AQA

ASSESSMENT and
QUALIFICATIONS
ALLIANCE

General Certificate of Education

Physics 6451
Specification A

PA04 Waves, Fields and Nuclear Energy

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.

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.

PA04 Section A Waves, Fields and Nuclear Energy
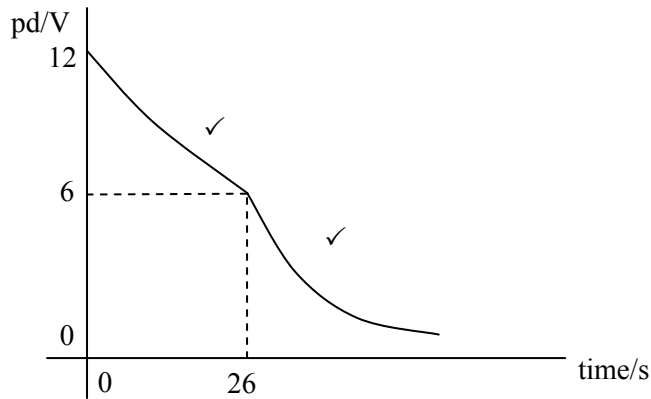
Key to Objective Test Questions

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

PA04 Section B Waves, Fields and Nuclear Energy

Question 1		
(a)	reference to resonance ✓ air set into vibration at frequency of loudspeaker ✓ resonance when driving frequency = natural frequency of air column ✓ more than one mode of vibration ✓ stationary wave (in air column) ✓ (or reference to nodes and antinodes) maximum amplitude vibration (or max energy transfer) at resonance ✓ [alternative answer to (a): first two marks as above, remaining four marks for wave reflected from surface (of water) ✓ interference/superposition (between transmitted and reflected waves) ✓ maximum intensity when path difference is $n\lambda$ ✓ maxima (or minima) observed when l changes by $\lambda/2$ ✓]	**Max 4**
(b) (i)	$\dfrac{\lambda}{2} = 523 - 168$ ✓ (= 355 mm) $\lambda = 710$ mm ✓ [if $\dfrac{\lambda}{4} = 168$, giving $\lambda = 670$ mm, ✓ (1 max) (672 mm)] (ii) $c(= f\lambda) = 480 \times 0.71$ ✓ $\qquad\quad = 341$ m s^{-1} ✓ $\qquad\quad$ (allow C.E. for incorrect λ from (i)) [allow $480 \times 0.67 = 320$ m s^{-1} ✓ (1max) (322 m s^{-1})]	**4**

Question 2		
(a)	same wavelength or frequency ✓ (same phase or) constant phase difference ✓	**2**
(b) (i)	narrow slit gives wide diffraction ✓ (to ensure that) both S_1 and S_2 are illuminated ✓ (ii) slit S acts as a point source ✓ S_1 and S_2 are illuminated from same source giving monochromatic/same λ ✓ paths to S_1 and S_2 are of constant length giving constant phase difference ✓ [or $SS_1 = SS_2$ so waves are in phase]	**Max 4**
(c)	graph to show: maxima of similar intensity to central maximum ✓ [or some decrease in intensity outwards from centre] all fringes same width as central fringe ✓	**2**

Question 3			
(a)	(i)	straight line through origin ✓	
	(ii)	$\dfrac{1}{\text{capacitance}}$ ✓	**3**
	(iii)	energy (stored by capacitor) ✓ (or work done (in charging capacitor))	
(b)	(i)	$RC = 5.6 \times 10^3 \times 6.8 \times 10^{-3}$ ✓ (= 38.1 s) $V(= V_0\, e^{-t/RC}) = 12\, e^{-26/38.1}$ ✓ 　　　　　　 $= 6.1$ V ✓ (6.06 V) [or equivalent using $Q = Q_0\, e^{-t/RC}$ and $Q = CV$]	
	(ii)	$(RC)' = 2.8 \times 10^3 \times 6.8 \times 10^{-3}$ ✓ (= 19.0 s) $V (= 6.06\, e^{-14/19}) = 2.9(0)$ V ✓ (use of $V' = 6.1$ V gives $V = 2.9(2)$ V)	
	(iii)		**7**

Question 4			
(a)		attractive **force** between point masses ✓ proportional to (product of) the masses ✓ inversely proportional to square of separation/distance apart ✓	3
(b)		$m\omega^2 R = (-)\dfrac{GMm}{R^2}\left(\text{or} = \dfrac{mv^2}{R}\right)$ ✓ (use of $T = \dfrac{2\pi}{\omega}$ gives) $\dfrac{4\pi^2}{T^2} = \dfrac{GM}{R^3}$ ✓ G and M are constants, hence $T^2 \propto R^3$ ✓	3
(c)	(i)	(use of $T^2 \propto R^3$ gives) $\dfrac{365^2}{(1.50\times10^{11})^3} = \dfrac{T_m^{\,2}}{(5.79\times10^{10})^3}$ ✓ $T_m = 87(.5)$ days ✓	4
	(ii)	$\dfrac{1^2}{(1.50\times10^{11})^3} = \dfrac{165^2}{R_N^{\,3}}$ ✓ (gives $R_N = 4.52\times10^{12}$ m) ratio $= \dfrac{4.51\times10^{12}}{1.50\times10^{11}} = 30(.1)$ ✓	

Question 5			
(a)	(i)	$\Delta m = Zm_p + (A - Z)m_n - M$ ✓	2
	(ii)	binding energy per nucleon $= \dfrac{(\Delta m)c^2}{A}$ ✓	
(b)	(i)	A in range $54 \rightarrow 64$ ✓ stability increases as binding energy per nucleon increases ✓ [or binding energy per nucleon is a measure of stability] [or large binding energy per nucleon shows nucleus is difficult to break apart]	5
	(ii)	binding energy per nucleon increases from about 7.6 to 8.5 ✓ increase of about 0.9 MeV for 235 nucleons ✓ hence 210 MeV ($\approx$ 200 MeV) in total ✓	

Quality of Written Communication: Q1 (a) and/or Q2 (b)	2