GCE 2005
January Series

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark Scheme

Physics Specification B

PHB2 Waves and Nuclear Physics

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 to download from the AQA Website: www.aqa.org.uk

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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**	
Very Poor QWC: the answer is disjointed, with significant errors in spelling, punctuation and grammar	**0**	**Max 2**

PHB2 Waves and Nuclear Physics

Section A

Question 1

(a)	electron	**B1**	**1**
(b)	they annihilate (condone disappear/destroy or eliminate each other)	**B1**	
	forming (two) gamma ray(s)/radiation or photon(s) (i.e. condone singular) NOT just energy	**B1**	**2**
			Total 3 Marks

Question 2

(a)	longitudinal wave	**B1**	**1**
(b)	arrows showing B displaced to the left and C to the right	**B1**	**1**
(c)	particles in the transmitting medium are made to vibrate/given energy or mention of a compression/region of increased pressure (or rarefaction)	**B1**	
	cause nearby particles to vibrate/have energy/move or the compression produces a compression further along (the medium)	**B1**	**2**
			Total 4 Marks

Question 3

(a)	Node	**C1**	**1**
(b)	Wavelength = 0.48 m or $v = f\lambda$	**C1**	
	36 m s^{-1}	**A1**	**2**
(c)	30 Hz	**B1**	**1**
			Total 4 Marks

Question 4

(a)	$d \sin \theta = n\lambda$ or $d \sin 12 = 6.3 \times 10^{-7}$	**C1**	
	3.0×10^{-6} m	**A1**	**2**
(b)	$n \sin 90 = (\leq) 3.0 \times 10^{-6} / 6.3 \times 10^{-7}$ or $n = 4.8$ Allow for approach using different n values even if unsuccessful	**C1**	

	number of orders visible = 4	**A1**	
	Total maxima = twice their maximum order + 1	**B1**	**3**
			Total 5 Marks

Question 5

(a)	$Be + \alpha \Rightarrow C + n$ (condone N; any other symbol must be defined as a neutron)		**B1**	
	${}^{9}_{4}Be + {}^{4}_{2}\alpha \Rightarrow {}^{12}_{6}C + {}^{1}_{0}n$ (Condone other symbols if Z and A correct)		**B1**	**2**
(b)	(i)	udd (1 up quarks and 2 down quarks)	**B1**	**1**
	(ii)	A meson has only two quarks (whereas a baryon has three)	**B1**	**1**
				Total 4 Marks

Question 6

(a)	Statement that Id^2 (or Ir^2) should be constant	**C1**	
	Calculation of Id^2 for two corresponding values of I and d	**C1**	
	Calculation of Id^2 for three corresponding values of I and d **with conclusion**	**A1**	**3**
	Or work out constant for one set Calculate intensity for 1 new distance Calculate intensity for 2 new distances and compares with graph Or Reads one value from graph and calculates value for double distance Explains that this is ¼ original intensity Does this twice with conclusion	**C1** **C1** **A1** **C1** **C1** **A1**	
(b)	$I = P/4\pi d^2$ or substitution of two corresponding values of I and d	**C1**	
	0.40 W (condone 1sf)	**A1**	**2**
			Total 5 Marks

Section Total 25 Marks

Section B

Question 7

(a)	There is a path difference (phase difference)between waves from the two reflectors		**B1**	
	ANY THREE from Minimum caused by **destructive** interference superposition producing no resultant amplitude he waves cancel each other out		**B1**	
	Reflected waves are coherent		**B1**	
	For a minimum the waves arrive in anti-phase or crest meets trough or labelled diagram showing this		**B1**	
	Appreciation that the path difference is twice the distance between the plates		**B1**	
	Minimum occurs when the path difference is a odd number of half wavelengths (however expressed) Or **(not very likely to be seen)** When there path difference is a whole number of wavelengths due to phase inversion at one reflector		**B1**	**Max 4**
	At least 2 marks for physics + use of Physics is accurate, the answer is fluent/well argued with few errors in spelling, punctuation and grammar		**2**	
	At least 1 mark for physics + some incorrect work the use of Physics is accurate, but the answer lacks coherence or spelling, punctuation and grammar are poor		**1**	
	the use of Physics is inaccurate, the answer is disjointed, with significant errors in spelling, punctuation and grammar		**0**	**Max 2**
(b)	(i)	Relevant working shown	**B1**	
		14 mm	**B1**	**2**
	(ii)	0.5/their (b)(i) (35.7 Hz) (must be clearly half a wavelength) Use of $v=f\lambda$ is a physics error	**B1**	**1**
(c)	(i)	spreading of wave (energy) (allow B1 if shown by diagram only) (NOT bending of a wave)	**B1**	
		when a wave meets a gap/slit/barrier/obstacle/aperture	**B1**	**2**

	(ii)	$\sin\theta = \lambda/b$ or $\sin\theta = 28/60$	**C1**	
		27.8°	**A1**	**2**
				Total 13 Marks

Question 8

(a)	(i)	A change in *frequency/wavelength/pitch* **(NOT sound increases)**	**B1**	
		when a source and observer are in relative motion or distance between source and observer is changing (NOT changes)	**B1**	**2**
	(ii)	Relevant example e.g. car moving toward the observer (sounding horn)/measuring blood flow using ultrasound/using radar to measure car speed	**M1**	
		Clear statement of what is observed including the direction of the frequency change (e.g. pitch higher than normal)	**A1**	**2**
(b)	(i)	$\Delta f/f = v/c$ or $\Delta f = 0.069 \times 10^{14}$ Hz	**C1**	
		4.5×10^6 m s^{-1} (Must use original frequency 4.6×10^6 m^{-1} is incorrect)	**A1**	**2**
	(ii)	$v = Hd$ or $4.5 \times 10^3 = 65\ d$ (condone powers of 10 for v)	**C1**	
		69 Mpc {[their (b)(i) in m]/65000 or [their (b)(i) in km]/65)	**A1**	**2**
(c)		Straight line through the origin	**M1**	
		Passing through 600 to 700 km s^{-1} at 10 Mpc	**A1**	**2**
				Total 10 Marks

Question 9

(a)	(i)	Z increases by 1	**B1**	
		A remains the same	**B1**	**2**
	(ii)	Correct curvature starting at 120 Bq	**B1**	
		60 (or 0.5 x their start value) at 12 h days later	**B1**	
		30 (or half their value at 12 h) and continuing to fall thereafter approximately exponentially	**B1**	**3**

(b)	(i)	6.6×10^{-11} J(s^{-1}) ($120 \times 5.5 \times 10^{-13}$)	**B1**	**1**
	(ii)	another particle is emitted in each decay (not gamma radiation) or the nucleus recoils	**B1**	
		anti-neutrino emitted (this would get first and second mark 2 marks)	**B1**	
		the other particle/neutrino/antineutrino/nucleus takes some/varying amounts of the energy	**B1**	**3**
(c)		7.5×10^{6}	**B1**	**1**
(d)		Particles are emitted in all directions/particles do not all go to detector	**B1**	
		Detector only detects some of the particles **that enter it**/mention of dead time or recovery time (not detector does not detect all the particles – this adds nothing)	**B1**	
		Some particles are absorbed by the window	**B1**	**Max 2** **Total 12 Marks**

Question 10

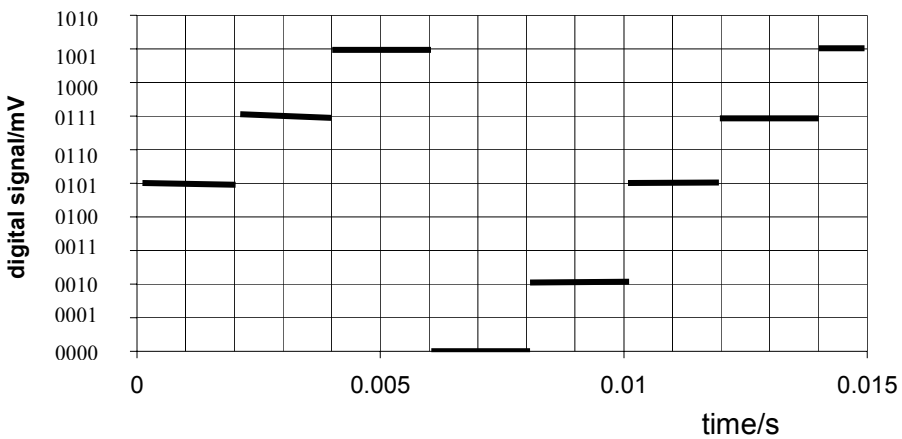
(a)	(i)	converts electromagnetic radiation(condone wave energy) into electrical energy (allow voltage/current variations/electrical signals/electronic signals)	**B1**	**1**
	(ii)	idea of a signal wave superimposed on a carrier	**C1**	
		the demodulator extracts/separates the signal from the carrier	**A1**	**2**
(b)		signal sent to a satellite and retransmitted to the receiver	**M1**	
		Microwaves; (≈10 cm)	**A1**	
		signal transmitted to and from intermediate transmitters	**M1**	
		VHF/UHF (≈30 cm;100 MHz-1GHz)	**A1**	
		Diffraction round Earths surface	**M1**	
		Long/medium waves	**A1**	
		reflection/refraction by ionosphere	**M1**	
		High frequency	**A1**	**Max 4**

At least 2 marks for physics + use of Physics is accurate, the answer is fluent/well argued with few errors in spelling, punctuation and grammar **2**

At least 1 mark for physics + some incorrect work the use of Physics is accurate, but the answer lacks coherence or spelling, punctuation and grammar are poor **1**

the use of Physics is inaccurate, the answer is disjointed, with significant errors in spelling, punctuation and grammar **0** **Max 2**

(c) (i)



Starts at 0101 **C1**
Indication of correct codes at all 0.002 intervals only (allow 1 error?) **C1**
or
Appreciation of step changes at 0.002 intervals (levels may be incorrect)
Correct output (verticals at changes may or may not be shown) **A1** **3**

(ii) $f = 1/T$ or period = 0.01 s (Use of $f = 1/T$ maybe implied by working) **C1**

100 Hz **A1** **2**

(iii) 0.0033(3) s (e.c.f Period 1/3 of the one used in (ii)) **B1** **1**

Total 15 Marks

Section Total 50 Marks

Paper Total 75 Marks