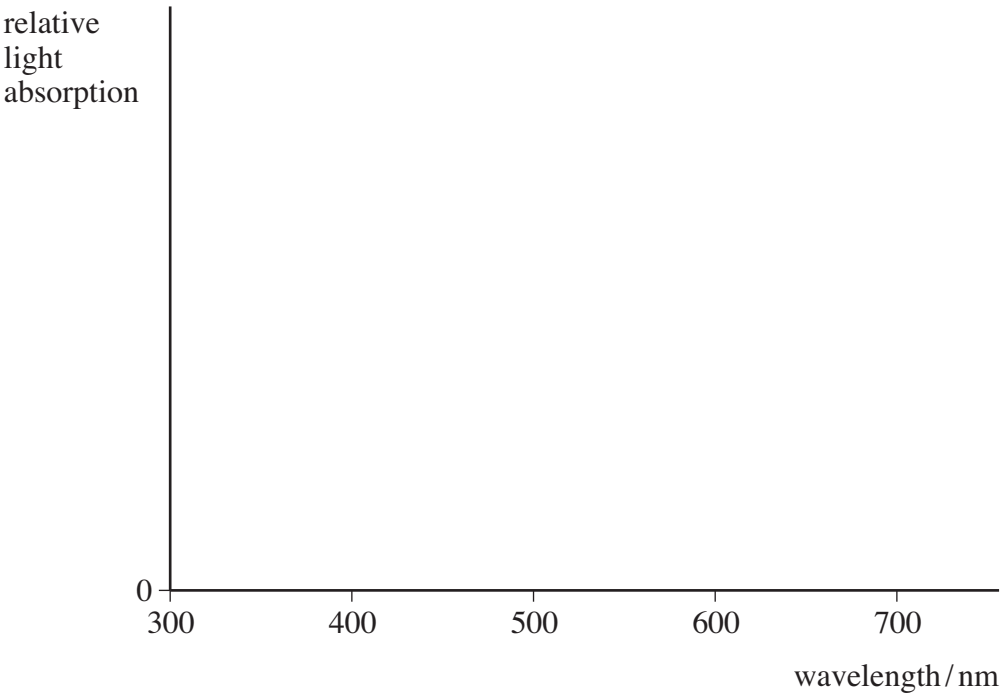
(2 marks)

1 (b) On the axes below sketch **three** curves to show how the response of each of the three types of cone found in the retina varies with the wavelength of light.

Label each of the three curves with the cone colour to which it refers.



(3 marks)

1 (c) State the condition that must be satisfied for two objects to be resolved as individual images on the retina.

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(1 mark)

1 (d) Explain how the resolution of the image of an object seen in very dim white light compares to that of the image of the same object seen in bright white light.

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(2 marks)

8

Turn over for the next question

2 (a) Sound waves are incident on the ear canal of a normal human ear. Describe the physical processes involved in the transmission of the energy from the air through to the inner ear.

Include an outline of how the variations in air pressure in the ear canal are amplified to produce greater pressure variations in the inner ear.

The quality of your written communication will be assessed in your answer.

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(6 marks)

2 (b) Define *intensity* of sound.

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(2 marks)

2 (c) A human ear has a threshold of hearing of 54 dB at a given frequency. Calculate the intensity of sound incident on the ear at this frequency.

Give your answer to an appropriate number of significant figures.

$I_o = 1.0 \times 10^{-12}\,W\,m^{-2}$

intensity of sound ..... $W\,m^{-2}$

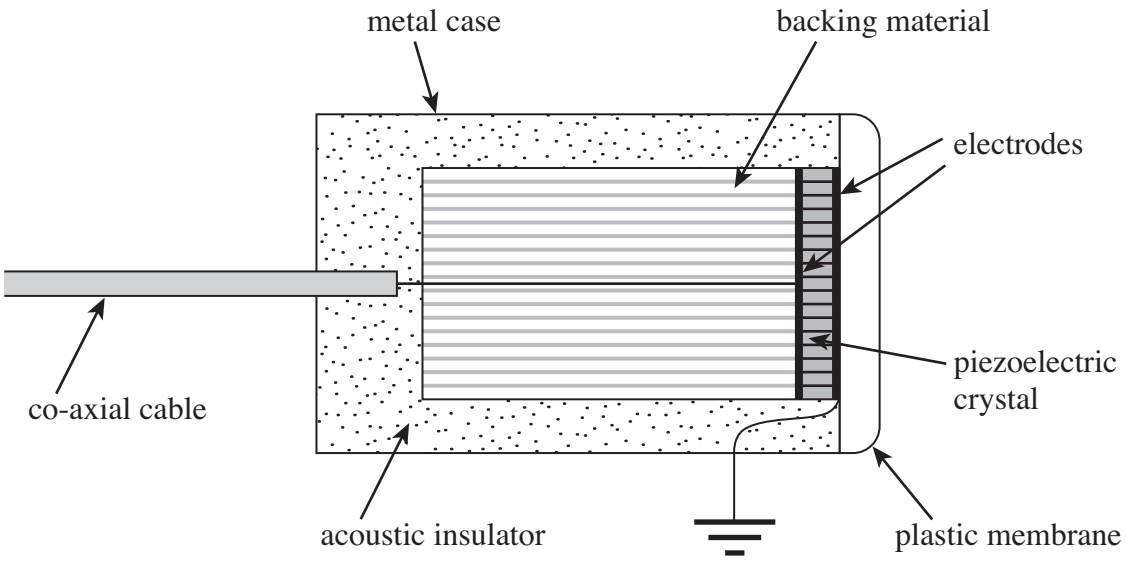
(3 marks)

11

Turn over for the next question

3 (a) **Figure 1** shows an ultrasound transducer used in an A-scan.

Figure 1



Outline, with reference to the diagram, the process by which the transducer produces a short pulse of ultrasound.

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(4 marks)

3 (b) Ultrasound is incident on the boundary between two materials. Some of the ultrasound is reflected at the boundary and the remainder is transmitted across the boundary. The ratio of the intensity of the reflected ultrasound, I_r, to the intensity of the incident ultrasound, I_i, is given by the equation

$$\frac{I_r}{I_i} = \left(\frac{Z_2 - Z_1}{Z_2 + Z_1}\right)^2$$

where Z_1 and Z_2 are the acoustic impedances of the two materials.

3 (b) (i) Calculate the percentage of the incident ultrasound which would be transmitted into the skin when incident on an air-skin boundary.

acoustic impedance of air = $4.29 \times 10^2\,\text{kg m}^{-2}\,\text{s}^{-1}$
acoustic impedance of skin = $1.65 \times 10^6\,\text{kg m}^{-2}\,\text{s}^{-1}$

transmitted percentage ..... %

(2 marks)

3 (b) (ii) When obtaining the ultrasound image of an unborn foetus, a coupling gel is used. Explain why a coupling gel is needed and state the property of the gel that ensures a good quality image.

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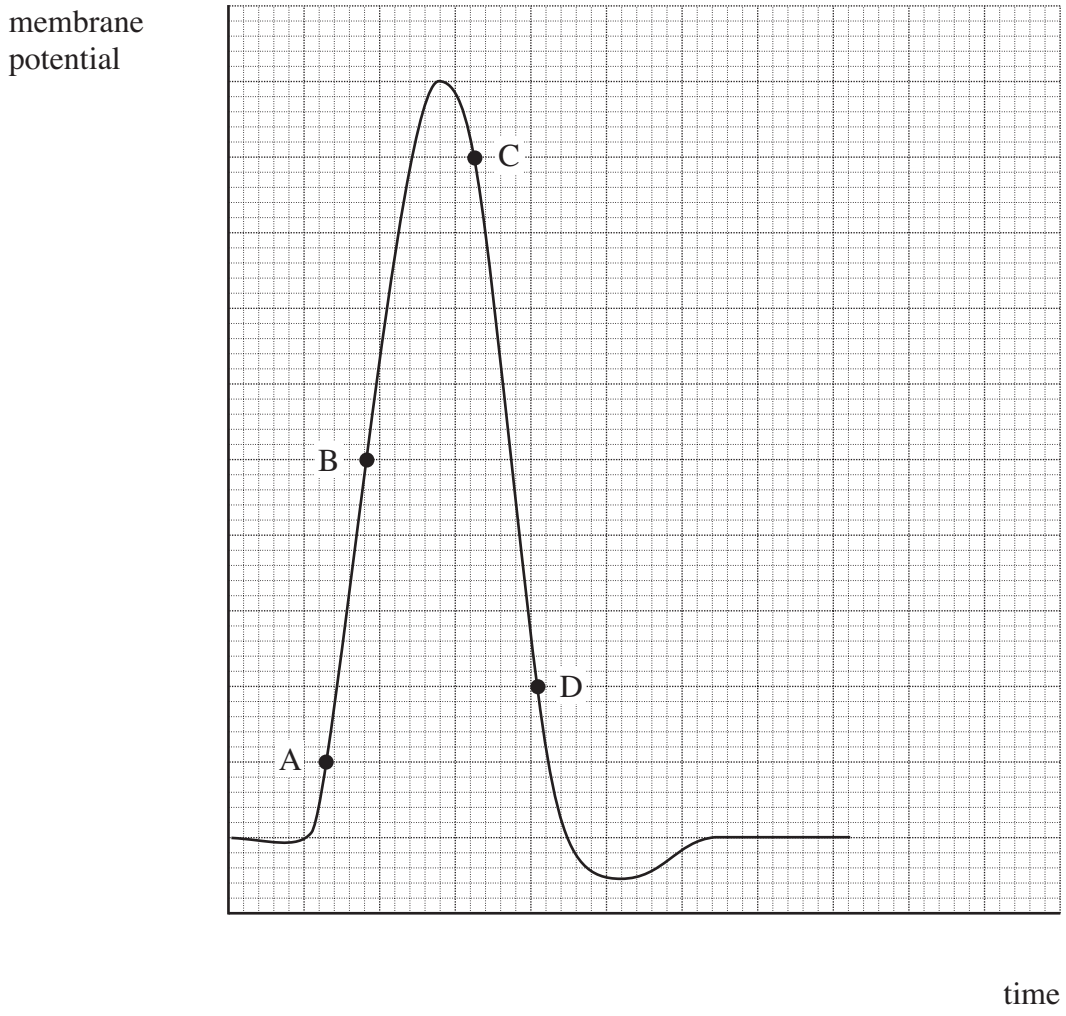
(2 marks)

8

Turn over ▶

4 **Figure 2** shows how the membrane potential of a nerve cell varies with time.

Figure 2



4 (a) Complete **Figure 2** by adding units and values to both axes.

(3 marks)

4 (b) (i) State the value of the resting potential.

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(1 mark)

4 (b) (ii) Name the process involved between points A and B on the curve and describe the ion movement which produces this change.

process .....

ion movement .....

.....

(2 marks)

4 (b) (iii) Name the process involved between points C and D on the curve and describe the ion movement which produces this change.

process .....

ion movement .....

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(2 marks)

8

END OF QUESTIONS

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