Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2015

Physics

Assessment Unit AS 2

assessing

Module 2: Waves, Photons and Medical Physics

[AY121]

THURSDAY 18 JUNE, MORNING

MARK SCHEME

Subject-specific Instructions

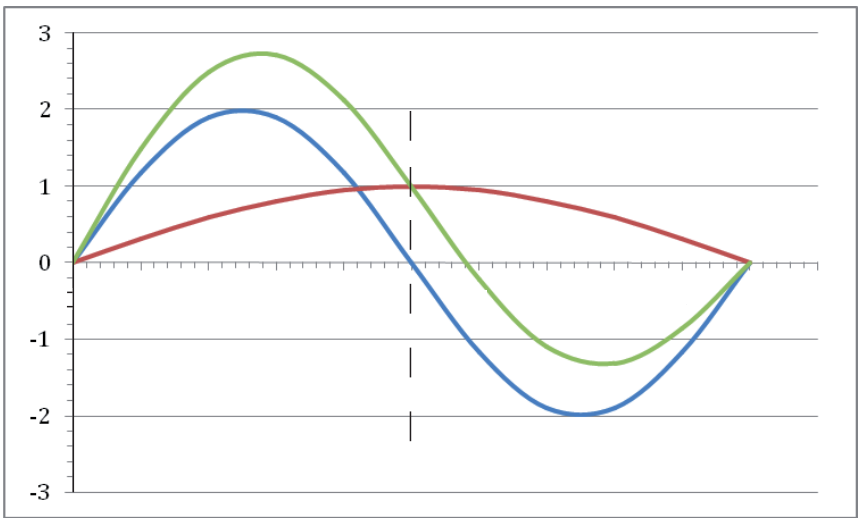
In numerical problems, the marks for the intermediate steps shown in the mark scheme are for the benefit of candidates who do not obtain the final correct answer. A correct answer and unit, if obtained from a valid starting-point, gets full credit, even if all the intermediate steps are not shown. It 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 a 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)**	Micro, IR, visible, UV, X-rays [–1] for each missing or in wrong order	[2]	
	(b)	v = fλ or subs [1] 3.2 m [1]	[2]	
	(c)	Em are transverse/sound longitudinal Em can travel through a vacuum/sound needs a medium to travel through Em waves can be polarised/sound can't [1] each correct answer	[3]	7
2	**(a)**	At i = 0 ° the light ray passes straight out or without bending. [1] As i increases the light bends away from the normal as it leaves the water [1] At i = critical angle light bends/travels along the surface of the water [1] At i larger than critical angle the light undergoes total internal reflection [1] Identifying partial reflection [1]	[5]	
	(b) **(i)**	$n = \frac{\sin i}{\sin r}$ [1] Subs [1] Shows ans to > 2 sf: 1.37 [1]	[3]	
	(ii)	Refractive index of cornea and water are similar [1] Light will not refract enough (to be focused) [1]	[2]	10
3	**(a)** **(i)**	Move screen [1] Get focused image [1] (Use metre rule/ruler) measure from (centre of) lens to screen [1]	[3]	
	(ii)	Using set 1 Penalty [–1] for using another set [1] $m = \frac{v}{u} = \frac{32.5}{15.0} = 2.15$ Eq^n, subs or ans [1] 2.15 × 5 = 10.73 cm ECF (m) ans [1]	[3]	
	(b)	Correct subs of any set of values into $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ [1] Calculates 3 correct values: 10.2 (10.23), 10.3 (10.31), 10.3 (10.26) [1] Averages values: 10.3 (10.27) [1] Use of mean *u* and mean *v* → [0]	[3]	
	(c)	Image wouldn't be formed on a screen or there would be no image [1] Object would be inside the focal point [1] Allow ECF **(b)** but max [1]	[2]	11

					AVAILABLE MARKS
4	(a)	When 2 waves meet/interfere the (resultant) displacement is equal to the **vector** sum of the individual displacements	[1] [1]	[2]	
	(b) (i)	Different frequencies/wave (sources) not coherent		[1]	
	(ii)				
		• Resultant higher than original waves initially • Crossing at correct point • Resultant correct after crossing point	[1] [1] [1]	[3]	
	(c) (i)	7 nodes, 6 antinodes		[1]	
	(ii)	Wavelength = 30 (cm) Speed = 21 ($m\,s^{-1}$) or 2100 (cm s^{-1}) Wavelength of 1st resonance = 180 (cm) f = 11.7 Hz	or v constant $\therefore$ f/6 as 6λ [1]	[1] [2]	9
5	(a)	Destructive interference		[1]	
	(b) (i)	Measures multiple fringes – must see evidence		[1]	
		Value = (measure when printed) ± 1 mm $\left(\frac{2.6}{4}\right)$ 6 mm ⩽ value ⩽ 7 mm	[1]	[2]	
	(ii)	$650 \times 10^{-9} = \frac{0.2 \times 10^{-3} \times \text{(their (b)(i))}}{D}$		[1]	
		D = (ans inserted when measurements for **(b)(i)** are taken from paper) 2.0 m	[1]	[2]	5

						AVAILABLE MARKS
6	(a)	(i)	Microphone		[1]	
		(ii)	Sine/cosine curve	[1]		
			Use timebase setting	[1]		
			Further detail, e.g. Multiply timebase setting by length of 1 complete cycle to find T or correct alternative	[1]		
			F = 1/T	[1]	[4]	
	(b)		**Spreading out** of a wave as it passes through a gap/around an obstacle	[1]		
			Gap width equal to wavelength of the wave	[1]	[2]	7
7	(a)		Comput**ed** tomography		[1]	
	(b)		Same type of radiation used/X-rays used in both	[1]		
			Amount of radiation is much larger in CT scan	[1]	[2]	
	(c)		Pregnant woman	[1]		
			Ionising radiation could harm (the foetus)	[1]	[2]	
	(d)		Puts together the images to form 3D information		[1]	6
8	(a)	(i)	(Discrete) bundle/packet of em energy	[1]		
			Electron moving from higher energy level to a lower one	[1]	[2]	
		(ii)	$E = \frac{hc}{\lambda}$	[1]		
			Subs	[1]		
			4×10^{-7} m	[1]	[3]	
		(iii)	J – eV conversion 3.11 (3.106) eV	[1]		
			–4.23 + 3.11	[1]		
			–1.12 eV	[1]	[3]	
			Penalty [–1] for positive value			
	(b)	(i)	Any medical use, e.g. cutting, tattoo removal, hair removal etc.			
			Reshaping eye lens/cornea			
			Use in keyhole surgery		[1]	
		(ii)	Zero phase difference	[1]		
			Only 1 colour/wavelength present	[1]		
			Narrow beam/light rays are parallel	[1]	[3]	12

			AVAILABLE MARKS
9	Wave behaviour: (any 3) Light shows diffraction Detail, e.g. Diffraction observable when slit size is similar to wavelength Polarisation Interference Detail, e.g. Young's double slit experiment } 2 named phenomena + 1 detail Particle Behaviour: (any 3) Photoelectric effect Detail, e.g. threshold frequency, intensity of light having no effect below f_0, increased ke as freq increases above f_0. [1] each correct statement	[6]	
	Quality of written communication **[2]** 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]** The candidate expresses ideas clearly, if not always fluently. There are some errors in grammar, punctuation and spelling, but not such as to suggest weakness in these areas. **[0]** 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]	8
		Total	**75**