

MARK SCHEME for the May/June 2007 question paper

9702 PHYSICS

9702/04

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

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Page 2	Mark Scheme	Syllabus	Paper
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- 1 (a) (region of space) where a mass experiences a force B1 [1]
- (b) (i) potential energy = $(-)\frac{GMm}{x}$
 $\Delta E_p = \frac{GMm}{2R} - \frac{GMm}{3R}$
 $= \frac{GMm}{6R}$ C1
M1
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
or molecules further apart/are able to slide over one another
kinetic energy unchanged so no temperature change
potential energy increased/changed so energy required B1
B1
B1 [3]
- (b) thermal energy/heat required to convert unit mass of solid to liquid
with no change in temperature/ at its normal boiling point M1
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 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
(any suggestion that acceleration becomes zero or that there is a deceleration scores 0/2) [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
 $= 1.22 \times 10^{-3}$ 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
as magnet moves, flux is cut by coil
e.m.f./current is induced in the coil
causing energy loss in load OR force on magnet
energy is derived from oscillations of magnet
OR force opposes motion of magnet
- (ii) $T = 0.60 \text{ s}$
 $\omega_0 (= 2\pi/T) = 10.5 \text{ rad s}^{-1}$
- (b) sketch: sinusoidal wave with period unchanged or slightly smaller
same initial displacement, less damping
- (c) (i) sketch: general shape – peaked curve
peak at ω_0 and amplitude never zero
- (ii) resonance
- (iii) useful: e.g. child on swing, microwave oven heating
avoid: e.g. vibrating panels, vibrating bridges
(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)
- (b) (i) negative (feedback)
- (ii) 1 gain $(= 5.8/0.069) = 84$
- (ii) 2 gain $= 1 + 120/X$
 $84 = 1 + 120/X$
 $X = 1.45 \text{ k}\Omega$
- (iii) gain increases OR bandwidth reduced OR output increases

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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]