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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics 5456

Specification B

PHB2 Waves and Nuclear Physics

Mark Scheme

2008 examination - January series

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Dr Michael Cresswell Director General

NOTES

Letters are used to distinguish between different types of marks in the scheme.

M indicates OBLIGATORY METHOD MARK
This is usually awarded for the physical principles involved, or for a particular point in the argument or definition. It is followed by one or more accuracy marks which cannot be scored unless the M mark has already been scored.

C indicates COMPENSATION METHOD MARK
This is awarded for the correct method or physical principle. In this case the method can be seen or implied by a correct answer or other correct subsequent steps. In this way an answer might score full marks even if some working has been omitted.

A indicates ACCURACY MARK
These marks are awarded for correct calculation or further detail. They follow an M mark or a C mark.

B indicates INDEPENDENT MARK
This is a mark which is independent of M and C marks.

e.c.f is used to indicate that marks can be awarded if an error has been carried forward (e.c.f. must be written on the script). This is also referred to as a 'transferred error' or 'consequential marking'.

Where a correct answer only **(c.a.o.)** is required, this means that the answer must be as in the Marking Scheme, including significant figures and units.

Only **one** unit penalty **(u.p.)** in this paper unless there is a mark allocated specifically for giving a correct unit in the marking. Note that the unit is only penalised in the final answer to the question.

Only **one** significant figure penalty **(s.f.)** in this paper.
Allow 2 or 3 s.f. unless otherwise stated. s.f. penalties include recurring figures and fractions for answers.

c.n.a.o. is used to indicate that the answer must be numerically correct but the unit is only penalised if it is the first error or omission in the section (see below).

Marks should be awarded for **correct** alternative approaches to numerical question that are not covered by the marking scheme. A correct answer from working that contains a physics error (PE) should not be given credit. Examiners should contact the Team Leader or Principal Examiner for confirmation of the validity of the method, if in doubt.

Quality of Written Communication

Before accessing marks for the Quality of Written Communication (QWC) a candidate must first score a minimum of one mark for the physics that is being communicated – this will allow access to 1 mark for QWC. If the candidate scores more marks for physics (a minimum of two or three – depending upon the total mark for that part of the question) then this will allow access to 2 marks for QWC.

Good QWC: the answer is fluent/well argued with few errors in spelling, punctuation and grammar	**2**	
Poor QWC: the answer lacks coherence or spelling, punctuation and grammar are poor	**1**	**Max 2**
Very Poor QWC: the answer is disjointed, with significant errors in spelling, punctuation and grammar	**0**	

PHB2 Waves and Nuclear Physics

Question 1				
(a)	(i)	6	**B1**	**2**
	(ii)	0.18 m	**B1**	
(b)	(i)	$v = f\lambda$ or $v = 900 \times 0.18$ (their (a) (ii))	**C1**	**3**
		162 m s^{-1} (e.c.f their (a) (ii) $\times$ 900)	**A1**	
	(ii)	20	**B1**	
			Total	**5**

Question 2				
(a)	(i)	meson	**B1**	**3**
	(ii)	(+) 1.6 $\times$ 10^{-19} C	**B1**	
	(iii)	anti-u + d	**B1**	
(b)		-1 if proton ticked -1 if alpha particle ticked -1 if only 2 ticks and both correct	**B2**	**2**

proton	tau	anti-neutrino	alpha particle	electron
	✓	✓		✓

			Total	**5**

Question 3				
(a)	(i)	refraction	**B1**	**3**
	(ii)	change in velocity/speed when light moves into atmosphere	**C1**	
		caused light moving slower in the atmosphere	**B1**	
(b)		energy reflected by the atmosphere	**B1**	**max 2**
		energy absorbed by the atmosphere	**B1**	
		energy scattered by particles in atmosphere	**B1**	
			Total	**5**

Question 4			
(a)	test Id^2 – constant stated or implied two correct calculations from 0.352; 0.350; 0.360 three correct calculations valid alternative approaches acceptable	**B1** **B1** **B1**	**3**
(b)	$I = \frac{P}{4\pi r^2}$ or correct substitution 4.5 to 4.6 W (up)	**C1** **A1**	**2**
(c)	inverse square law only applies to point source loudspeaker is not a point source loudspeaker directs energy in particular direction energy losses when vibrating the air diffraction effects	**B1**	**1**
		Total	**6**

Question 5				
(a)	(i)	speed at which the astronomical object is moving away from the Earth (not the speed of the astronomical object)	**B1**	**3**
	(ii)	≈ 500 km s^{-1} Mpc^{-1}	**B1** **B1**	
(b)		a body moving at the speed of light would be at the limit of the observable universe substitute 3×10^8 for v in $v = Hd$	**B1** **B1**	**2**
			Total	**5**

Question 6			
(a)	two waves which have constant phase difference (and the same frequency)	**B1**	
	plus any **four** from:		
	waves from transmitters superpose or interfere	**B1**	
	path difference mentioned	**B1**	**max 5**
	maximum when signals are in phase or pd = $n\lambda$	**B1**	
	minimum when they are in antiphase or pd = $(n + ½)\lambda$	**B1**	
	link between path difference and phase difference	**B1**	
	as plane moves the signals move in and out of phase	**B1**	
	At least 2 marks for physics + **Good QWC** At least 2 marks for physics + **Poor QWC** At least 2 marks for physics + **Very Poor QWC** 1 mark for physics + sufficient attempt + **Good or Poor QWC** 1 mark for physics + insufficient attempt or **Very Poor QWC** No marks for physics or **Very Poor QWC**	**2** **1** **0** **1** **0** **0**	**max 2**
(b) (i)	distance between the minimums = 3.2 × 125 = 400 m	**B1**	
(ii)	$y = \frac{\lambda D}{d}$	**C1**	**4**
	$400 = \frac{32D}{550}$	**C1**	
	6900 m	**A1**	
		Total	**11**

Question 7				
(a)	(i)	correct point indicated	**B1**	**5**
	(ii)	$\frac{\Delta f}{f} = \frac{v}{c}$ or correct substitution	**C1**	
		$5.8 \times 10^4\,\text{m s}^{-1}$	**A1**	
	(iii)	$2.4 \times 10^{11}\,\text{Hz}$	**B1**	
	(iv)	frequency is higher	**B1**	
(b)		$d \sin\theta = n\lambda$	**C1**	**4**
		correct substitution	**C1**	
		$d = 1.269 \times 10^{-6}\,\text{m}$	**C1**	
		lines per mm = $1 \times 10^{-3}/1.269 \times 10^{-6}$ = 788 (790)	**A1**	
(c)		two from temperature of surface/intensity/star	**B1**	**2**
		type/composition/age/distance from Earth	**B1**	
			Total	**11**

Question 8				
(a)	(i)	1 alpha particle	**B1**	**5**
		1 beta particle	**B1**	
	(ii)	(electron) antineutrino	**B1**	
	(iii)	appreciation that beta particles are to be detected	**B1**	
		if walls are thick betas would not be detected by the GM tube	**B1**	
		or beta particles are not very penetrating/easily absorbed		
		or walls need to be low density and thin to maximise count rate		
		or polythene stops alphas		
(b)	(i)	decay is a random process	**B1**	**7**
		sample is of low activity so fluctuations more noticeable	**B1**	
	(ii)	need to account for background/count rate due to sample is lower than recorded	**B1**	
		actual count rate is measured count rate - background	**B1**	
	(iii)	method correct from working	**C1**	
		one determination in range 70 ± 5 s	**C1**	
		repeat and average using correct data	**A1**	
			Total	**12**

Question 9				
(a)		allows many channels/more information along same communication path simultaneously	**B1**	**max 2**
		adds/converts/modulates/superimposes an audio signal on to a radio frequency	**B1**	
		carrier frequency is a high frequency	**B1**	
		higher frequency enables transmission over long distances	**B1**	
(b)	(i)	amplitude	**B1**	**2**
	(ii)	frequency	**B1**	
(c)		period of information = 2×10^{-4} s	**B1**	**3**
		frequency = $1/T$ = 5000 Hz	**B1**	
		10 000 Hz	**B1**	
		or minimum bandwidth = 2 × frequency transmitted		
			Total	**7**

Question 10			
	any two X-rays are electromagnetic or ultrasound are mechanical ultrasound frequencies are much lower than X-ray frequencies X-rays are more penetrating than ultrasound X-rays are transverse waves/ultrasound longitudinal waves **any two** advantages of ultrasound less dangerous to patient and operator can yield information about fluid flow rate (blood) or organ movement no need for e.g. barium meals for contrast better contrast between soft tissue types real time display of movement **any two** disadvantages less penetrating reflect from surface so needs gels contrast/resolution is not as good as with X-rays	**B1** **B1** **B1** **B1** **B1** **B1** **B1** **B1** **B1** **B1** **B1** **B1**	**max 6**
	At least 2 marks for physics + **Good QWC** At least 2 marks for physics + **Poor QWC** At least 2 marks for physics + **Very Poor QWC** 1 mark for physics + sufficient attempt + **Good or Poor QWC** 1 mark for physics + insufficient attempt or **Very Poor QWC** No marks for physics or **Very Poor QWC**	**2** **1** **0** **1** **0** **0**	**max 2**
		Total	**8**