ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics 6451

Specification A

PA04 Waves, Fields and Nuclear Energy

Mark Scheme

2008 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.

Further copies of this Mark Scheme are available to download from the AQA Website: www.aqa.org.uk

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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.

GCE Physics, Specification A, PA04, Waves, Fields and Nuclear Energy

Section A

This component is an objective test for which the following list indicates the correct answers used in marking the candidates' responses.

	Keys to Objective Test Questions															
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	
	C	A	A	D	B	A	C	D	D	C	A	B	D	C	B	

Section B

Question 1		
(a)	$T\left(=2\pi\sqrt{\frac{m}{k}}\right)$ gives $\frac{1}{0.92} = 2\pi\sqrt{\frac{400}{k}}$ ✓ from which $k = 1.3(4) \times 10^4$ N m^{-1} ✓ [or by use of effective spring constant for all four springs: springs in parallel so $k' = 4k$ for a total mass of 1600 kg]	**2**
(b) (i)	when $t = 0.20$ s $x(= A\cos 2\pi ft) = 90\cos 2\pi\,(0.92 \times 0.20)$ ✓ gives $x = 36(.3)$ mm ✓ downwards ✓	**max 4**
(ii)	vertical speed $v\ (= 2\pi f\sqrt{A^2 - x^2}\,)$ $= 2\pi \times 0.92\sqrt{((90\times10^{-3})^2 - (36.3\times10^{-3})^2)}$ ✓ [**or** $v = (-2\pi fA \sin 2\pi ft)$ $= (-)\ 2\pi \times 0.92 \times 90 \times 10^{-3} \sin(2\pi \times 0.92 \times 0.20)$ ✓] gives $v = 0.47(6)$ m s^{-1} ✓	
(c)	same period maintained throughout graph ✓ exponential decay of amplitude ✓	**2**
(d) (i)	resonance ✓	**2**
(ii)	3300 (rev min^{-1}) ✓	
	Total	**10**

Question 2			
(a)	(i)	bright and dark bands (or fringes) ✓ equally spaced ✓ of similar intensity to each other (or suitable comment about decrease of intensity outwards from centre) ✓	max 4
	(ii)	central band wider than others ✓ intensity decreases greatly away from centre of pattern ✓	
(b)	(i)	fringe width $w = \frac{58}{20} = 2.9\,\text{mm}$ ✓	5
	(ii)	$\lambda = \frac{ws}{D}$ gives $\frac{w}{D} = \frac{w'}{D'}$ (since λ and s are constant) ✓ $\frac{2.9}{D} = \frac{3.7}{D + 0.80}$ gives D = 2.9 m ✓	
	(iii)	$\lambda = \frac{2.9 \times 10^{-3} \times 0.60 \times 10^{-3}}{2.9}$ ✓ = 6.0×10^{-7} m (600 nm) ✓	
		Total	**9**

Question 3			
(a)	(i)	gravitational force (or field) decreases as r increases ✓ gravitational force (or field strength) is proportional to $(1/r^2)$ ✓ [award both marks for second statement alone]	4
	(ii)	mass of Moon M $\left(=\frac{Fr^2}{Gm}\right)=\frac{1600\times(1.75\times10^6)^2}{6.67\times10^{-11}\times1000}$ ✓ $= 7.3(5)\times10^{22}$ kg ✓ [**or** by use of any other consistent values of F and r]	
(b)	(i)	E_P lost = area under graph ✓ acceptable method for finding area and values ✓ acceptable value for E_P lost ✓ [allow $(2.8 \pm 1.0)\times10^9$ J] [**alternative mark scheme**, for candidates who use values from the graph: potential of Moon's surface $=\left(-\frac{GM}{r}\right)=-\frac{6.67\times10^{-11}\times7.35\times10^{22}}{1.75\times10^6} = -2.80\times10^6$ (J kg^{-1}) ✓ change in potential $\Delta V = (-2.80\times10^6) - 0$ $= (-)2.80\times10^6$ (J kg^{-1}) ✓ potential energy lost (= $m\,\Delta V$) = $1000\times2.80\times10^6$ $= 2.80\times10^9$ J ✓]	5
	(ii)	$\frac{1}{2}mv^2 = 2.8\times10^9$ (or the E_P value from (b) (i)) ✓ gives escape speed v = 2370 m s^{-1} (or a consistent value) ✓ [**alternative mark scheme**, for candidates who use gravitational potential equation: $\frac{1}{2}mv^2 = \frac{GMm}{r}$ gives $v = \sqrt{\frac{2GM}{r}}$ $= \sqrt{\frac{2\times6.67\times10^{-11}\times7.35\times10^{22}}{1.75\times10^6}}$ ✓ = 2370 m s^{-1} ✓]	
		Total	**9**

Question 4			
(a)		current $I\left(=\frac{F}{Bl}\right)=\frac{1.4\times10^{-3}\times9.81}{45\times10^{-3}\times40\times10^{-3}}$ ✓ = 7.6(3) A ✓	**2**
(b)	(i) (ii)	magnetic flux change Φ (= BA) = 45 × 10-3 × 40 × 10^{-3} × 20 × 10^{-3} ✓ = 3.6 × 10^{-5} Wb ✓ use of $\in=\frac{\Delta\Phi}{\Delta t}$ ✓ gives time taken Δt = $\frac{3.6\times10^{-5}}{0.15\times10^{-3}}$ ✓ = 0.24 s ✓ [**alternative for (ii)** $v\left(=\frac{\in}{Bl}\right)=\frac{0.15\times10^{-3}}{45\times10^{-3}\times40\times10^{-3}}$ ✓ = 8.33 × 10^{-2} (m s^{-1}) ✓ $\Delta t=\frac{l}{v}=\frac{20\times10^{-3}}{8.33\times10^{-2}}$ = 0.24 s ✓]	**5**
		Total	**7**

Question 5			
(a)	(i) (ii)	fission reaction is induced by neutron bombardment (or neutron absorption) ✓ fission releases neutrons ✓ released neutrons cause more fissions ✓ minimum mass of fissile material ✓ for self-sustaining reaction to be maintained ✓	**max 4**
(b)	(i) (ii)	carbon (graphite) or water ✓ effective in slowing neutrons (or has relatively low mass atoms/molecules) ✓ does not absorb neutrons ✓ carbon dioxide (gas) or water ✓ high (specific) heat capacity [or absorbs heat well] ✓ flows readily ✓	**max 4**
		Total	**8**

Quality of Written Communication Q2 (a) and/or Q5 (a)	**2**