A-level

Physics

PHYA5/2B – Medical Physics

Mark scheme

2450

June 2016

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Question	Answers	Additional Comments/Guidance	Mark	ID details
1(a)(i)	The two images are formed on receptors/cells separated by at least one **unstimulated** receptor/cell	Allow images separated by at least 2 cell diameters	1	
1(a)(ii)	Cones are used as **ONLY** cones at fovea		1	
1(a)(iii)	Distance images apart on retina = 2 x cone diameter Diameter = $(0.130 \times 10^{-3} \times 52 \times 10^{-3}) / 2 = 3.4 \times 10^{-6}$ m	Allow 1 mark for correct sep of images calc. $(0.130 \times 10^{-3} \times 52 \times 10^{-3})$ in calc Allow 1 mark for wrong distance calc divided by 2 for final answer/ angle divided by 2	1 1	
1(b)(i)	Ciliary muscles relax / suspensory ligaments contract Producing lens of less power / greater focal length	Allow decreasing the curvature of the lens/flatter/thinner/less spherical	1 1	
1(b)(ii)	Cones stop working and rods start enlarged pupil Then the third mark for **either** dark adaptation – takes some mins for rods to fully function / eye to **adapt** **or** (Iris) circular muscles relax / (iris) radial muscles contract	 Accept dilated pupil Accept concentric for cicular	1 1 1	
Total			9	

uestion	Answers	Additional Comments/Guidance	Mark	ID details
2(a)	(Intensity) measured on dBA scale / adjusted scale which mimics normal ear (so values around 0dBA) at all frequencies		1 1	
2(b)(i)	Figure 2 - falling to larger values as frequency increases	Start must be between 0 and 20 dBA must not consistently go above 0dBA must cover the 0.125 to 8 kHz range can go on after 8 kHz	1	
2(b)(ii)	Figure 3 – falling to larger values and then going up to smaller values as frequency increases Maximum value at f = 4 kHz	Start must be between 0 and 20 dBA must not consistently go above 0dBA must cover the 0.125 to 8 kHz range can go on after 8 kHz	1 1	
2(c)(i)	$I = I_0 \times 10^{9.2}$ or correct substitution in formula $I = 1.6 \times 10^{-3}$ W m^{-2}		1 1	
2(c)(ii)	Use of $4 \times \pi \times 400 \times 400$ Correct calc to give 3.2×10^{3} W	Allow ecf from previous calculation	1 1	
Total			9	

Question	Answers	Additional Comments/Guidance	Mark	ID details
3(a)	Alternating pd applied across the electrodes/crystal Causes crystal to expand and contract Produces (ultrasonic) vibrations at front of membrane Backing material damps vibration of the crystal when pd is removed	Max 3 Any reverse argument converting ultrasound to signal gains zero	3	
3(b)	To allow probe to act as a receiver	Auto marked	1	
3(c)	Needed between probe and skin If air present, large difference in acoustic impedance so little transmitted / Gel excludes air and has acoustic impedance close to that of skin Gel maximises transmission	 Use of minimising/maximising pulses/waves penalises 1 mark from last 2 marks Accept minimises reflection	1 1 1	
Total			7	

Question	Answers	Additional Comments/Guidance	Mark	ID details
4(a)	Points to be considered: A – glass envelope. This is needed to allow low pressure within the tube B – heated cathode. Heated to provide thermionic emission of electrons from the surface C – anode. Used to accelerate electrons across the gap between cathode and anode. lead shielding - Prevents much of the emission in unwanted directions. The anode rotates to allow heat to be dissipated over greater area and thus allows longer use without over-heating. The anode is bevelled to allow a larger 'target' area for the electrons, whilst also producing a smaller 'source' area for the photons in the required direction. Low pressure is required in the tube to allow the electrons to be accelerated across the gap without colliding with gas atoms and losing energy in the collision. Electrons colliding with anode material excite / ionise the atoms and as the atoms de-excite X-ray photons of specific energies are produced. Electrons can also be decelerated as they pass through the anode. The energy of the X-ray photon is equal to the energy lost by the decelerated electron. This can be any value from the max energy of the electron to zero. This produces a continuous background spectrum of X-ray photon energies. Good candidates will name and state the use of the labelled components and will expand on a property of the anode and suggest why some X-rays are produced.		6	

	Middle candidates will name and state the use of 3 or all of the labelled components. They may try to expand on the anode properties or the method of X-ray production. Poor candidates may be able to name some labelled components, but will fail to apply the ideas.			
4(b)(i)	Thickness of material needed to reduce (beam) intensity by half	Accept (beam) power NOT energy	1	
4(b)(ii)	ln2 / 15 = 0.046	Use of 50 and 25 is EOP	1	
4(b)(iii)	% $I_T / I_0 = e^{-(0.046 \times 12)} \times 100$ = 58 %	 If 0.0462 is used, the answer 57.4 or 57 is correct	1 1	
Total			10	