Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2014

Physics

Assessment Unit AS 2

assessing

Module 2: Waves, Photons and Medical Physics

[AY121]

THURSDAY 19 JUNE, MORNING

MARK SCHEME

Subject-specific Instructions

In numerical problems, the marks for the intermediate steps shown in the mark scheme are for the benefit of candidates who do not obtain the final correct answer. A correct answer and unit, if obtained from a valid starting-point, gets full credit, even if all the intermediate steps are not shown. It is not necessary to quote correct units for intermediate numerical quantities.

Note that this “correct answer” rule does not apply for formal proofs and derivations, which must be valid in all stages to obtain full credit.

Do not reward wrong physics. No credit is given for consistent substitution of numerical data, or subsequent arithmetic, **in a physically incorrect equation**. However, answers to subsequent stages of questions that are consistent with an earlier incorrect numerical answer, and are based on physically correct equation, must gain full credit. Designate this by writing **ECF** (Error Carried Forward) by your text marks.

The normal penalty for an arithmetical and/or unit error is to lose the mark(s) for the answer/unit line. Substitution errors lose both the substitution and answer marks, but 10^n errors (e.g. writing 550 nm as 550×10^{-6} m) count only as arithmetical slips and lose the answer mark.

					AVAILABLE MARKS
1	(a)	(i)	a periodic disturbance	[1]	
		(ii)	EM/Transverse **oscillations perpendicular** to **direction of travel** [1] Longitudinal **oscillations** are **parallel** [1]	[2]	
	(b)	(i)	microwave, visible, X-ray ([1] each)	[3]	
		(ii)	choose 3.2 cm [1], $f = c/\lambda$ and subs [1], 9.4×10^9 Hz [1] ecf within part for 560 pm gives S.E. 5.4×10^{17} Hz [1]	[3]	
	(c)	(i)	oscillations/vibrations are confined to one plane	[1]	
		(ii)	Rotation of polaroid (in front of source) [1] to show extinction [1]	[2]	
	(d)		EM waves travel at the speed of light (others much slower) **or** EM travel through vacuum (others require a medium) **or** EM variation in E and B fields (others particle oscillation)	[1]	13
2	(a)	(i)	axes labelled sin i and sin r [1], straight line through origin drawn [1]	[2]	
		(ii)	gradient of line if sin i vs sin r, $(\text{grad})^{-1}$ if sin r vs sin i	[1]	
	(b)	(i)	$\sin C = (1.37)^{-1}$ [1], C = 46.9° [1]	[2]	
		(ii)	angle of incidence i = 45° **or** i < C therefore no TIR [1] angle of refraction in air r > i in glass therefore not 1 [1] ray 2 chosen [1] ecf **(i)**	[3]	8
3	(a)		the point to which rays **parallel** to principal axis converge [1] after passing through the lens [1]	[2]	
	(b)	(i)	two rays correctly drawn from image [1], [1] object located and labelled [1], arrows [1]	[4]	
		(ii)	(object moved further from lens [1]), further than 2f [2]	[2]	
	(c)	(i)	subs 1/300 = 1/240 + 1/v into formula [1] calculates v = 1200 mm [1]	[2]	
		(ii)	m = v/u = 1200/240 = 5 ecf from **(c)(i)** Eqn or subs [1] image h = 30 × 5 = 150 mm ecf for m [1]	[2]	
		(iii)	Virtual, magnified, erect ([1] each) ([–1] for each mistake to [0])	[2]	
		(iv)	power = 3.33 [1] dioptres or m^{-1} [1]	[2]	16

				AVAILABLE MARKS
4	(a)	sketch to show resonance tube in water container [1] and loudspeaker with sig. gen. or tuning fork (just above open end) [1]	[2]	
	(b)	beginning at lowest level/shortest tube [1], (slowly) raise inner tube [1] **or** beginning at low frequency [1], slowly increase frequency of signal [1] until (considerable) increase in loudness is detected [1]	[3]	
	(c)	(read frequency and) length of **air column** [1], calculate v = 4 f l [1] Repeat for various f values and average for V [1] Second mode of vibration method is acceptable Graphical analysis is acceptable	[3]	
	(d)	superposition [1] source and reflected waves in tube [1] driving frequency = natural frequency [1]	[3]	11
5	(a)	**(i)** min of **curve** at 10^{-12} and just above 10^{3} [1] (gentle slope to left of min) up to almost 10^{1} + f ≈ 10 Hz [1] (steeper slope to the right) up to almost 10^{-1} + f ≈ 10^{4} Hz [1]	[3]	
		(ii) very large range of frequencies to cover	[1]	
	(b)	**(i)** correct subs shown in equation	[1]	
		(ii) 5% of 0.1 W m^{-2} = 5 × 10^{-3} W m^{-2} [1], subs to give 97 dB [1] reduction of 13 dB [1] ecf defender dB S.E. 0.2 dB [2]	[3]	
	(c)	reflection of ultrasound from tissue boundaries (internal) [1] output is spikes/peaks on a time-based display [1] from which distances/depths are calculated [1] 1–15 MHz [1]	[4]	
		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]	14

					AVAILABLE MARKS
6	(a)	(i)	**photons** of specific wavelength are emitted [1] which are the result of electron transitions [1] between discrete/allowed energy levels within the atom [1]	[3]	
		(ii)	$E = hc/\lambda$ [1], correct subs to give 3.03×10^{-19} J [1] J → eV conversion for 1.89 eV [1]	[3]	
	(b)	(i)	photoelectric effect	[1]	
		(ii)	There was an error in this question. In the question, the word 'longer' was replaced by 'lower' meaning that candidates were not able to answer the question. Therefore this question was disregarded. Question 6 was marked out of 10 marks instead of 13 marks. The candidate's mark out of 10 was then multiplied by 1.3 to bring the question total back to 13.		
	(c)	(i)	wavelength associated with a moving mass/particle	[1]	
		(ii)	correct subs into eqn. [1] $v = 5.92 \times 10^{5}$ m s^{-1} [1]	[2]	13
				Total	**75**