ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark scheme June 2002

GCE

Physics A

Unit PHA7/W

Unit 7: Applied Physics

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

1(a)(i) α (radiation) ✓

(ii) γ (radiation) ✓ (*2*)

(b)(i) the radiation needs to pass through the <u>body</u> (to be detected) ✓

(ii) (otherwise) the activity of the source becomes too weak (during measurements) ✓

(iii) the decaying source may remain in the body for a <u>long time</u> and could cause damage ✓
[or the activity of the source will be low unless a large quantity is used ($T_{1/2} \propto 1/\lambda$)] (*3*)

(c) corrected count rate at 0.2 m (= 2550 – 50) = 2500 (c min^{-1}) ✓
corrected count rate at least distance (= 6000 – 50) = 5950 (c min^{-1}) ✓

<u>use</u> of $I = \text{k}\dfrac{I_o}{x^2}$ (or in the form $\dfrac{I_1}{I_2} = \left(\dfrac{x_2}{x_1}\right)^2$) ✓

(allow C.E. for using uncorrected count rate)

gives least distance = $0.20 \times \left(\dfrac{2500}{5950}\right)^{1/2}$ ✓

least distance = 0.13 m ✓ (*5*)

(*10*)

Section B

2(a)(i) 60 km h^{-1} = $\frac{60\times1000}{3600}$ = 17 m s^{-1} ✓ (16.7)

(use of $E_k = ½mv^2$ gives) $E_k = 0.5 \times 1800 \times (16.7)^2 = 250$ kJ ✓

(v = 17 m s^{-1} gives E_k = 260 kJ)

(ii) (use of $E_k = ½I\omega^2$ gives) $I = \frac{2E_k}{\omega^2}$ ✓

$I = \frac{2\times187.5\times10^3}{360^2}$ = 2.9 kg m^2 ✓

(E_k = 195 kJ gives I = 3.1 kg m^2) (*4*)

(b) advantage: weight (and mass) of flywheel B is less ✓

reason: because ($I = \Sigma mr^2$) mass is distributed further away from the axis of rotation ✓

less mass means translational acceleration of vehicle is greater [or less weight in climbing hills] ✓ max(*2*)

(*6*)

3(a)(i) two correct points from straight line (e.g. (0,0) and (300,150)) ✓

$\alpha\left(=\frac{\omega_2-\omega_1}{t}\right)=\frac{150-0}{0.3}$ = 500 rad s^{-2} ✓

(ii) $T (= I\alpha) = 4.20 \times 10^{-7} \times 500 = 2.1 \times 10^{-4}$ N m ✓ (*3*)

(b)(i) resistive torque is negligible at low speeds ✓

resistive torque increases as speed increases ✓

resultant accelerating torque decreases so α decreases ✓

until resistive torque = applied torque ✓

zero net torque, so constant angular speed ✓

(any three)

(ii) (use of $P = T\omega$ gives) $P = 2.1 \times 10^{-4} \times 225 = 4.73 \times 10^{-2}$ W ✓

(allow C.E. for value of T)

(iii) $E (= Pt) = 4.73 \times 10^{-2} \times 60 = 2.84$ J ✓ (*5*)

(*8*)

4(a) work done = area between line and volume axis ✓
suitable method used to estimate area (e.g. counting squares)
($\approx$ 1100 squares) ✓
correct scaling factor (1 square $\equiv 5 \times 10^{-4}$ (J)) ✓
work done = 0.55 J $\pm$ 0.05 J ✓ (*4*)

(b) (two pairs of p,V values from the graph)
isothermal since $p \times V$ is same for both points (= 0.30 J) ✓ (*1*)

(c) work done on gas increases internal energy ✓
(slow compression) gives heat time to escape (from gas) ✓ (*2*)

(d) $T = 1600 + 273 = 1873$ K ✓
(use of $pV = nRT$ gives) $n\left(= \frac{pV}{RT}\right) = \frac{0.30}{8.3 \times 1873} = 1.9 \times 10^{-5}$ (mol) ✓
(allow C.E. for value of pV from (b)) (*2*)
(*9*)

5(a)(i) $\eta_{max} = \frac{T_H - T_C}{T_H}$ ✓
$= \frac{360 - 280}{360} = 0.22$ (or 22%) ✓

(ii) (use of $\eta = \frac{W_{out}}{Q_{in}}$ gives) $Q_{in} = \frac{5 \times 10^6}{0.22} = 23$ MW ✓
(allow C.E. for value of η_{max})

(iii) $Q_{out} = (23 - 5) = 18$ MW ✓ (*4*)
(allow C.E. for value of Q_{in})

(b) loss of heat to the atmosphere during the process ✓
friction between moving parts ✓
losses in the electrical generating system ✓
variation in sea temperature ✓
any other sensible and correct physics ✓ $_{max}$(*2*)

(c) no fuel transportation costs ✓
no cost of raw fuel ✓
no cost of removing/treating waste products $_{max}$(*1*)
(*7*)

The Quality of Written Communication marks are awarded primarily for the quality of answers to Q3(b)(i) and Q2(b).