ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark scheme June 2002

GCE

Physics B

Unit PHB2

The Assessment and Qualifications Alliance (AQA) is a company limited by guarantee registered in England and Wales 3644723 and a registered charity number 1073334
Registered address: Addleshaw Booth & Co., Sovereign House, PO Box 8, Sovereign Street, Leeds LS1 1HQ
Kathleen Tattersall: *Director General*

Unit 2: Waves and Nuclear Physics

Notes for guidance

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.

Note: 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.

Where an error carried forward (e.c.f.) is allowed by the Marking Scheme for an incorrect answer, e.c.f. must be written on the script if an error has been carried forward.

Instructions to Examiners

1 Give due credit to alternative treatments which are correct. Give marks for what is correct; do not deduct marks because the attempt falls short of some ideal answer. Where marks are to be deducted for particular errors specific instructions are given in the marking scheme.

2 Do not deduct marks for poor written communication. Refer the script to the Awardsmeeting if poor presentation forbids a proper assessment. In each paper candidates may be awarded up to two marks for the Quality of Written Communication in cases of required explanation or description. However, no candidate may be awarded more than the total mark for the paper. Use the following criteria to award marks:

2 marks: Candidates write with almost faultless accuracy (including grammar, spelling and appropriate punctuation); specialist terms are used confidently, accurately and with precision.

1 mark: Candidates write with reasonable and generally accurate expression (including grammar, spelling and appropriate punctuation); specialist terms are used with reasonable accuracy.

0 marks: Candidates who fail to reach the threshold for the award of one mark.

3 An arithmetical error in an answer should be marked A.E. thus causing the candidate to lose one mark. The candidate's incorrect value should be carried through all subsequent calculations for the question and, if there are no subsequent errors, the candidate can score all remaining marks (indicated by ticks). These subsequent ticks should be marked C.E. (consequential error).

4 With regard to incorrect use of significant figures, normally a penalty is imposed if the number of significant figures used by the candidate is one less, or two more, than the number of significant figures used in the data given in the question. Themaximum penalty for an error in significant figures is **one mark per paper**. When the penalty is imposed, indicate the error in the script by S.F. and, in addition, write S.F. opposite the mark for that question on the front cover of the paper to obviate imposing the penalty more than once per paper.

5 No penalties should be imposed for incorrect or omitted units at intermediate stages in a calculation or which are contained in brackets in the marking scheme. Penalties for unit errors (incorrect or omitted units) are imposed only at the stage when the final answer to a calculation is considered. The maximum penalty is **one mark per question**.

6 All other procedures, including the entering of marks, transferring marks to the front cover and referrals of scripts (other than those mentioned above) will be clarified at the standardising meeting of examiners.

Section A

Question 1

(a)	distance travelled = 2 × 18 m Speed = 36/0.11 = 327 m/s [164 m/s scores 2]	C1 M1 A1	**3**
(b)	mention of standing waves **or** superposition **or** interference mention of two waves, opposite directions because they are permanently out of phase, permanently destructively interfere, permanently in antiphase	B1 B1 B1	**3**

Question 2

	use of inverse-square law 3 × distance so 1/9 × intensity (or equivalent calc) $1.9 \times 10^{-8}/9 = 2.11 \times 10^{-9}$ Wm^{-2}	C1 C1 A1	**3**

Question 3

(a)	Transverse	B1	**1**
(b)	correct example of transverse wave (e.g. light/electromagnetic/radio etc. allow photon b.o.d.)	B1	**1**
(c)	[transverse] displacement vector perpendicular to energy direction [accept 'direction of motion'] [longitudinal] vector parallel to energy direction polarization is restriction of displacement vector to one plane OWTTE [allow any or all marks on clear diagram]	B1 B1 B1	**3**

Question 4

(a)	$^{228}_{89}$Ac $^{0}_{-1}\beta$ suitable *anti*-neutrino indication (anit-electron nuetrino not required)	B1 B1 B1	**3**
(b)	Down quark changes to up quark	B1	**1**

Question 5

(a)	$\pi^- + p^{(+)} = n + \pi^+ + K^-$	B1	**1**
(b)	Charge conservation equation correct Baryon conservation equation correct Lepton conservation equation correct All comments and checks consistent	M1 M1 M1 A1	**4**

Question 6

	X-rays are absorbed Bones absorb more **OR** absorption depends on density [NOT 'bones stop X-rays' or 'X-rays reflect from bone']	B1 B1	**2**

Max 25 on Section A

Section B

Question 7

(a)	Draw curve in on graph (at least one point missed)	B1	
	Clear use of graph to determine half-life	B1	
	[repeat and average required]		
	Answer in range 650± 50 s [600–700]	B1	
			3
(b)	Mention of background radiation	B1	
	because this increases the count rate	B1	
			2
(c)	Curve displaced upwards	B1	
	leading to half-life that is too long	B1	
			2
(d)	Take count with source absent	B1	
	Over long time (5+ min) **or** Average several times (3 or more) and…	B1	
	Because background is small **or** subtract correction	B1	
	Or correction is negative		
			3
			10

Question 8

(a)(i)	Spectral line moved to longer wavelength position (allow 'to red end of spectrum')	B1	**1**
(a)(ii)	Mention of Doppler effect	B1	
	Expansion of universe/Big Bang	B1	
	Wavelength increased (or frequency decreased)	B1	
	Successive 'peaks' of wave emitted at increasing distance from Earth [allow 'wave stretched']	B1	
	Wavelength observed on Earth increases **compared** with source stationary	B1	**max 4**
	the use of physics terms is accurate, the answer is fluent/well argued with few errors in spelling, punctuation and grammar	B2	
	award for 2+		
	the use of physics terms is accurate, but the answer lacks coherence or the spelling, punctuation and grammar are poor	B1	
	award for 1		
	the use of physics terms is inaccurate, and the answer is disjointed with significant errors in spelling, punctuation and grammar	B0	**max 2**
(b)(i)	use of $c = f\lambda$	C1	
	$\Delta f = 3 \times 10^8/(561 \times 10^{-9}) - 3 \times 10^8/(540 \times 10^{-9})$	M1	
	$= (5.348 - 5.556) \times 10^{14}$ [$= 2.08 \times 10^{13}$ Hz]	A1	
	[explicit subtraction **or** to 3+ s.f. required for A mark]		**3**
(ii)	$\Delta f/f = v/c$	C1	
	$V = c * \Delta f/f$ [or $\Delta\lambda/\lambda$] $= 3 \times 10^8 \times 2.08 \times 10^{13}/5.556 \times 10^{14}$ [ecf from bi]	M1	
	$= 1.12 \times 10^7$ m/s	A1	**3**
(iii)	[$d = v/H$]	C1	
	conversion to km/s	M1	
	$d = 11.2 \times 10^3/65 =$ [172 Mpc] [ecf from bii]	A1	
	$= 172 \times 10^6 \times 3 \times 10^{16} = 5.17 \times 10^{24}$ m		**3**
			16

Question 9

(a)(i)	[sin $\theta = \lambda/b$]		
	sin $\theta = 6.2 \times 10^{-7} / 0.15 \times 10^{-3}$ [$= 4.13 \times 10^{-3}$ m] (condone $\times 10^{-3}$ in this mark)	C1	
	$\theta = \sin^{-1}(4.13 \times 10^{-3}) = 0.236°$	A1	
			2
(ii)	white light contains many wavelengths/frequencies	B1	
	white central maximum	B1	
	lines become coloured bands	B1	
			3
(b)(i)	*[$w = D\lambda/d$]*		
	$w = 5 \times 6.2 \times 10^{-7} / 0.3 \times 10^{-3}$	C1	
	$= 10.3 \times 10^{-3}$ m	A1	
	so max-min = 5.2×10^{-3} m [ecf half candidate value]	B1	
			3
(ii)	maximum occurs when light waves add continuously in phase [i.e peak and peak arriving together] [allow 'constructive interference']	B1	
	because path difference is a whole number of wavelengths	B1	
			2
(iii)	appropriate comment about observing conditions [e.g. dark room etc, but not 'visible light']	B1	
	similar [allow same] amplitude	B1	
	light is coherent		
	slits emit light of same frequency and constant phase difference [**or** wavetrains overlap time is long enough for detection		**max 2**
	or photon emissions last long enough]		**12**

Question 10

(a)(i) (ii)	Range within 15 – 20 000 Hz (high ***f*** must equal or exceed 10 kHz; low *f* must be equal to or below 50 Hz)	B1	
(iii)	same as candidate range in (ai) (difference or range acceptable)	B1	
	12 kHz [allow samples per second/per minute as unit]	B1	
(b)	Two advantages e.g. easy *elimination* of noise [**not** no noise], narrower bandwidth, more channels in available spectrum, opportunity to multiplex, etc) [not fibre optic argument, not distance argument]	B1 B1	
(c)	**3 marks max** for three correct routes + **2 max** for two correct wavelengths for these routes. Stop marking physics after third route response.	B1 B1 B1 B1 B1	**max 5**

Station A→ B	line of sight	long and short*
	through earth	**very** long
	cable	long
	etc	
Station A→ C	diffraction	long
	reflection	long
	satellites	short
	refraction	long and short*
	sporadic E/ducting	short
	etc.	
	do not allow any route twice	*candidate can write 'long and/or short' or 'any wavelength' etc. but sense must be 'all wavelengths'
	etc	

the use of physics terms is accurate, the answer is fluent/well argued with few errors in spelling, punctuation and grammar **award for 4+ only**	B2	
the use of physics terms is accurate, but the answer lacks coherence or the spelling, punctuation and grammar are poor **award for 2 or 3 only**	B1	
the use of physics terms is inaccurate, and the answer is disjointed with significant errors in spelling, punctuation and grammar **award for 0 or 1**	B0	**max 2**

12