CAMBRIDGE
INTERNATIONAL EXAMINATIONS

NOVEMBER 2002

GCE Advanced Level

MARK SCHEME

MAXIMUM MARK : 60

SYLLABUS/COMPONENT :9702 /4

PHYSICS
(STRUCTURED QUESTIONS (A2 CORE))

UNIVERSITY of CAMBRIDGE
Local Examinations Syndicate

1 (a) (i) $Q = mc\Delta\theta$ C1
$2300 = 0.75 \times c \times (100 - 20) / 120$ ...(if uses ±273, then –2)..... C1
$c = 4600\ \text{J kg}^{-1}\ \text{K}^{-1}$ ...(allow 1 sf)..... A1
(ii) $Q = mL$ C1
$2300 = (0.375 / 420) \times L$
$L = 2.6 \times 10^6\ \text{J kg}^{-1}$ ...(alow 1 sf)..... A1 [5]

(b) e.g. heat losses, power not constant etc M1
(do not allow if releated to s.h.c., rather than l.h.c.)
effect on value for L ..... A1 [2]

2 (a) $E = hc / \lambda = (6.63 \times 10^{-34} \times 3.0 \times 10^8) / (486 \times 10^{-9})$ C1
$= 4.09 \times 10^{-19}\ \text{J}$ ...(allow 2 sf)..... A1 [2]

(b) energy level drawn at $4.09 \times 10^{-19}\ \text{J}$ B1
transition 4.09×10^{-19} to zero clear B1
transition 4.09×10^{-19} to 3.03×10^{-19} clear ..... B1 [3]
(-1 for reversed arrows, -1 for extra level at 1.06)

3 (a) (i) constant amplitude B1
(ii) period = 0.75 s ...(allow ±0.2 s)..... C1
$\omega = 2\pi/T$ C1
$\omega = 8.4\ \text{rad s}^{-1}$ ...(-1 for 1 sf)..... A1
(iii) either use of gradient or $v = \omega y_0$ C1
$v = 0.168\ \text{m s}^{-1}$ ..... A1 [6]
(allow ±0.02 for construction: gradient drawn at wrong place 0/2)

(b) (i) 1.3 Hz B1
(ii) at $\frac{1}{2}f_0$, 'pulse' provided to mass on alternate/some oscillations M1
so 'pulses' build up the amplitude ..... A1 [3]

4 (a) (i) $\frac{1}{2}mv^2 = GMm / R$ B1
$v^2 = 2GM / R$ A0
(ii) $g = GM/R^2$ M1
clear algebra giving $v^2 = 2gR$ ..... A1 [3]

(b) $\frac{1}{2}mv^2 = 3/2kT$
$v^2 = 3kT / m$ C1
$3kT / m = 2gR$ C1
$T = (2 \times 6.6 \times 10^{-27} \times 9.81 \times 6.4 \times 10^6) / (1.38 \times 10^{-23} \times 3)$ C1
$T = 2.0 \times 10^4\ \text{K}$ ..... A1 [4]

5 (a) two capacitors in series
or any circuit such that $V \leq 25$ V across any C B1
in parallel with second series pair or any correct combination ..... B1 [2]

(b) two capacitors in series in parallel with a single capacitor
or other correct combination ..... B2 [2]
(leads not shown, then –1 overall)

6 (a) e.g. E-field, force independent of speed, B-field, force ∝ speed ... B2
E-field, force along field direction, B-field, force normal etc ... B2 [4]

(b) (i) out of plane of paper (not 'upwards') B1
(ii) $mv^2 / r = Bqv$ C1
$r = (1.67 \times 10^{-27} \times 4.5 \times 10^6) / (0.12 \times 1.6 \times 10^{-19})$ C1
$r = 0.39$ m ..... A1 [4]

(c) (i) arrow pointing up page B1
(ii) $Bqv = Eq$ C1
$E = 0.12 \times 4.5 \times 10^6$
$= 5.4 \times 10^5$ V m^{-1} ..... A1 [3]

(d) gravitational force $<< F_B$ or F_E ..... B1 [1]

7 (a) (i) the wire cuts magnetic field B1
e.m.f. induced when there is a change/cutting of flux B1
(ii) (Lenz) e.m.f. 'opposes' change causing it B1
as direction of movement changes, so does e.m.f. ..... B1 [4]

(b) $x_0 = 1.5$ mV ...(allow ±0.1) C1
$\omega = 2\pi / T = 2\pi / (3 \times 10^{-3})$ C1
$= 2090$ rad s^{-1} C1
$x = 1.5 \sin 2090t$ ..... A1 [4]

8 (a) probability of decay of a nucleus M1
per unit time ..... A1 [2]

(b) $A = \lambda N$ ...(ignore sign)..... B1 [1]

(c) (i) $1\ m^3$ contains $1 / 0.024 = 41.7$ mol C1
$1\ m^3$ contains $41.7 \times N_A = 2.5 \times 10^{25}$ molecules A1

(ii) number $= (2.5 \times 10^{25}) / (1.5 \times 10^{21}) = 1.67 \times 10^4$ A1

(iii) $\lambda T_{½} = 0.693$
$\lambda = 0.693 / 56 = 0.0124\ s^{-1}$ C1
activity $= 0.0124 \times 1.67 \times 10^4$
$= 210$ Bq ..... A1 [5]