ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark scheme June 2003

GCE

Physics A

Unit PHA7/W

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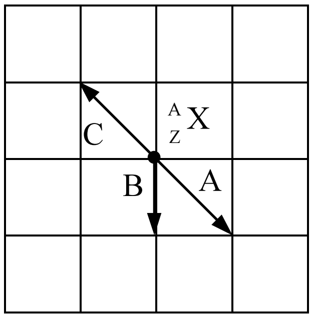
Units 5 - 9 : Section A

1

(a)(i)



correct arrows: A ✓
B ✓
C ✓

(a)(ii) $e^{-1} + {}^{A}_{Z}X \rightarrow {}^{A}_{Z-1}Y + \nu_e$ ✓ (*4*)

(b)(i) $((4.18 - 1.33) \times 10^{-13}) = 2.85 \times 10^{-13}$ (J) ✓

(b)(ii) 1.33×10^{-13} (J)
0.30×10^{-13} (J) for 3 correct values ✓
1.63×10^{-13} (J)

(b)(iii) (use of $\Delta E = hf$ gives) $f\left(= \frac{1.63 \times 10^{-13}}{6.63 \times 10^{-34}}\right) = 2.46 \times 10^{20}$ Hz ✓

(allow C.E. from (b)(ii) if largest value taken) (*3*)

(c)(i) (✓ for each precaution with reason to $_{max}2$)

handle with (long) (30 cm) tweezers
because the radiation intensity decreases with distance

store in a lead box (immediately) when not in use
to avoid unnecessary exposure to radiation

[or any sensible precaution with reason]

(b)(ii) γ rays are more penetrating and are therefore more hazardous (to the internal organs of the body)

β^- particles are more hazardous because they are more ionising ✓
(✓ for any argued case for either radiation) (*3*)

(*10*)

Unit 7 : Section B

2

(a) (use of $v = \omega r$ gives $\omega = \frac{3.5}{0.2}$ = 18 rad s^{-1} ✓ (*1*)

(b)(i) $\alpha = \frac{\omega_2 - \omega_1}{t} = (-)\frac{(17.5 + 17.5)}{4.6}$ = (–)7.6 rad s^{-2} ✓

(b)(ii) (use of $T = I\alpha$ gives) $T = 40 \times 7.6 = 300$ N m ✓
(allow C.E. for value of α from (i))

(b)(iii) (use of *angular impulse* = *Tt* gives)
angular impulse = 300 × 4.6 = 1.4 × 10^3 kg m^2 rad s^{-1} ✓
(allow C.E. for value of *T* from (ii))

(b)(iv) uniform torque therefore uniform acceleration, $\therefore t = 2.3$ s ✓
$\theta = \frac{(\omega_1 + \omega_2)}{2} t = \frac{17.5}{2} 2.3 = 20(.13)$ (rad) ✓
number of turns = $\frac{20.13}{2\pi}$ = 3.2 (so 3 complete turns) ✓ (*6*)

(*7*)

3

(a)(i) torque = 4 × 0.60 × 1.8 = 4.3(2) N m ✓

(a)(ii) $\omega = \frac{2\pi}{110} = 5.7(1) \times 10^{-2}$ (rad s^{-1}) ✓
at steady speed, frictional torque = applied torque ✓
(use of $P = T\omega$ gives) $P = 4.32 \times 5.71 \times 10^{-2} = 0.25$ W ✓
(allow C.E. for value of *T* from (i)) (*4*)

(b)(i) average power = 0.5 × 0.25 = 0.125 (W) ✓
energy = average power × time = 0.125 × 12 ✓ (= 1.5 J)
(allow C.E. for value of *P* from (a)(ii))

(b)(ii) (use of *kinetic energy* = ½$I\omega^2$ = 1.5 gives)
$I = \frac{2 \times 1.5}{(5.71 \times 10^{-2})^2}$ = 910 kg m^2 ✓
(allow C.E. for value of ω from (a)(ii)) (*3*)
(*7*)

4

(a) (use of pV^{γ} = *constant* gives)
$1.01 \times 10^5 \times (4.25 \times 10^{-4})^{1.4} = 1.70 \times 10^5 \times V^{1.4}$ ✓
V calculated correctly (= 2.93×10^{-4})
or substitution to show equal pV^{γ} ✓ (*2*)

(b) $\dfrac{p_1V_1}{T_1} = \dfrac{p_2V_2}{T_2}$ ✓
$T_1 = 273 + 23 = 296$ (K) ✓
$T_2 = \dfrac{1.7\times10^5 \times 2.93\times10^{-4} \times 296}{1.01\times10^5 \times 4.25\times10^{-4}}$ = 343 K (70 °C) ✓ (*3*)

(c) slow compression is isothermal (temperature does not increase) ✓
greater change in volume needed to rise to same final pressure ✓
(or correct pV sketches showing adiabatic and isothermal processes)
hence less ✓✓ (*3*)
(*8*)

5

(a) work per cycle = area enclosed = $6 \times 10^5 \times 4.5 \times 10^{-3}$ = 2.7 (kJ) ✓
power = work output per sec = $\dfrac{2700}{0.20}$ = 13.5 kW ✓
(allow C.E. for incorrect work per cycle) (*2*)

(b) modified engine uses less steam per cycle ✓
so lower energy input per cycle ✓
input energy per cycle ≈ $^1/_3$ of that in unmodified cycle ✓
work output per cycle is less than for unmodified cycle ✓
work output per cycle > ½ of that in unmodified cycle ✓
hence greater efficiency ✓ $_{max}$(*4*)
(*6*)

Quality of Written Communication (Q1(c)(i) and Q5(b)) (*2*)
(*2*)