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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics 5456
Specification B

PHB2 Waves and Nuclear Physics

Mark Scheme

2005 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.

Notes for Examiners

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 questions 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)	$\lambda = yd/D$ substitution correct: $\frac{7.8 \times 10^{-3} \times 2.5 \times 10^{-4}}{3.5}$ condone powers of 10 5.6×10^{-7} m	**C1** **C1** **A1**	**3**
(b)	waves arrive out of phase (with each other) path difference is 1.5λ idea of cancellation/destructive interference/negative interference destruction	**B1** **B1** **B1**	**3**

Question 2 (a)	any neutrino electron anti neutrino	**C1** **A1**	**2**
(b)	$0 \rightarrow 1 + (-1) + 0$ $1 \rightarrow 1 + 0 + 0$ $0 \rightarrow 0 + 1 + (-1)$	**B1** **B1** **B1**	**3**

Question 3	**A** and/or **B** are amplifiers but treat the misidentification of either as TO i/p transducer turns sound signal into electrical signal/voltage modulator modifies the (amplitude or frequency) of carrier signal/adds signal to carrier wave amplifier increases the amplitude of the signal/makes the signal stronger aerial changes electrical signal to radio wave/em wave/transmits a radio wave ignore descriptions of reception functions tolerate capitalisation of names of components in QWC marks	**B1** **B1** **B1** **B1** **B1**	**5**
	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 or 2 marks for physics + sufficient attempt + **Poor QWC** 1 or 2 marks for physics + insufficient attempt or **Very Poor QWC** No marks for physics or **Very Poor QWC**	**2** **1** **0** **1** **0** **0**	**Max 2**

Question 4 (a) (i)	diffraction	**B1**	**1**
(ii)	(for significant diffraction) obstacle/gap/aperture needs to be of same order of magnitude as the wavelength (allow reference to gap or aperture) long wave is of the order of km **or** short wave is of the order of m **or** uses sinθ = λ/b to explain the need for parity	**B1** **B1**	**2**
(b)	reflection from bands in the atmosphere (accept bounce) use of electrical cables and/or optical fibre cables satellite relay stations refraction through atmosphere through the Earth **any three**	**B1** **B1** **B1**	**3**

Question 5 (a) (i)	remove electrons from atoms by colliding with them/knocking into them	**B1** **B1**	**2**
(ii)	fewer collisions per metre because beta particles are smaller/less ionising (accept smaller charge) **not** less mass so lose energy over a larger distance	**B1** **B1** **B1**	**Max 2**
(b) (i)	one correct construction shown on graph (52 s – 53 s) at least one other determination visible on graph averaging process shown	**M1** **M1** **A1**	**3**
(ii)	N = 1.08 to 1.1 x 10^{21} (condone errors in powers of 10) $A = \lambda N$ 1.4(3) x 10^{19} Bq (allow decays/second) **allow ecf for minor error in N** **or** attempt to find gradient at 72 s correct extraction from a tangent of graph 1.3 to 1.5 x 10^{19} Bq (allow decays / second)	**B1** **C1** **A1**	**3**
(c) (i)	any two correct origins e.g. cosmic rays, from the sun, named isotopes **or** radioactive materials in rocks or the air, fallout, medical sources, other named manmade sources **not** humans or food or space	**B1** **B1**	**2**

(ii)	background count rate much less than the activity of the source	**B1**	**1**

Question 6 (a)	basis of a workable method	**B1**	**4**
	measurement of the distance travelled or the wavelength including appropriate apparatus	**B1**	
	measurement of the time taken or frequency including appropriate apparatus	**B1**	
	processing the answer	**B1**	
	At least 2 marks for physics + **Good QWC**	**2**	**Max 2**
	At least 2 marks for physics + **Poor QWC**	**1**	
	At least 2 marks for physics + **Very Poor QWC**	**0**	
	1 or 2 marks for physics + sufficient attempt + **Poor QWC**	**1**	
	1 or 2 marks for physics + insufficient attempt or **Very Poor QWC**	**0**	
	No marks for physics or **Very Poor QWC**	**0**	
(b) (i)	$v = f\lambda$	**C1**	**2**
	0.61 (0.607) m	**A1**	
(ii)	$\sin\theta = \lambda/b$ accept $\sin\theta = n\lambda/b$ where n = 1 but don't accept $\sin\theta = n\lambda/d$	**B1**	**3**
	correct substitution or $\sin\theta$ = 0.69(3) even if they've used $\sin\theta = n\lambda/d$	**C1**	
	46° (45.6°) **ecf from (i)**	**A1**	

Question 7 (a) (i)	90° < deviation of **A** < 180° **or** 0° < deviation of **C** < 90°	**M1**	**2**
	distance of closest approach of **A** < distance of closest approach of **B** but does not touch the nucleus	**A1**	
(ii)	small nucleus (compared with size of atom)/atom mostly empty space	**M1**	**Max 3**
	backscattering shows small nucleus	**A1**	
	small or zero deviations show mostly empty space	**A1**	
	massive dense nucleus	**M1**	
	nucleus not knocked out by alpha particle	**A1**	
(b) (i)	magnetic field	**B1**	**1**

(ii)	greater radius of curvature in the same direction significantly smaller radius of curvature and deviated in the opposite direction	**B1** **B1**	**2**
(c) (i)	alpha particles would be absorbed by the metal foil	**B1**	**1**
(ii)	proton	**B1**	**1**

Question 8 (a)	idea that there are waves in opposite directions because of reflection at end of string the two waves interfere with each other/superimpose	**B1** **B1** **B1**	**3**
(b) (i)	one loop with **N** at each end and **A** in the middle	**M1** **A1**	**2**
(ii)	4 approximately even loops all nodes and antinodes correctly marked for their number of loops	**B1** **B1**	**2**
(c) (i)	length halved/0.35 (m)	**B1**	**1**
(ii)	tension greater T = 720 (N)/increased by a factor of 4	**C1** **A1**	**2**

Question 9 (a)	less bright lower intensity bluer or whiter lower wavelength or higher frequency (at energy peak) or higher temperature	**B1** **B1** **B1** **B1**	**Max 3**
(b) (i)	some frequencies are absorbed by (cooler) gas around the sun	**B1** **B1**	**2**
(ii)	(spacing of) dark lines is characteristic of the atoms elements present (characteristic spacings) can be used to identify frequencies for use in doppler calculations/calculating red shift/working out distance/materials or elements present in other galaxies	**B1** **B1**	**2**