



ASSESSMENT and
QUALIFICATIONS
ALLIANCE

Mark scheme

June 2002

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. However, no candidate may be awarded more than the total mark for the paper. Use the following criteria to award marks:
 - 2 marks: Candidates write with almost faultless accuracy (including grammar, spelling and appropriate punctuation); specialist terms are used confidently, accurately and with precision.
 - 1 mark: Candidates write with reasonable and generally accurate expression (including grammar, spelling and appropriate punctuation); specialist terms are used with reasonable accuracy.
 - 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 A.E. 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 C.E. (consequential error).
- 4 With regard to incorrect use of significant figures, normally a penalty is imposed if the number of significant figures used by the candidate is one less, or two more, than the number of significant figures used in the data given in the question. 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 S.F. and, in addition, write S.F. 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

Key to Objective Test Questions

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

Section B

- 1(a) forced vibrations or resonance ✓ (1)
- (b) reference to natural frequency (or frequencies) of structure ✓
 driving force is at same frequency as natural frequency of structure ✓
 resonance ✓
 large amplitude vibrations produced or large energy transfer to structure ✓
 could cause damage to structure [or bridge to fail] ✓ max(4)
- (c) stiffen the structure (by reinforcement) ✓
 install dampers or shock absorbers ✓
 [or other acceptable measure e.g. redesign to change natural frequency
 or increase mass of bridge or restrict number of pedestrians] (2)
 (7)
- 2(a) $Q = CV$ ✓
 $(= 4.7 \times 10^{-6} \times 6.0) = 28 \times 10^{-6} \text{ C}$ or $28 \mu\text{C}$ ✓ (2)
- (b) $E = \frac{1}{2}CV^2$ ✓
 $= \frac{1}{2} \times 4.7 \times 10^{-6} \times 2.0^2$ ✓
 $= 9.4 \times 10^{-6} \text{ J}$ ✓
 [or $E = \frac{1}{2}QV$ ✓
 $= \frac{1}{2} \times 9.4 \times 10^{-6} \times 2.0$ ✓
 $= 9.4 \times 10^{-6} \text{ J}$ ✓] (3)
- (c) time constant is time taken for V to fall to $\frac{V_0}{e}$ ✓
 $\therefore V$ must fall to 2.2 V ✓
 time constant = 32 ms ✓
 [or draw tangent at $t = 0$ ✓
 intercept of tangent on t axis is time constant ✓
 accept value $30 - 35 \text{ ms}$ ✓]
 [or $V = V_0 \exp(-t/RC)$ or $Q = Q_0 \exp(-t/RC)$ ✓
 correct substitution ✓
 time constant = 32 ms ✓] (3)
- (d) time constant = RC ✓
 $R = \frac{32 \times 10^{-3}}{4.7 \times 10^{-6}} = 6800 \Omega$ ✓
 (allow C.E. for value of time constant from (c)) (2)
 (10)

3(a) $\theta = 90^\circ$ (or 270° or $\frac{\pi}{2}$ or $\frac{3\pi}{2}$) ✓ (1)

(b) $\Phi = BA \cos \theta$ ✓
 $= 2.5 \times 10^{-3} \times 35 \times 10^{-3} \times 20 \times 10^{-3} \times \cos 30^\circ = 1.5 \times 10^{-6} \text{ Wb}$ ✓ (2)

(c) $\Phi_{\max} = 2.5 \times 10^{-3} \times 35 \times 10^{-3} \times 20 \times 10^{-3} \text{ (Wb)}$ ✓ (= 1.75×10^{-6})
 flux linkage = $650 \times 1.75 \times 10^{-6} = 1.1(4) \times 10^{-3} \text{ (Wb turns)}$ ✓ (2)
 (5)

4(a) induced fission: (large) nucleus splits unto two (smaller nuclei) ✓
 brought about by bombardment or collision ✓
 thermal neutrons have low energies or speeds (< 1 eV) ✓ (3)

(b)(i) $N = 3$ ✓

(ii) released neutrons have high(er) energies or speeds ✓

(iii) $\Delta m = 234.99333 - (91.90645 + 140.88354) - (2 \times 1.00867)$ ✓
 $= 0.186 \text{ u}$ ✓

(if last term in Δm omitted or incorrect number of neutrons
 used in calculation, treat answer as C.E.)

energy released = $0.186 \times 931 = 173 \text{ MeV}$ ✓

(allow C.E. for Δm)

(5)

(8)

The Quality of Written Communication marks are awarded primarily for the quality of answers to Q1(b)(c) and Q4(a).