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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics 6451

Specification A

PHA7/W Applied Physics

Mark Scheme

2007 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.

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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.

PHA7/W: Applied Physics

Question 1			
(a)		the decay constant is the number of disintegrations per second divided by the number of nuclei/atoms (available) for decay **or** the proportion of nuclei decaying in one a given time period **or** the decay constant λ is the constant of proportionality in the equation $\Delta N/\Delta t = -\lambda N$ ✓ sample X initially has more counts per second/the total count from sample X is always larger ✓ the count rate from sample X falls more rapidly than from sample Y ✓	**3**
(b)	(i)	use of $A = A_0e^{-\lambda t}$ ✓ $1.0 \times 10^2 = 1.0 \times 10^5\, e^{-\lambda \times 6.9 \times 10^6}$ ✓ (or alternative substitution) $\lambda = \ln 1000/6.9 \times 10^6$ ✓ (to give $1.00 \times 10^{-6}\,s^{-1}$)	**7**
	(ii)	$T_{1/2}$ (= ln 2/ λ) = 6.9×10^5 (s) ✓ = 8.0(1) (days) ✓	
	(iii)	(use of $dN/dt = -\lambda N$) $N = 1.0 \times 10^5/1.0 \times 10^{-6}$ ✓ $= 1 \times 10^{11}$ (atoms) ✓	
		Total	**10**

Question 2			
(a)		$0.24 \times$ input energy = 1.3×10^{11} input energy = $\frac{1.3\times10^{11}}{0.24}$ ✓ (=5.4×10^{11} J)	**1**
(b)		$\frac{5.4\times10^{11}}{10.4\times10^{6}}$ = 52 100 kg ✓	**1**
(c)	(i)	changes 420 ºC to 693 K ✓ (use of $\eta = T_H - T_C / T_H$ gives) = η (693-283)/693 = 0.59 (59%) ✓	**4**
	(ii)	valid reason, e.g. friction in moving parts heat losses from boiler, or turbine, or to surroundings $I^2 R$ energy losses in generator processes in real steam cycle not truly adiabatic or isothermal any one ✓	
	(iii)	does not use an irreplaceable fuel source trees will absorb the CO_2 produced in combustion so less contribution to global warming (allow carbon neutral) may not require imports of fossil fuel if wood grown locally wood does not produce acid rain/no SO_2 produced any one ✓	
		Total	**6**

Question 3			
(a)	(i)	area under graph = $\pi/2$ ✓ $(0.5 \times 25 \times \omega) + (25 \times \omega) + (0.5 \times 30 \times \omega) = \pi/2$ $(12.5 + 25 + 15)\ \omega = \pi/2$ $52.5\omega = 1.57$✓ giving $\omega = 0.030\ \text{rad s}^{-1}$ **or** area = $(0.5 \times 25 \times 0.030) + (25 \times 0.030) + (0.5 \times 30 \times 0.030)$ = 1.57 rad which is $\pi/2$ ✓	**3**
	(ii)	$\alpha = 0.030/25$ $= 1.2 \times 10^{-3}\ \text{rad s}^{-2}$ ✓	
(b)	(i)	driving torque ($T = I\alpha$ gives) $T = 9.1 \times 10^8 \times 1.2 \times 10^{-3}$ ✓ $(= 1.09 \times 10^6\ \text{N m})$ motor torque needed = $(1.09 \times 10^6) + (3.5 \times 10^5)$ $= 1.44 \times 10^6\ \text{N m}$ ✓	**4**
	(ii)	$P\ (= T\omega) = 3.5 \times 10^5 \times 0.030 = 10.5\ \text{kW}$ ✓	
	(iii)	$E_K\ (= 0.5\ I\ \omega^2) = 0.5 \times 9.1 \times 10^8 \times 0.030^2$ $= 4.1 \times 10^5\ \text{J}$ ✓	
		Total	**7**

Question 4			
(a)		1500 (rev min^{-1}) $\times\ 2\pi/60$ ✓ angular momentum = $I\omega = 0.56 \times 157$ $= 87.9\ \text{N m s}$ (or kg m^2 s^{-1}/or kg m^2 rad s^{-1}) ✓	**2**
(b)	(i)	ang. momentum (or $I\omega$) is constant ✓ I increases when clutch engaged, so ω falls ✓	**5**
	(ii)	I after engagement = 0.56 + 0.94 = 1.5 (kg m^2) ✓ $87.9 = 1.5 \times \omega_2$ $\omega_2 = 58.6\ \text{rad s}^{-1}$ ✓ (accept 560 rev min^{-1})	
	(iii)	angular impulse = change in angular momentum $= 0.94 \times 58 = 55.1\ \text{N m s}$ ✓	
		Total	**7**

Question 5		
(a) (i)	appreciation that $\Delta W = 0$ ✓ so ΔU (=ΔQ) = 700 J ✓	**6**
(ii)	$n = \frac{PV}{RT} = \frac{1.0\times10^5\times0.5\times10^{-3}\text{ J}}{8.3\times293}$ ✓ n = 0.021 mol	
(iii)	W = area enclosed (by loop) ✓ appropriate method for finding area (e.g. counting squares) ✓ correct scaling factor used to give answer of 350 J ± 30 J ✓	
(b)	piston always moving so heating not at constant volume in real cycle no sharp corners on real cycle because valves take time to open and close maximum temperature not realised because of imperfect combustion expansion and compression strokes not truly adiabatic in real cycle – heat losses occur real cycle needs induction and exhaust strokes any two ✓✓	**2**
		8

Quality of Written Communication Q1 (a) and/or Q5 (b)	**2**