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.

Mark schemes must be read in conjunction with the question papers and the report on the examination.

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1	**(a)**		(region of space) where a <u>mass</u> experiences a force	B1	[1]
	(b)	**(i)**	potential energy = (–)GMm / x	C1	
			$\Delta E_P = GMm/2R - GMm/3R$	M1	
			$= GMm/6R$	A0	[2]
		(ii)	$E_K = ½m\ (7600^2 - 7320^2)$	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	
			$M = 6.39 \times 10^{23}$ kg	A1	[2]
		(ii)	e.g. no energy dissipated due to friction with <u>atmosphere/air</u>		
			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	B1	
			kinetic energy unchanged so no temperature change	B1	
			potential energy increased/changed so energy required	B1	[3]
	(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 = 0.16×4.2 x 100		
			= 67.2 kJ	C1	
			$67.2 = 0.205 \times L$	C1	
			$L = 328$ 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 cm^2 $\pm$ 0.4 cm^2	C2	
			(if outside $\pm$ 0.4 cm^2 but within $\pm$ 0.8 cm^2, allow 1 mark)		
			1.0 cm^2 represents ($1.0 \times 10^{-2} \times 2.5 \times 10^3$ =) 25 V	C1	
			potential difference = 530 V	A1	[4]
	(c)		$½mv^2 = qV$		
			$½ \times 9.1 \times 10^{-31} \times v^2 = 1.6 \times 10^{-19} \times 530$	C1	
			$v = 1.37 \times 10^7$ 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)*		

4	**(a)**		r.m.s. output = 9/√2 or peak input = 230√2	C1	
			$N_S/N_P = V_S/V_P$	C1	
			N_S = 138 → 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 <u>from surface</u>		
			either with zero k.e *or* photon energy is minimum	A1	[2]
		(ii)	correct conversion eV → J or J → 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 = λN, with symbols explained)*		
	(b)	**(i)**	$\lambda = \ln 2/(28 \times 365 \times 24 \times 3600)$	C1	
			$= 7.85 \times 10^{-10}\ s^{-1}$	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 = $(1.22 \times 10^{-3}/2.54 =)\ 4.8 \times 10^{-4}\ cm^3$	A1	[1]
	(c)		*either* very small volume of Strontium-90 has high activity		
			or dust can be highly radioactive	B1	
			breathing in dust presents health hazard	B1	[2]

7	**(a) (i)**	oscillations are <u>damped</u>/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)	$T = 0.60$ s	C1	
		ω_0 (= $2\pi/T$) = 10.5 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 ω_0 and amplitude never zero	A1	[2]
	(ii)	<u>resonance</u>	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 kΩ	A1	[2]
	(iii)	gain increases OR bandwidth reduced OR output increases	B1	[1]

9	**(a)**	X-ray beam directed through body onto detector (plate) different tissues absorb/attenuate beam by different amounts giving ‘shadow’ image of structures any other detail e.g. comment re sharpness or contrast	B1 B1 B1 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*) graph drawn as a series of steps steps occurring at correct times	B2 M1 A1	[4]
	(b)	sample more frequently greater number of bits	B1 B1	[2]
11	**(a)**	modulator and oscillator identified both amplifiers identified correctly ADC and parallel-to serial converter identified	B1 B1 B1	[3]
	(b)	computer at cellular exchange monitors signal strength switches call from one base station to another to maintain maximum signal strength	B1 B1 B1 B1	[4]