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General Certificate of Education (A-level)
June 2013

Physics A PHA5B

(Specification 2450)

Unit 5B: Nuclear and Thermal Physics

Medical Physics

Final

Mark Scheme

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Section B – Medical Physics

Question	Part	Sub Part	Marking Guidance	Mark	Comments
1	(a)		**Only** cones at fovea ✓ as you move away from fovea fewer cones more rods ✓	2	Allow centre for fovea
1	(b)		three labelled curves blue, green, red in order from left to right ✓ roughly at correct height ✓ Green > Red >> Blue each curve covers the correct range of wavelengths Blue 375 to 500; Green 425 to 675; Red 475 to 725 (all + or – 30} ✓	3	Green>red>2/3green Blue<1/4green
1	(c)		the two images fall on receptors with at least one (unstimulated) receptor between them ✓	1	Allow 'separated by at least 2 cell diameters'
1	(d)		Cones used in bright light, rods used in dim light resolution in bright light better because size of cones smaller than size of rod: or resolution in dim light worse because several rods connected to 1 nerve (well away from fovea)	2	Do not accept, 'greater density of cones'
2	(a)		**The candidate's writing should be legible and the spelling, punctuation and grammar should be sufficiently accurate for the meaning to be clear.** The candidate's answer will be assessed holistically. The answer will be assigned to one of three levels according to the following criteria. **Good to Excellent** The information conveyed by the answer is clearly organised, logical and coherent, using appropriate specialist vocabulary correctly. The form and style of writing is appropriate to answer the question. *The candidate explains the principles of transfer of vibrations, from mechanical vibration of the ear drum, through mechanical oscillations of*	Mark range 5-6	

			the malleus, incus and stapes acting as a lever system, producing mechanical vibration of the oval window and then pressure waves in the fluid in the cochlea. They use the correct names of the relevant parts of the ear *They then explain the increase in pressure with sensible use of numbers, reduction in area of about 20 and increase in force of about 1.5, resulting in pressure increase of about 30.* **Modest to Adequate** The information conveyed by the answer may be less well organised and not fully coherent. There is less use of specialist vocabulary, or specialist vocabulary may be used incorrectly. The form and style of writing is less appropriate. *The candidate explains some of the principles of transfer of vibrations and mentions some of the names of the relevant parts of the ear. They talk about the increase in pressure, but may fail to add relevant numbers* **Poor to Limited** The information conveyed by the answer is poorly organised and may not be relevant or coherent. There is little correct use of specialist vocabulary. The form and style of writing may be only partly appropriate. *The candidate explains a principle of transfer of vibrations or explains the increase in pressure and mentions at least one of the names of the relevant parts of the ear* **Incorrect, Inappropriate or No Response** No answer at all or answer refers to unrelated, incorrect or inappropriate physics. **The explanation expected could include the following:** Outer ear acts as a funnel gathering waves into the ear canal pressure waves incident on eardrum eardrum vibrates, mechanical vibrations mechanical vibrations passed through a system of three bones acting as	3-4 2-1 0	

			levers malleus, incus and stapes the last bone sets the oval window into mechanical vibration this produces pressure waves in the liquid in the cochlea. three bone lever system increase force by about 1.5 (1.3 to 1.7) times ✓ cross sectional area of the oval window about 20 (15 to 25) times less than the cross sectional area of the eardrum ✓ larger force / smaller area gives pressure about 30 times greater, (any answer for pressure, to agree with other values quoted)		
2	(b)		Intensity is the power per unit (cross-sectional) area (in path of the wave) ✓ At normal incidence ✓	2	
2	(c)		rearrange equation to give I= ✓ correct answer 2.5(12) x 10^{-7} W m^{-2} ✓ correct to 2 sig figs ✓	3	
3	(a)		Alternating potential difference applied across the crystal ✓ causes crystal to expand and contract ✓ creating pressure waves in the crystal / plastic membrane ✓ frequency of alternating pd equal to that of crystal /resonant frequency of crystal✓ which is above 20 kHz ✓ short application of ac to produce short pulse ✓ use of backing material to damp and stop vibration of crystal ✓	Max 4	
3	(b)	(i)	correct calculation of ratio $I_r / I_i = 0.99896$ ✓ subtract from 1 and multiply by 100 to give 0.10% ✓	2	Do not give mark for 99.8 ecf from calc for 2nd mark

3	(b)	(ii)	gel is between the probe and the skin to exclude air ✓ gel should have acoustic impedance equal/close to that of the skin/soft tissue ✓ to ensure maximum transmission/greatly increase transmission into the body: or to minimise reflection / greatly reduce reflection at body boundary ✓	Max 2	

4	(a)		both mV and ms labelled as units ✓ time scale 0 to 5 overall time for peak shape to be >0.75 ms and <4ms ✓ potential scale resting -70 to peak +30; (allow values between -90 and -70: +20 and +40) ✓	3	Allow any correct units, but then values on scales must match

4	(b)	(i)	-70mV ✓	1	Ecf from graph

4	(b)	(ii)	Depolarisation ✓ Na^+ ions into the membrane/cell/axon ✓	2	Need positive sodium ions

4	(b)	(iii)	Repolarisation ✓ K^+ ions out of the membrane/cell/axon ✓	2	Need positive potassium ions