Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2012

Physics

Assessment Unit AS 2

Module 2: Waves, Photons and Medical Physics

[AY121]

MONDAY 18 JUNE, MORNING

MARK SCHEME

1 **(a)** 350–400 to 700–800 nm [1]

(b)

		Increases	Decreases	Stays the same
(i)	Frequency of the wave	✓		
(ii)	Energy per photon of the wave	✓		
(iii)	Speed of the wave			✓

[1] each correct [3]

(c) **(i)** Amplitude 2.5 cm ± 0.1 [1]
Period/Frequency 4 s/0.25 Hz(s^{-1}) [1] [2]

(ii) 90° or 270° [1] [1] 7

2 **(a)** **(i)** Passes from one medium/material into another
(different refractive index (optical) density) [1]
at an angle > 0° [1] [2]

(ii) (Incident at boundary) between **more dense** medium into
less dense [1]
Angle must be **greater** than the critical angle [1] [2]

(b) **(i)** $d = 5000 \times 25 \times 10^{-3}$ **or** d = 125 m [1]
62.5 (cos 35) ecf for d [1]
51.2 m [1] [3]

(ii) $\frac{\text{Sin } 35}{\text{Sin } 90} = \frac{v_A}{v_B}$ or n = 0.57 [1]
$v_B = 8720 \text{ m s}^{-1}$ [1] [2] 9

3 **(a)** **(i)** Distance from bulb to lens marked as u and screen to lens as v [1]

(ii) Graph of 1/u against 1/v (or 1/v against 1/u) [1]
Read intercept [1]
f = 1/intercept [1]
or **or** v/u graph
Evaluate $\frac{1}{u} + \frac{1}{v}$ with u = v line [1]
intercept 2f
Determine f for **each pair** [1]
Average to obtain f [1] [3]

(b) **(i)** 250 = v/u and $\frac{1}{4} = 1/u + 1/v$ [1]
Further correct subs, e.g. $\frac{1}{4} = 250/v + 1/v$ [1]
Correct calculation leading to 1004 [1] [3]

(ii) (u = v/250 =) 4.02 cm
$\left(\textbf{or } \frac{1}{u} = \frac{1}{v} - \frac{1}{f} \right)$ [1] 8

AVAILABLE MARKS

						AVAILABLE MARKS
4	**(a)**	**(i)**	Waves have equal frequency/speed **or** Reflected wave meets incident wave	[1]		
			Superposition/interference occurs	[1]	[2]	
		(ii)	Antinode drawn at transducer. Node at reflector	[1]		
			1st overtone correctly drawn and labelled	[1]	[2]	
	(b)	**(i)**	$v = f\lambda$, subs 340 = 13 500 λ giving λ = 0.0252 m	[1]		
			$\frac{3}{4}\lambda$ = 0.019 m = 1.9 cm (1.89)	[1]	[2]	
		(ii)	0.63 cm (0.625 cm) ecf **(i)**		[1]	7
5	Labelled diagram showing: laser/light (and filter) + single slit			[1]		
	Double slits and screen			[1]		
	Distance from slits to screen 1m–5m			[1]		
	Slit separation 0.1 mm–0.5 mm			[1]		
	Pattern of bright and dark fringes			[1]		
	Equally spaced			[1]		
	(Interference) – dark where waves meet out of phase, light where waves in phase and superpose			[2]	[8]	8
6	**(a)**	**(i)**	So that the sound is **not** just heard in a **straight line in front** of the speaker/sound **spreads** out around the room **or** similar explanation		[1]	
		(ii)	Smaller opening/110 mm	[1]		
			Higher frequency = shorter wavelength, (best diffraction)	[1]		
			Best diffraction occurs when opening is similar to wavelength of wave	[1]	[3]	
	(b)	**(i)**	Power per unit area/energy per second per unit area		[1]	
		(ii)	Correct single subs	[1]		
			72.6 dB or 90.8 dB calculated	[1]		
			18.2 dB	[1]	[3]	8
7	**(a)**	**(i)**	B scan		[1]	
		(ii)	1–15 MHz		[1]	
	(b)	(Relatively) inexpensive No harmful/ionising radiation Good for soft tissue (Any **two**, [1] each)			[2]	
	(c)	e.g. Water-based/cellulose jelly, film of oil		[1]		
		Ensures most of the ultrasound enters the body		[1]		
		Prevents reflection at the boundary		[1]	[3]	7

					AVAILABLE MARKS
8	**(a)**	Photoelectric effect		[1]	
	(b)	Increase frequency/reduce wavelength/use UV	[1]		
		Frequency must be above threshold frequency **or** photons must have energy > work function	[1]		
		Energy and frequency (E = hf) related	[1]	[3]	
	(c)	Takes different amounts of energy to get them to the surface	[1]		
		Excess energy = kinetic energy	[1]	[2]	6
		Energy level reference → [0]/[2]			
9	**(a)**	Uses E = hf and c = fλ **or** E = hc/λ	[1]		
		4.58×10^{-19}	[1]	[2]	
	(b)	Lines getting closer towards top	[1]		
		All values correct, $(-0.87, -1.36, -2.42) \times 10^{-19}$	[1]		
		1 or 2 values correct (penalise no "negatives" only once)	[1]	[3]	
	(c)	Population inversion Metastable state Stimulated emission } Exact words not required	[1] [1] [1]	[3]	
		Quality of Written Communication			
		2 marks The candidate expresses ideas clearly and fluently, through well-linked sentences and paragraphs. Arguments are generally relevant and well-structured. There are few errors of grammar, punctuation and spelling.			
		1 mark The candidate expresses ideas clearly, if not always fluently. Arguments may sometimes stray from the point. There are some errors in grammar, punctuation and spelling, but not such as to suggest a weakness in these areas.			
		0 marks The candidate expresses ideas satisfactorily, but without precision. Arguments may be of doubtful relevance or obscurely presented. Errors in grammar, punctuation and spelling are sufficiently intrusive to disrupt the understanding of the passage.		[2]	10
10	**(a)**	Electrons **or** particles behave as waves		[1]	
	(b)	Subs into $\lambda = \frac{h}{p}$ **or** $\lambda = \frac{h}{mv}$	[1]		
		Realisation that mass must be determined	[1]		
		Calculates mass = 9.11×10^{-31} kg	[1]		
		Compares calculated mass with that quoted in the Data and Formulae Sheet	[1]	[4]	5
				Total	**75**