Version 1.0: 0807

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics 5456

Specification B

PHB2 Waves and Nuclear Physics

Mark Scheme

2007 examination - June 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.

Set and published by the Assessment and Qualifications Alliance.

The Assessment and Qualifications Alliance (AQA) is a company limited by guarantee registered in England and Wales (company number 3644723) and a registered charity (registered charity number 1073334).
Registered address: AQA, Devas Street, Manchester M15 6EX
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.

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).

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.

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)	sin $\theta = n\lambda/d$ correct substitution 23(.3)º	**C1** **C1** **A1**	**3**
(b)	realises that max value of sin θ is 1 or max value of θ is 90º 2 orders visible	**C1** **A1**	**2**
			Total 5

Question 2			
(a)	transverse - oscillations perpendicular to the direction of wave/travel longitudinal - oscillations are parallel to direction of energy transfer/propagation	**B1** **B1**	**2**
(b) (i)	lamp - vibrations in all planes (perpendicular to direction of propagation)/ polarised - vibrations confined to one plane	**B1**	**3**
(ii)	sound or seismic P waves particle oscillations in same direction as direction of wave (propagation) **or** only transverse waves can be polarised/longitudinal waves can't be polarised	**B1** **B1**	
			Total 5

Question 3			
(a)	bends nearer to the normal at 1st face total internal reflection at lower face some transmission at right hand face with refraction in correct direction	**M1** **A1** **A1**	**3**
(b)	difference in refractive index for different wavelengths/(change in) speed **or** angle of refraction different colours or wavelengths causes the white light to split into separate colours/wavelengths	**B1** **B1**	**2**
			Total 5

Question 4			
(a) (i)	down down up	**B1**	**2**
(ii)	up up down	**B1**	
(b)	proton + electron + neutrino	**B1**	**3**
	the numbers are correct on the neutron, proton and electron	**B1**	
	neutrino is an (electron) antineutrino	**M1**	
			Total 5

Question 5			
(a)	correct basic shape	**M1**	**2**
	no intercept in ordinate *and* intersects energy axis (at E_{max})	**A1**	
(b) (i)	idea that another particle must carry away energy for the betas with less energy than E_{max}	**B1**	**3**
(ii)	**any 2 out of 3:**		
	neutrino has no/very little mass	**B1**	
	neutrino has no charge	**B1**	
	interacts weakly with other matter	**B1**	
			Total 5

Question 6			
(a)	makes an appropriate correct calculation to test for inverse square law	M1	
	makes correct calculations involving all three data sets	A1	3
	suitable conclusion supported by appropriate argument	A1	
(b) (i)	**max two:**		
	background not accounted for/deadtime	B1	
	random nature of decay	B1	
	d is not effective distance	B1	
	time for count may be insufficient	B1	
	could be alpha and/or beta coming from the source	B1	
(ii)	**any two pairs:**		
	measure background subtracts from measured count rate to give corrected count rate	M1 A1	6
	measure for longer period/repeats & (averages)/uses more active source to minimise random variation/bigger count of background	M1 A1	
	turns GM tube sideways minimise *d* error or eliminates alpha and beta	M1 A1	
	puts absorber between tube and source eliminates alpha and beta	M1 A1	
(c)	as distance increases, area over which radiation is spread increases	B1	
	area is proportional to square of radius	B1	max 2
	doesn't get absorbed (significantly)	B1	
	allow B1 for $\frac{I}{4\pi r^2}$		
			Total 11

Question 7			
(a)	$y = \lambda D/d$	**C1**	
	correct substitution	**C1**	**3**
	0.75 m	**A1**	
(b)	**maximum 3 from each section**		
	for light:		
	1 not coherent	**B1**	
	2 no constant phase relationship	**B1**	
	3 fringes would be too close together to observe	**B1**	
	4 appropriate calculation performed - 2.3×10^{-6} m	**B1**	**max 5**
	for sound:		
	5 are coherent	**B1**	
	6 because signals are identical/from same sig gen/have the same wavelength or frequency	**B1**	
	7 fringes are of appropriate separation to detect	**B1**	
	At least 2 marks for physics + **Good QWC**	**2**	
	At least 2 marks for physics + **Poor QWC**	**1**	
	At least 2 marks for physics + **Very Poor QWC**	**0**	
	1 mark for physics + sufficient attempt + **Good or Poor QWC**	**1**	**max 2**
	1 mark for physics + insufficient attempt or **Very Poor QWC**	**0**	
	No marks for physics or **Very Poor QWC**	**0**	
			Total 10

Question 8			
(a)	wave is reflected from the end / 2 waves travelling in opposite directions	B1	4
	the two waves superpose or interfere	B1	
	maximum is where two waves interfere constructively	B1	
	minimum is where they interfere destructively	B1	
(b) (i)	recognises that 1 cycle is 3.2 to 3.3 cm	B1	8
	T = 3.2/2 ms or 1.6 ms	B1	
	correct processing to get 606 to 625 Hz	B1	
(ii)	2.5 wavelengths = 1.4 m	C1	
	λ = 0.56 m	A1	
(iii)	$v = f\lambda$	C1	
	correct substitution – their (i) × their (ii)	A1	
	350 m s^{-1} including correct unit ecf	A1	
			Total 12

Question 9			
(a)	$v = Hd$	B1	4
	evidence of conversion of distance (e.g. $3.7 \times 10^{24}/3.1 \times 10^{16}$)/ 119 MPc	B1	
	774/776 seen	B1	
	powers of 10 convincingly and correctly dealt with	B1	
(b) (i)	$\Delta f/f = v/c$	C1	5
	0.19×10^{14} Hz	C1	
	$7.3 \times 10^{14} - 0.19 \times 10^{14} = 7.1 \times 10^{14}$ Hz	A1	
(ii)	$\lambda = c/f$	C1	
	$4.2(3) \times 10^{-7}$ m **ecf** from (i)	A1	
			Total 9

Question 10			
	optical fibres digital signal used mention of binary code lights on/off represent binary 1/0 fibres make use of internal reflection uses pulses of visible light or infra red fewer boosters required more secure less interference to signal or noise **multiplexing** signal divided into parts parts sent in order interspersed with parts of other signals each signal is reassembled many signals can be sent in the real time of 1 original signal	**max 2** for how **max 1** for benefit **max 2** for how **max 1** for benefit	**B1** **B1** **B1** **B1** **B1** **B1**	**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