



ASSESSMENT and
QUALIFICATIONS
ALLIANCE

Mark scheme January 2003

GCE

Physics A

Unit PHA8/W

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Unit 8: Turning Points in Physics

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.

Section A (common to all Option Modules PHA5/W - PHA9/W)

1

- (a) (use of 'isotope' instead of 'nucleus' not accepted)
 there is equal probability of any nucleus decaying,
 it cannot be known which particular nucleus will decay next,
 it cannot be known at what time a particular nucleus will decay,
 the rate of decay is unaffected by the surrounding conditions,
 it is only possible to estimate the proportion of nuclei decaying
 in the next time interval
 any two statements ✓✓ (2)
- (b) continuous curve starting at 5.5×10^5 Bq
 plus correct 1st half-life (2.6 yrs, 2.75×10^5 Bq) ✓
 correct 2nd half-life (5.2 years, 1.4×10^5 Bq) ✓
 (allow C.E. for incorrect 1st half-life) (2)
- (c)(i) (use of $T_{1/2} = \frac{\ln 2}{\lambda}$ gives) $\lambda = \frac{\ln 2}{2.6 \times 3.15 \times 10^7}$ ✓
 $= 8.5 \times 10^{-9} \text{ (s}^{-1}\text{)}$ ✓ (8.46 $\times 10^{-9} \text{ (s}^{-1}\text{)})$
- (c)(ii) (use of $\frac{dN}{dt} = -\lambda N$ gives) $N = \frac{5.5 \times 10^5}{8.5 \times 10^{-9}}$ ✓
 $= 6.5 \times 10^{13} \text{ (atoms)}$ ✓
 (allow C.E. for value of λ from (i))
- (c)(iii) (use of $N = N_0 e^{-\lambda t}$ and $A \propto N$ gives)
 $t \left(= \frac{\ln(A_0 / A)}{\lambda} \right) = \frac{\ln(1.0 \times 10^5 / 0.75 \times 10^5)}{8.5 \times 10^{-9}}$ ✓
 $= 3.4 \times 10^7 \text{ (s)}$ ✓
 (allow C.E. for value of λ from (i))

(6)
 (10)

Section B**2**

- (a) waves/wavelets are emitted by each slit ✓
 each slit diffracts light ✓
 the two slits are coherent emitters/sources of light waves ✓
 bright fringes formed where light from one slit reinforces light from the other slit
 [or dark fringes formed where light from one slit cancels light from the other slit] ✓
 path difference to a bright fringe = whole number of wavelengths
 [or path difference to a dark fringe = (whole number + half) wavelengths] ✓ max(4)
- (b)(i) light consists of corpuscles/particles ✓
 corpuscles would not be diffracted
 [or pass straight through] ✓
 only two bright fringes would be seen ✓
- (b)(ii) Newton's scientific pre-eminence
 [or there was no evidence that light travelled slower in water
 as predicted by Huygens' theory]
 [or Huygens' theory considered light waves as longitudinal
 and therefore could not explain polarisation] ✓ max(3)
(7)

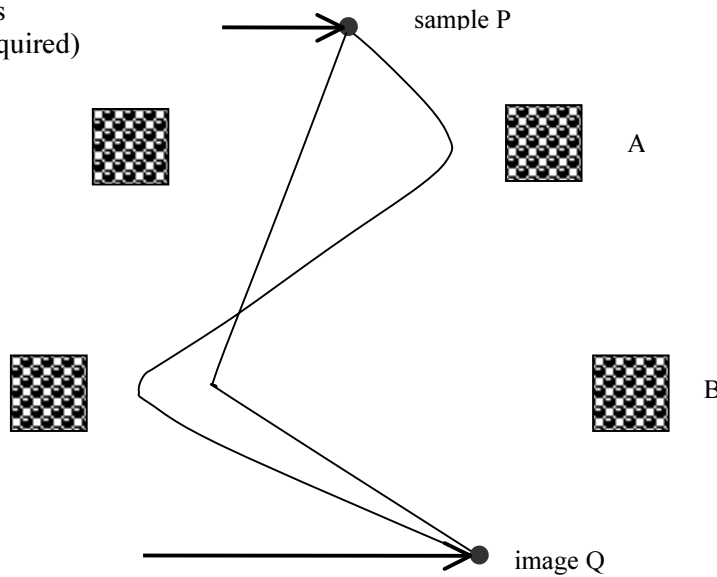
3

- (a) path curves upwards from O to P ✓
 path is tangential to curve at P and straight beyond P ✓ (2)
- (b)(i) magnetic field exerts a force on a moving charge/electron ✓
 magnetic force has a downwards component (at all points)
 [or magnetic force < electric force] ✓
- (b)(ii) magnetic force = Bev ✓
 electric force $\left(= \frac{eV_p}{d} \right) = eE$ ✓
 $Bev = eE$ (gives $v = \frac{E}{B}$) ✓ (5)
- (c) work done (or eV) = gain of kinetic energy (or $\frac{1}{2}mv^2$) ✓
 $\frac{e}{m} = \frac{v^2}{2V}$ ✓
 $= \frac{(3.2 \times 10^7)^2}{2 \times 2900} = 1.8 \times 10^{11} \text{ C kg}^{-1}$ ✓ (3)
(10)

4

- (a)(i) straight paths outside the lenses ✓
 correct direction of deflection on passing through A ✓
 path through B correct for path drawn through A ✓

for examples
 (only one required)



- (a)(ii) lens A: magnifies (or forms an intermediate image before B) ✓
 lens B: magnifies and focuses (or forms an enlarged image on the screen) ✓ max(4)

- (b) increase of voltage causes increase of speed (of the electrons) ✓
 hence a reduced de Broglie wavelength ✓
 less diffraction for reduced wavelength ✓
 better resolution if less diffraction ✓ max(3)
(7)

5

(i) $v \left(= \frac{45}{152 \times 10^{-9}} \right) = 2.96 \times 10^8 \text{ m s}^{-1} \checkmark$ (1)

(ii) $t = 152 \text{ ns} \checkmark$
 $t_0 \left[= 152 \left(1 - \frac{v^2}{c^2} \right)^{1/2} \right] = 152 \left(1 - \left(\frac{2.96}{3.00} \right)^2 \right)^{1/2} \checkmark$
 $\qquad \qquad \qquad = 25 \text{ ns} \checkmark$

[or $l_0 = 45 \text{ (m)} \checkmark$
 $l = 45 \left[1 - \left(\frac{2.96}{3.00} \right)^2 \right]^{1/2} = 7.3 \text{ (m)} \checkmark$

$t_0 \left(= \frac{7.3}{2.96 \times 10^8} \right) = 25 \text{ ns} \checkmark$ (4)

(4)

The Quality of Written Communication marks are to be awarded for the quality of answers to Q1(a) and Q2(a) ✓ ✓

(2)

(2)