

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
GCE Advanced Subsidiary Level and GCE Advanced Level

## MARK SCHEME for the May/June 2007 question paper

### 9702 PHYSICS

9702/04

Paper 4 (A2 Structures Questions), maximum raw mark 100

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

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- 1 (a) (region of space) where a mass experiences a force B1 [1]
- (b) (i) potential energy =  $(-)\frac{GMm}{x}$  C1  
 $\Delta E_p = \frac{GMm}{2R} - \frac{GMm}{3R}$  M1  
 $= \frac{GMm}{6R}$  A0 [2]
- (ii)  $E_k = \frac{1}{2}m(7600^2 - 7320^2)$  M1  
 $= (2.09 \times 10^6)m$  A0 [1]
- (c) (i)  $2.09 \times 10^6 = (6.67 \times 10^{-11} M)/(6 \times 3.4 \times 10^6)$  C1  
 $M = 6.39 \times 10^{23} \text{ kg}$  A1 [2]
- (ii) e.g. no energy dissipated due to friction with atmosphere/air  
rocket is outside atmosphere  
not influenced by another planet etc. B1 [1]
- 2 (a) (on melting,) bonds between molecules are broken/weakened B1  
or molecules further apart/are able to slide over one another B1  
kinetic energy unchanged so no temperature change B1 [3]  
potential energy increased/changed so energy required
- (b) thermal energy/heat required to convert unit mass of solid to liquid M1  
with no change in temperature/ at its normal boiling point A1 [2]
- (c) (i) thermal energy lost by water =  $0.16 \times 4.2 \times 100$   
 $= 67.2 \text{ kJ}$  C1  
 $67.2 = 0.205 \times L$  C1  
 $L = 328 \text{ kJ kg}^{-1}$  A1 [3]
- (ii) more energy (than calculated) melts ice M1  
so, (calculated)  $L$  is lower than the accepted value A1 [2]
- 3 (a) field strength = potential gradient M1  
correct sign OR directions discussed A1 [2]
- (b) area is  $21.2 \text{ cm}^2 \pm 0.4 \text{ cm}^2$  C2  
*(if outside  $\pm 0.4 \text{ cm}^2$  but within  $\pm 0.8 \text{ cm}^2$ , allow 1 mark)*  
 $1.0 \text{ cm}^2$  represents  $(1.0 \times 10^{-2} \times 2.5 \times 10^3 =) 25 \text{ V}$  C1  
potential difference = 530 V A1 [4]
- (c)  $\frac{1}{2}mv^2 = qV$   
 $\frac{1}{2} \times 9.1 \times 10^{-31} \times v^2 = 1.6 \times 10^{-19} \times 530$  C1  
 $v = 1.37 \times 10^7 \text{ ms}^{-1}$  A1 [2]
- (d) (i)  $d = 0$  B1 [1]
- (ii) acceleration decreases then increases B1  
some quantitative analysis (e.g. minimum at 4.0 cm) B1 [2]  
*(any suggestion that acceleration becomes zero or that there is a deceleration scores 0/2)*

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- 4 (a) r.m.s. output =  $9/\sqrt{2}$  or peak input =  $230\sqrt{2}$  C1  
 $N_S/N_P = V_S/V_P$  C1  
 $N_S = 138 \rightarrow 140$  turns A1 [3]
- (b) (i) four diodes correctly positioned regardless of output polarity M1  
giving correct output polarity (*all 'point to left'*) A1 [2]
- (ii) capacitor shown in parallel with R B1 [1]
- (c) (i) time  $t_1$  to time  $t_2$  B1 [1]
- (ii) sketch: same peak values M1  
ripple reduced and reasonable shape A1 [2]
- 5 (a) (i) packet/discrete quantity/quantum (of energy) of e.m. radiation B1 [1]
- (ii) either  $E = (6.63 \times 10^{-34} \times 3 \times 10^8)/(350 \times 10^{-9})$   
or  $E = (6.63 \times 10^{-34} \times 8.57 \times 10^{14})$  M1  
 $E = 5.68 \times 10^{-19}$  J A0 [1]
- (iii) 0.5 B1 [1]
- (b) (i) energy of photon M1  
to cause emission of electron from surface  
*either* with zero k.e *or* photon energy is minimum A1 [2]
- (ii) correct conversion eV  $\rightarrow$  J or J  $\rightarrow$  eV seen once B1  
photon energy must be greater than work function C1  
350 nm wavelength and potassium metal A1 [3]
- 6 (a) probability of decay M1  
of a nucleus per unit time A1 [2]  
(*allow 1 mark for  $A = \lambda N$ , with symbols explained*)
- (b) (i)  $\lambda = \ln 2/(28 \times 365 \times 24 \times 3600)$  C1  
 $= 7.85 \times 10^{-10} \text{ s}^{-1}$  A1 [2]
- (ii)  $A = (-)\lambda N$   
 $N = (6.4 \times 10^9)/(7.85 \times 10^{-10})$  C1  
 $= 8.15 \times 10^{18}$  C1  
mass =  $(8.15 \times 10^{18} \times 90)/(6.02 \times 10^{23})$  (e.c.f. for value of  $N$ ) C1  
 $= 1.22 \times 10^{-3} \text{ g}$  A1 [4]
- (iii) volume =  $(1.22 \times 10^{-3}/2.54) = 4.8 \times 10^{-4} \text{ cm}^3$  A1 [1]
- (c) *either* very small volume of Strontium-90 has high activity B1  
or dust can be highly radioactive B1 [2]  
breathing in dust presents health hazard

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- 7 (a) (i) oscillations are damped/amplitude decreases B1  
as magnet moves, flux is cut by coil B1  
e.m.f./current is induced in the coil B1  
causing energy loss in load OR force on magnet B1  
energy is derived from oscillations of magnet  
OR force opposes motion of magnet B1 [5]
- (ii)  $T = 0.60 \text{ s}$  C1  
 $\omega_0 (= 2\pi/T) = 10.5 \text{ rad s}^{-1}$  A1 [2]
- (b) sketch: sinusoidal wave with period unchanged or slightly smaller M1  
same initial displacement, less damping A1 [2]
- (c) (i) sketch: general shape – peaked curve M1  
peak at  $\omega_0$  and amplitude never zero A1 [2]
- (ii) resonance B1 [1]
- (iii) useful: e.g. child on swing, microwave oven heating B1  
avoid: e.g. vibrating panels, vibrating bridges B1 [2]  
*(for credit, stated example must be put in context)*

## Section B

- 8 (a) e.g. infinite (voltage) gain  
infinite input impedance  
zero output impedance  
infinite bandwidth  
infinite slew rate  
*(any three, 1 each)* B3 [3]
- (b) (i) negative (feedback) B1 [1]
- (ii) 1 gain  $(= 5.8/0.069) = 84$  B1 [1]
- (ii) 2 gain  $= 1 + 120/X$  C1  
 $84 = 1 + 120/X$   
 $X = 1.45 \text{ k}\Omega$  A1 [2]
- (iii) gain increases OR bandwidth reduced OR output increases B1 [1]

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- 9 (a)** X-ray beam directed through body onto detector (plate) B1  
different tissues absorb/attenuate beam by different amounts B1  
giving 'shadow' image of structures B1  
any other detail e.g. comment re sharpness or contrast B1 [4]
- (b)** X-ray image is flat OR 2-dimensional (1)  
CT scan takes many images of a slice at different angles (1)  
these build up an image of a slice through the body (1)  
series of images of slices is made (1)  
so that 3D image can be built up (1)  
image can then be rotated (1)  
1 mark for each point, max 5 B5 [5]
- 10 (a)** correct values of 2, 5, 10, 15 and 4 (–1 each error) B2  
graph drawn as a series of steps M1  
steps occurring at correct times A1 [4]
- (b)** sample more frequently B1  
greater number of bits B1 [2]
- 11 (a)** modulator and oscillator identified B1  
both amplifiers identified correctly B1  
ADC and parallel-to serial converter identified B1 [3]
- (b)** computer at cellular exchange B1  
monitors signal strength B1  
switches call from one base station to another B1  
to maintain maximum signal strength B1 [4]