ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark scheme January 2004

GCE

Physics A

Unit PA10

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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.

Unit 10

1

(a)(i) (use of $E = Pt$ gives) $E = 3000 \times 320 = 960\,\text{kJ}$ ✓

(ii) (use of $Q = mc\Delta\theta$ gives) $Q = 2.4 \times 4200 \times (100 - 16)$ ✓
$= 850\,\text{kJ}$ ✓

(iii) energy needed to heat the kettle material ✓
[or heat loss to surroundings] (*4*)

(b)(i) (use of $I = \frac{P}{V}$ gives) $I = \frac{3000}{230} = 13\,(\text{A})$ ✓

(use of $V = IR$ gives) $R\left(=\frac{230}{13}\right) = 18\,\Omega$ ✓ $(17.7\,\Omega)$

(allow C.E. for value of *I*)

[or correct use of $R = \frac{V^2}{P}$ to give correct *R*]

(ii) $A = \pi\frac{(0.65 \times 10^{-3})^2}{4}\,(\text{m}^2)$ ✓ $(= 3.32 \times 10^{-7}(\text{m}^2))$

(use of $\rho = \frac{AR}{l}$ gives) $\rho = \frac{3.32 \times 10^{-7} \times 17.7}{0.25}$ ✓

$= 2.3 \times 10^{-5}\,\Omega\,\text{m}$ ✓ $(2.35 \times 10^{-5}\,\Omega\,\text{m})$

(use of $R = 18\,\Omega$ gives $\rho = 2.4 \times 10^{-5}\,\Omega\,\text{m}$)

(allow C.E. for value of *R* from (i) and value of *A*) (*5*)

(*9*)

2

(a) increased impact time ✓
same loss of momentum ✓
force = change of momentum/impact time ✓
∴ force is reduced ✓
[alternative for 2nd and 3rd : reduced deceleration of body ✓
force = mass × acceleration ✓]
[or area of contact increased ✓
force on driver 'spread out' over larger area ✓
pressure or force/unit area on driver reduced ✓]
[or air bag absorbs E_k of driver ✓
over a greater distance ✓
force = $\frac{\Delta E_k}{\text{distance}}$ ✓
force is reduced ✓] (*4*)

(b) (use of $v^2 = u^2 + 2as$ gives) $a\left(=\frac{v^2-u^2}{2s}\right) = \frac{(0)-18^2}{2\times 2.5}$ ✓

$a = -65\ \mathrm{m\,s^{-2}}$ ✓ ($-64.8\ \mathrm{m\,s^{-2}}$) (hence deceleration = $65\ \mathrm{m\,s^{-2}}$) (2)

(6)

3

(a)(i) 12 (± 2) ✓

(ii) 10 ms ✓

(iii) time period (T) = 0.84 (s) ✓ (or f = 1.2 Hz)

amplitude (A) = 50 (mm) ✓

max speed $\left(=\frac{2\pi A}{T}\right) = \frac{2\pi \times 0.050(\mathrm{m})}{0.84}$ ✓

$= 0.37\ (\mathrm{m\,s^{-1}})$ ✓

max displacement between readings

(= max speed × time between successive readings)

$= 0.37\ (\mathrm{m\,s^{-1}}) \times 1.0 \times 10^{-2}$ (s) ✓

= 3.7 mm ✓

[alternative for last four marks:

$x = \mathrm{A}\cos 2\pi f\left(\frac{T}{4}\right.$ ✓ + 0.01 ✓ $\left.\right)$

$= 50\cos\frac{2\pi}{0.84}\times(0.21+0.01)$ ✓

= 3.7 mm ✓] (8)

(b) when pd across pot.div. = 1.0 V, pd across R (= 1.3 – 1.0) = 0.3 (V) ✓

$\frac{R}{4.7(\mathrm{k\Omega})} = \frac{0.3}{1.0}$ ✓

$R = 1.4\ \mathrm{k\Omega}$ ✓ (3)

(11)

4

(a)(i) $\sin c = \frac{1}{1.5}$ ✓

$c = 42°$ ✓ (41.8°)

(ii) $1.5 \sin i = \sin 40$ ✓

$i = 25°$ ✓ (25.4°) (use of $c = 41.8°$ gives $i = 26.4°$)

(iii) total internal reflection at R ✓

further total internal reflection below Q ✓

further total internal reflection ✓ (7)

(b)(i) light ray enters fibre without refraction ✓
total internal reflection at fibre/air surface ✓

(ii) pulse in fibre 1 takes longer because it travels across the fibre as well as along it ✓ (3)

(10)

5

(a) suitable calculation using a pair of values of x and corresponding t to give an average of 2.2 m s^{-1} (± 0.05 m s^{-1}) ✓
valid reason given ✓
(e.g. larger values are more reliable/accurate or use of differences eliminates zero errors) (2)

(b)(i) column D (y/t (cm s^{-1})
186
210
233
259
284
307 all values correct to 3 s.f. ✓

(ii) graph: chosen graph gives a straight line (e.g. y/t against t) ✓
axes labelled correctly ✓
suitable scale chosen ✓
minimum of four points correctly plotted ✓
best straight line ✓

(iii) u (= y - intercept) = 162 cm s^{-1} (± 4 cm s^{-1}) ✓
gradient = 495 (cm s^{-2}) (± 25 cm s^{-2}) ✓
k = gradient (= 495 cm s^{-2}) ✓ (9)

(c)(i) u : initial vertical component of velocity ✓

(ii) $k : = \frac{1}{2} g$ ✓ (2)

(d) $v^2 = u^2 + 2.2^2$ ✓
gives $v = (1.62^2 + 2.2^2)^{1/2} = 2.7$ m s^{-1} (± 0.1 m s^{-1}) ✓ (2)

(15)

6

(a) microwaves from transmitter are polarised [or vibrate in certain plane or direction] ✓
rotating transmitter through 90° rotates plane of vibration/polarisation of the microwaves ✓
receiver signal becomes zero when receiver is perpendicular o plane/direction of vibration/polarisation of the microwaves ✓ (3)

(b)(i) (use of $c = f\lambda$ gives) $f\left(= \frac{3.0 \times 10^8}{0.12}\right) = 2.5 \times 10^9$ Hz ✓

(ii) no energy/amplitude/intensity/vibrations at nodes ✓
food at nodes would not be heated ✓ (3)
(6)

7

(a)(i) $E = \frac{Q}{4\pi\varepsilon_0 R^2}$ ✓

$V = \frac{Q}{4\pi\varepsilon_0 R}$ ✓ (gives $E = \frac{V}{R}$)

[or $E = \frac{Q}{4\pi\varepsilon_0 r^2}$ and $V = \frac{Q}{4\pi\varepsilon_0 r}$ ✓

$\therefore E = \frac{V}{r}$ gives $E = \frac{V}{R}$ when $r = R$ ✓]

(ii) $V (= ER) = 3.3 \times 10^6\,(\text{V m}^{-1})$ ✓ $\times 0.20$ (m) ✓
= 660 kV ✓ (5)

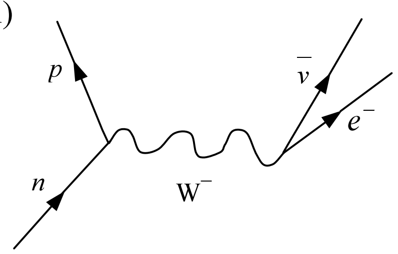
(b)(i) V_p (= 100 √2) = 140 kV ✓ (141 kV)

(ii) minimum radius $= \frac{140(\text{kV})}{3.3(\text{kV mm}^{-1})}$ ✓ (= 42.4 mm)
minimum diameter (= 2 × 42.40) = 85 mm ✓
(use of V_p = 141 kV gives minimum diameter = 86 mm)
(allow C.E. for value of V_p in (i)) (3)
(8)

8

(a)(i) $^{40}_{20}\text{Ca}$ ✓

(ii)

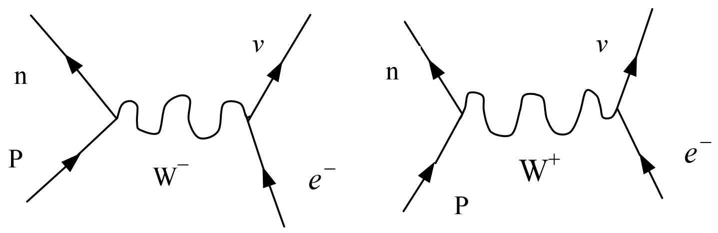


n, p correct ✓
W^- correct ✓
β^-(or e^-) and ν correct ✓

(4)

(b)(i) $^{40}_{18}Ar$ ✓

(ii)



n, p, W^-/W^+ correct ✓
e^- and ν correct ✓

(*3*)

(c)(i) 1 Ar atom + 8 Ca atoms (originally K atoms) + 4 K atoms remaining ✓

(ii) $N_0 = 13$, $N = 4$ ✓

$\lambda\left(=\frac{\ln 2}{T_{1/2}}\right) = \frac{0.693}{1250\times10^6\,(\text{yr})}$ ✓ $(5.54\times10^{-10}\,(\text{yr}^{-1}))$

(use of $N = N_0\exp(-\lambda t)$ gives) $4 = 13\exp(-\lambda t)$ ✓

$4 = 13\exp(-5.54\times10^{-10}\times t)$ ✓

t = 2100 million years ✓ (2128 million years) (± 50 million years) (*6*)

(*13*)

Quality of Written Communication (Q2(a) and Q6(a)) ✓✓ (*2*)

(*2*)