GCE 2004
June Series

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark Scheme

Physics B
Unit PHB2

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.

Further copies of this Mark Scheme are available from:

Publications Department, Aldon House, 39, Heald Grove, Rusholme, Manchester, M14 4NA
Tel: 0161 953 1170

or

download from the AQA website: www.aqa.org.uk

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 3644723 and a registered charity number 1073334. Registered address AQA, Devas Street, Manchester. M15 6EX. *Dr Michael Cresswell Director General*

Marking Scheme

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 Awards meeting 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. Use the following criteria to award marks:

2 marks: Candidates write legibly with accurate spelling, grammar and punctuation; the answer containing information that bears some relevance to the question and being organised clearly and coherently. The vocabulary should be appropriate to the topic being examined.

1 mark: Candidates write with reasonably accurate spelling, grammar and punctuation; the answer containing some information that bears some relevance to the question and being reasonably well organised. Some of the vocabulary should be appropriate to the topic being examined.

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 AE 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 CE (consequential error).

4 With regard to incorrect use of significant figures, normally two, three or four significant figures will be acceptable. Exceptions to this rule occur if the data in the question is given to, for example, five significant figures as in values of wavelength or frequency in questions dealing with the Doppler effect, or in atomic data. In these cases up to two further significant figures will be acceptable. The maximum penalty for an error in significant figures is **one mark per paper**. When the penalty is imposed, indicate the error in the script by SF and, in addition, write SF 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.

PHB2 Waves and Nuclear Physics

Section A

Question 1

(a)	Refraction	B1	**1**
(b)	The speed is reduced	B1	
	(*Figure 1)* shows reduced wavelength (*accept distance between wavefronts)*/ray/wave/angle turns towards **normal**	B1	**2**
(c)	**(**Mechanical) waves travel faster in solids/ slower in liquids	B1	**1**

Question 2

(a)	Good diagram of pressure variations/particle oscillations *with at least one label indicating direction of propagation, pressure variation or density variation*	B1	
	Plus *any two from five of*		
	Vibrating source	B1	
	Energy transferred to (air) molecules	B1	
	Energy passed on by collisions between molecules	B1	
	Oscillations of air molecule neighbours slightly out of phase	B1	
	Oscillations/waves are longitudinal/energy transfer parallel to vibrations	B1	**3**
(b)	Diagram showing several transverse vibrations/waves which are subsequently limited to one after polarisation	B1	
	Valid example (light, microwaves etc.) *accept sunlight*	M1	
	Suitable polariser *for the stated example* (polaroid, reflection, metal grid etc). **Not** *sunglasses*	A1	**3**

Question 3

(a)	Electron 0, -1 *correct positions*	B1	
	Chlorine 37,17	B1	
	Neutrino symbol (ν or υ or similar). **Not** *anti-neutrino*	B1	**3**
(b)	reference to *both* up and down quarks	C1	
	reference to 3 quarks per nucleon	C1	
	proton: uud, neutron: udd	A1	**3**

Question 4

(a)	*superposition* (of progressive waves)	B1	
	incident wave and reflected wave/wave reflected through 180^{O}/waves travelling in opposite directions	B1	
	same frequency/wavelength	B1	
	in same medium.	B1	
	Any 3 out of 4 points		**3**
(b)	$f = c/\lambda$	C1	
	$\lambda = 1.24$	C1	
	$f = 258$ Hz	A1	
	e.g. $f = 512$ gets 1 mark		**3**

Question 5

infra red	B1		
a value in the range (4 .. 7) x 10^{-7} (1 or 2 sf only)	B1		
gamma rays **and** the nucleus. *Accept nuclear/nuclide etc.*	B1	**3**	
			25

Section B

Question 6

(a)	Gamma rays are very penetrating/alpha/beta rays would not be detected (outside body)	B1		
	Gamma rays are **less** ionising/**less** hazardous (to patients)/ alpha/beta are more ionising/**more** hazardous	B1	**2**	
(b)	Background radiation/count is much smaller/negligible	B1		
	Random fluctuations in the readings greater than background	B1	**2**	
(c)	Accurate plotting *check all four points (± ½ square)*	M1		
	reasonably smooth curve with even point scatter	A1	**2**	
(d)	two or more half-lives averaged	B1		
	Half-life calculated from best fit line	C1		
	Half-life = 13 ±1 hour	A1	**3**	
	allow ecf from inaccurate plotting, but straight line = P.E.			
(e)	High activity (so only a small sample needed)	B1		
	Decays quickly	B1		
	Less risk to patient/other people	B1		
	(Short half-life ok because) medical test doesn't last long	B1		
	Any two from four		**2**	**11**

Question 7

(a)	H = v/d	C1		
	best fit line drawn	M1		
	gradient of line shown to be 65 ± 4	A1	**3**	
(b)	*use of* d = v/H	B1		
	answer 260 (*accept 262* or *accurate graph read-off*) (Mpc)	B1	**2**	
(c)	(a distance) x 10^6 x 3.3	C1		
	(a distance) x 9.5 x 10^{15}	C1		
	answer = 1.5 x 10^{10} (years)	A1	**3**	
(d)	mention or description of *Doppler effect*	B1		
	mention of *red shift*	B1		
	measurement of wavelength or frequency	B1		
	giving *longer wavelength/lower frequencies* than on Earth	B1		
	description of use of the shift formula ($\Delta f/f = v/c$)	B1		
	mention of the v<<c condition	B1		
	any 4 points from 6		**4**	

QWC	Accurate use of Physics terminology + fluent, well argued explanation + good spelling and grammar + **at least 2 marks for the Physics**	**2**	
	Accurate use of terminology + comprehensible explanation + **at least 1 mark for Physics**	**1**	
	No marks for the Physics *and/or* disjointed answer with poor spelling and grammar	**0**	
			14

Question 8

(a)		Symmetrical pattern with central and subsidiary maxima	B1		
		First minima at $\sin^{-1}(\lambda/b)$ and $-\sin^{-1}(\lambda/b)$	B1		
		well drawn showing subsidiary intensity <0.5 x central	B1	**3**	
(b)		$\lambda = b\sin\theta$	M1		
		$= 6.28 \times 10^{-7}$ (m)	A1	**2**	
(c)	(i)	*use of* $n = 2$ or $d = 1/(5.0 \times 10^5)$	C1		
		$\sin\theta = 2 \times 6.3 \times 10^{-7} \times 5.0 \times 10^5 = 0.63$	C1		
		$\theta = 39^O$	A1	**3**	
	(ii)	(much) wider spacing of maxima/fringes	B1		
		subsidiary maxima brighter/higher intensity	B1		
		sharper/narrower maxima/fringes	B1		
		any 2 from 3		**2**	**10**

Question 9

(a)	(i)	15 to 20 000 Hz *allow min 10 ..50 Hz and max 15 .. 25 kHz*	B1	**1**	
	(ii)	15 000 Hz / upper limit from (a) (i)	B1	**1**	
(b)	(i)	*diagram showing a continuous signal (plotted against time) with sampling ordinates*	B1		
		signal sampled at regular **time** intervals (*clearly on graph or in words)*	B1	**2**	
	(ii)	30 000 Hz / 2 x answer in (a) (ii)	B1	**1**	
(c)		**Less** powerful transmitters (needed for DAB)/signal travels further			
		smaller aerials needed to receive signals	B1		
		better quality/clearer sound (heard by listener)	B1		
		easier reduction of interference (*accept less background noise*)	B1		
		more stations available (in a given bandwidth)/more data transferred **in the same time**	B1		
		any 2 from 5 points		**2**	**7**

Question 10

fundamental particles have no sub-structure/can not be split	B1	
leptons are fundamental particles	B1	
leptons are not affected by the strong nuclear force	B1	
electrons, muons, tauons, neutrinos (*credit 2 or more)* are leptons	B1	
hadrons are effected by the strong force	B1	
hadrons are sub-classified into mesons and baryons	B1	
hadrons/baryons/mesons are made up of quarks/are not fundamental particles	B1	
quarks are (possibly) fundamental particle	B1	
protons and neutrons are baryons/hadrons	B1	
protons are stable	B1	
electrons and neutrinos are stable	B1	
no other particles are stable/examples (*credit 2 or more)*of unstable articles	B1	
antiparticles have identical mass and opposite charge	B1	
the positron is an antiparticle	B1	
when a particle collides with its antiparticle they annihilate	B1	
and their masses are converted into energy	B1	
any six points from 16		**6**

QWC	Accurate use of Physics terminology + fluent, well argued explanation + good spelling and grammar + **at least 2 marks for the Physics**	**2**
	Accurate use of terminology + comprehensible explanation + **at least 1 mark for Physics**	**1**
	No marks for the Physics *and/or* disjointed answer with poor spelling and grammar	**0**

8