ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark scheme January 2003

GCE

Physics A

Unit PA04

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Unit 4: Waves, Fields and Nuclear Energy

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

1-B; 2-A; **3**-D; **4**-C; **5**-D; **6**-B; **7**-B; **8**-D; **9**-B; **10**-C; **11**-D; **12**-A; **13**-B; **14**-A; **15**-B.

Section B

1(a) (use of $T = 2\pi\sqrt{\frac{l}{g}}$ gives) $T = 2\pi\sqrt{\frac{0.80}{9.81}}$ ✓

$= 1.8$ s ✓ (*2*)

(b) $mgh = \frac{1}{2} mv^2$ ✓

$v = \sqrt{(2 \times 9.81 \times 20 \times 10^{-3})}$ ✓ ($= 0.63$ m s^{-1})

$v_{max} = 2\pi fA = \frac{2\pi A}{T}$ ✓

$A = \frac{0.63 \times 1.8}{2\pi}$ ✓ ($= 0.18$ m)

[or by Pythagoras $A^2 + 780^2 = 800^2$ ✓

gives A $= \sqrt{(800^2 - 780^2)}$ ✓ (= 180 mm)

(or equivalent solution by trigonometry ✓ ✓)

$v_{max} = 2\pi fA$ or $= \frac{2\pi A}{T}$ ✓

$= \frac{2\pi \times 0.18}{1.8}$ ✓ ($= 0.63$ m s^{-1})] (*4*)

(c) tension given by F, where $F - mg = \frac{mv^2}{l}$ ✓

$F = 25 \times 10^{-3} \left(9.81 + \frac{0.63^2}{0.8}\right) = 0.26$ N ✓ (*2*)

(*8*)

2(a) slits act as coherent sources ✓

waves/light diffract at slits ✓

waves overlap/superpose/meet/cross ✓

bright patches : constructive/waves in phase/reinforce ✓

dark patches : destructive/waves out of phase/cancel ✓ max (*3*)

(b)(i) spacing $w = \frac{76 \pm 1(\text{mm})}{26} = 3.0$ or 2.9 mm ✓ (2.92 ± 0.04 mm)

15 or more fringes used ✓

(b)(ii) (use of $\lambda = \frac{ws}{D}$ gives) $\lambda = \frac{2.92 \times 10^{-3} \times 0.90 \times 10^{-3}}{4.2}$ ✓

$= 6.26 \times 10^{-7}$ ✓

(allow C.E. for sensible value of w from (i)) (*4*)

(*7*)

3(a)(i) $E\ (=\frac{Q}{4\pi\varepsilon_o r^2}) = \frac{29\times1.6\times10^{-19}}{4\pi\times8.85\times10^{-12}\times(1..15\times10^{-10})^2}$ ✓

$= 3.15\times10^{12}$ V m^{-1} (or N C^{-1}) ✓

(a)(ii) $V(=-\frac{GM}{r}) = (-)\ \frac{6.67\times10^{-11}\times63\times1.66\times10^{-27}}{1.15\times10^{-10}}$ ✓

$= (-)\ 6.07\times10^{-26}$ ✓ – sign and J kg^{-1} ✓ (*5*)

(b) arrow pointing to the right ✓ (*1*)

(*6*)

4(a)(i) thick
high density
material giving minimal fatigue problems after irradiation
any other sensible property eg withstands high temperature any two ✓ ✓

(a)(ii) (reinforced) concrete ✓ (*3*)

(b) effect of shielding:

γ rays - intensity (greatly) reduced ✓
neutrons - some absorption ✓
(or speed or energy reduced by collisions)
neutrinos - very little effect ✓

why shielding becomes radioactive:

neutron absorption by nuclei or atoms ✓
makes nuclei (not particles) neutron rich or unstable ✓
become β^- emitters and/or γ emitters ✓ max (*4*)

(*7*)

The Quality of Written Communication marks are to be awarded for the quality of answers to Q4(b) and Q2(a) ✓ ✓ (*2*)

(*2*)