ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark scheme June 2003

GCE

Physics A

Unit PA10

Unit 10

1

(a)(i) $r = 0.012$ (m) ✓

(use of $v = 2\pi fr$ gives) $v = 2\pi 50 \times 0.012$ ✓

$= 3.8 \text{ m s}^{-1}$ ✓ (3.77 m s^{-1})

(a)(ii) correct use of $a = \dfrac{v^2}{r}$ or $a = \dfrac{3.8^2}{0.012}$ ✓

$= 1.2 \times 10^3 \text{ m s}^{-2}$ ✓

[or correct use of $\alpha = \omega^2 r$]

(allow C.E. for value of v from (i)) (*5*)

(b) panel resonates ✓

(because) motor frequency = natural frequency of panel ✓ (*2*)

(*7*)

2

(a)(i) pd across resistor (= 3.0 – 2.2) = 0.8 (V) ✓

(use of $V = IR$ gives) $R\left(= \dfrac{0.8}{0.035}\right) = 23\ \Omega$ ✓ (22.9 Ω)

(a)(ii) charge flow in 1 s = 0.035 (C) ✓

no. of electrons (in 1 s) $\left(= \dfrac{0.035}{1.6 \times 10^{-19}}\right) = 2.2 \times 10^{17}$ ✓ (2.19×10^{17}) (*4*)

(b)(i) (use of $E = hf = \dfrac{hc}{\lambda}$ gives) $E = \dfrac{6.63 \times 10^{-34} \times 3 \times 10^8}{635 \times 10^{-9}}$ ✓

$= 3.1(3) \times 10^{-19}$ J ✓

(b)(ii) (use of $P = VI$ gives) P (= 2.2 × 0.035) = 0.077 (W) ✓

[or use of $P = I^2R$ with $R\left(= \dfrac{2.2}{0.035}\right) = 63$ (Ω)]

maximum no. of photons emitted per sec. = $\dfrac{0.077}{3.1 \times 10^{-19}}$

$= 2.5 \times 10^{17}$ ✓ (2.48×10^{17})

(allow C.E. for value of E from (i) and value of P from (ii)) (*4*)

(*8*)

3

(a)(i) (use of $P = VI$ gives) P (= 2.4 × 20) = 48 W ✓

(a)(ii) incident (solar) power (= 1.4 × 2.5) = 3.5 (kW) ✓

efficiency = $\dfrac{48}{3500}$ ✓

= 0.014 ✓ (or 1.4%)

[or efficiency = $\frac{48}{2.5}$/1400]

(allow C.E. for incorrect values of input and output power) (*4*)

(b)(i) in 1 s source emits 1.1×10^{14} particles ✓

energy emitted in 1 s = $1.1 \times 10^{14} \times 5.1 \times 1.6 \times 10^{-13}$ (J)✓ (= 90 J)

(b)(ii) $T_{1/2} = \frac{\ln 2}{\lambda}$ + correct use or $\lambda = \frac{\ln 2}{90 \times 365 \times 24 \times 3600}$ ✓

= 2.44×10^{-10} s^{-1} ✓

[or $\lambda = \frac{\ln 2}{90}$ = 7.7×10^{-3} yr^{-1}]

(b)(iii) no. of nuclei $\left(= \frac{\text{activity}}{\text{decay constant}} = \frac{11 \times 10^{14}}{2.44 \times 10^{-10}} \right)$ = $4.5(1) \times 10^{23}$ ✓

(allow C.E. for incorrect value of λ in (ii))

mass of isotope = $\frac{4.51 \times 10^{23} \times 0.239}{6.02 \times 10^{23}}$ ✓

= 0.18 kg ✓

(allow C.E. for incorrect no. of nuclei) (*7*)

(*11*)

4

(a)(i) area = 120×10^{6} (m^2) ✓

mass = $120 \times 10^{6} \times 10 \times 1100 = 1.3 \times 10^{12}$ kg ✓

(ii) (use of $E_p = mgh$ gives) $\Delta E_p = 1.3 \times 10^{12} \times 9.8 \times 5 = 6.4 \times 10^{13}$ J ✓

(allow C.E. for incorrect value of mass from (i))

(a)(iii) power (from sea water) = $\frac{6.4 \times 10^{13}}{6 \times 3600}$ ✓

[or correct use of $P = Fv$]

= 3000 (MW) ✓

(allow C.E. for incorrect value of ΔE_p from (ii))

power output = 3000×0.4 ✓

= 120 MW ✓

(allow C.E. for incorrect value of power) (*7*)

(*7*)

5

(a)(i) initial acceleration/increase of speed ✓

reaches a constant speed/velocity ✓

acceleration decreases to become zero (at this speed) ✓

(a)(ii) drag/frictional forces increases with speed ✓

drag equal to weight (– upthrust) ✓

no resultant force at terminal speed

[or balanced forces or forces cancel] ✓ $_{\max}$(*5*)

(b) column C

26.6
39.7
49.4 — four values correct ✓
75.2 — all values correct and to 3 or 4 s.f. ✓
118
173.5 *(2)*

(c)(i) column E

1.42
1.60
1.69 — all values correct and to 3 or 4 s.f. ✓
1.88
2.07
2.24

(b)(ii) axes labelled and suitable scales chosen ✓
at least 5 points plotted correctly ✓
acceptable line ✓ *(4)*

(d)(i) gradient $= \left((\text{e.g.}) \frac{2.40 - 1.00}{0.7} \right) = 2.0$ ✓

n = gradient (= 2) ✓

(d)(ii) intercept on y-axis = log k ✓
intercept = 1.0 ✓
k (= $10^{1.0}$) = 10 ✓
units of k: for $n = 2$, mm^{-1} s^{-1} ✓ max*(5)*

(16)

6(a)(i) volume of air is less with the powder present ✓
pressure α 1/volume so pressure is greater ✓

(a)(ii) initial volume = 3.5×10^{-4} (m^3) ✓
final volume = 2.5×10^{-4} (m^3) ✓

final pressure $= \frac{100 \times 10^3 \times 3.5 \times 10^{-4}}{2.5 \times 10^{-4}}$ ✓ $= 140 \times 10^3$ Pa ✓

[alternative: no.of moles (n) (= $\frac{p_0 V_0}{RT_0}$) = $\frac{1.0 \times 10^5 \times 3.5 \times 10^{-4}}{RT_0}$ ✓✓

final pressure $\left(= \frac{nRT_0}{V_1} \right) = \frac{1.0 \times 10^5 \times 3.5 \times 10^{-4}}{2.5 \times 10^{-4}}$ ✓ = 140 kPa ✓] *(6)*

(b)(i) volume of powder $\left(= \frac{\text{mass}}{\text{density}} = \frac{0.13}{2700} \right) = 4.8 \times 10^{-5}$ m^3 ✓

(b)(ii) assuming powder volume as in (b)(i),
initial volume = $(3.5 - 0.48) \times 10^{-4}$ (m^3) ✓
final volume = $(2.5 - 0.48) \times 10^{-4}$ (m^3) ✓

final pressure = $\dfrac{100\times10^3\times3}{2}$ = 150×10^3 Pa ✓

test successful as calculated final pressure = measured final pressure ✓ (5)

(11)

7

(a)(i) (in 1 s), $E = 0.045 \times 4200 \times (47 - 15)$ ✓

$= 6050$ J ✓

(a)(ii) $P\left(=\dfrac{E}{t}\right) = 6.0$ kW ✓ (3)

(b)(i) (use of $P = VI$ gives) $I\left(=\dfrac{6050}{230}\right) = 26$ A ✓ (26.3 A)

(allow C.E. for value of P from (a))

(b)(ii) radius $= 1.2\times10^{-3}$ (m) ✓

cross-sectional area $= \pi(1.2\times10^{-3})^2$ (or 4.5×10^{-6} (m^2)) ✓

$\dfrac{R}{l} = \dfrac{\rho}{A}$ ✓

$= \dfrac{1.7\times10^{-8}}{4.5\times10^{-6}}$ ✓

$= 3.8\times10^{-3}\ \Omega\ m^{-1}$ ✓

(allow C.E. for value of A)

(b)(iii) $\dfrac{V}{l}\left(=\dfrac{IR}{l} = 26\times3.8\times10^{-3}\right)$ = 0.1 ($V\ m^{-1}$) (per wire)

two wires per cable gives pd per metre = 2×0.1 ✓ (= 0.20 $V\ m^{-1}$) ✓

(iv) maximum length $\left(=\dfrac{6}{0.2}\right) = 30$ m ✓ (9)

(12)

8

(a) $mg = T\cos 6$ ✓

$F = T\sin 6$ ✓

hence $F = mg\tan 6$ ✓

[or correct use of triangle:

✓ for sides correct, ✓ for 6^o, ✓ for $\tan 6 = F/mg$

or $F\Delta x = mg\,\Delta h$, $\tan\theta = \dfrac{\Delta h}{\Delta x}$ $\tan 6^o = \dfrac{F}{mg}$ (3)

(b)(i) (use of $E = \dfrac{V}{d}$ gives) $E = \dfrac{4200}{60\times10^{-3}} = 7.0\times10^4\ V\ m^{-1}$ ✓

(ii) (use of $Q = \frac{F}{E}$ gives) $Q \left(= \frac{mg\tan 6}{E} \right) = \frac{2.1 \times 10^{-4} \times 9.8\tan 6}{7 \times 10^{4}}$ ✓

$= 3.1 \times 10^{-9}$ C ✓

(allow C.E. for value of *E* from (i)) (3)

(6)

Quality of Written Communication (Q1(b) and Q6(a)(i) ✓✓ (2)

(2)