June 2004

GCE ADVANCED SUBSIDIARY LEVEL AND ADVANCED LEVEL

MARK SCHEME

MAXIMUM MARK: 60

SYLLABUS/COMPONENT: 9702/04

PHYSICS
Paper 4 (Structured Questions (A2 Core))

Categorisation of marks

The marking scheme categorises marks on the *MACB* scheme.

B marks: These are awarded as independent marks, which do not depend on other marks. For a B-mark to be scored, the point to which it refers must be seen specifically in the candidate's answer.

M marks: These are method marks upon which A-marks (accuracy marks) later depend. For an M-mark to be scored, the point to which it refers must be seen in the candidate's answer. If a candidate fails to score a particular M-mark, then none of the dependent A-marks can be scored.

C marks: These are compensatory method marks which can be scored even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known it. For example, if an equation carries a C-mark and the candidate does not write down the actual equation but does correct working which shows he/she knew the equation, then the C-mark is awarded.

A marks: These are accuracy or answer marks which either depend on an M-mark, or allow a C-mark to be scored.

Conventions within the marking scheme

BRACKETS
Where brackets are shown in the marking scheme, the candidate is not required to give the bracketed information in order to earn the available marks.

UNDERLINING
In the marking scheme, underlining indicates information that is essential for marks to be awarded.

1	(a)		charge is quantised/enabled electron charge to be measured	B1	[1]
	(b)		all are (approximately) n x (1.6 x 10^{-19} C)	M1	
			so e = 1.6 x 10^{-19} C (allow 2 sig. fig. only	A1	[2]
			summing charges and dividing ten, without explanation scores 1/2		
			Total		[3]
2	(a)		mean (value of the) square	M1	
			of the speeds (velocities) of the atoms/particles/molecules	A1	[2]
	(b)	(i)	$p = \frac{1}{3}\rho < c^2 >$	C1	
			$<c^2>$ = 3 x 2 x 10^5/2.4 = 2.5 x 10^5	C1	
			r.m.s speed = 500 ms^{-1}	A1	[3]
		(ii)	new $<c^2>$ = 1.0 x 10^6 or $<c^2>$ increases by factor of 4	C1	
			$<c^2> \propto T$ or 3/2 kT = 1/2 m$<c^2>$	C1	
			T = {(1.0 x 10^6) / (2.5 x 10^5)} x 300		
			= 1200 K	A1	[3]
			Total		[8]
3	(a)	(i)	(force) = $GM_1M_2/(R_1 + R_2)^2$	B1	
		(ii)	(force) = $M_1R_1\omega^2$ or $M_2R_2\omega^2$	B1	[2]
	(b)		ω = 2π/(1.26 x 10^8) or 2π/T	C1	
			= 4.99 x 10^{-8} rad s^{-1}	A1	[2]
			allow 2 s.f.: 1.59π x 10^{-8} scores 1/2		
	(c)	(i)	reference to either taking moments (about C) or same (centripetal) force	B1	
			$M_1R_1 = M_2R_2$ or $M_1R_1\omega^2 = M_2R_2\omega^2$	B1	
			hence $M_1/M_2 = R_2/R_1$	A0	[2]
		(ii)	R_2 = 3/4 x 3.2 x 10^{11} m = 2.4 x 10^{11} m	A1	
			R_1 = (3.2 x 10^{11}) – R_2 = 8.0 x 10^{10} m (allow *vice versa)*	A1	[2]
			if values are both wrong but have ratio of four to three, then allow 1/2		
	(d)	(i)	M_2 = {$(R_1 + R_2)^2$ x R_1 x ω^2} / G (any subject for equation)	C1	
			= (3.2 x $10^{11})^2$ x 8.0 x 10^{10} x (4.99 x $10^{-8})^2$/(6.67 x 10^{-11})	C1	
			= 3.06 x 10^{29} kg	A1	
		(ii)	less massive (only award this mark if reasonable attempt at **(i)**)	B1	[4]
			(9.17 x 10^{29} kg for more massive star)		
			Total		[12]
4	(a)		e.g. amplitude is not constant or wave is damped	B1	
			do not allow 'displacement constant'		
			should be (-)cos, (not sin)	B1	[2]
	(b)		T = 0.60 s	C1	
			ω = 2π/T = 10.5 rad s^{-1} *(allow 10.4 → 10.6)*	A1	[2]
	(c)		same period	B1	
			displacement always less	M1	
			amplitude reducing appropriately	A1	[3]
			for 2nd and 3rd marks, ignore the first quarter period		
			Total		[7]

5	**(a)**		the (value of the) direct current	M1	
			that dissipates (heat) energy at the same rate (in a resistor)	A1	**[2]**
			allow 'same power' and 'same heating effect'		
	(b)		$\sqrt{2}I_{rms} = I_0$	B1	**[1]**
	(c)	**(i)**	power $\propto I^2$ or $P = I^2R$ or $P = VI$	C1	
			ratio = 2.0 (allow 1 s.f.)	A1	**[2]**
		(ii)	advantage: e.g. easy to change the voltage	B1	
			disadvantage: e.g. cables require greater insulation		
			.... rectification – with some justification	B1	**[2]**
	(d)	**(i)**	3.0 A (allow 1 s.f.)	A1	
		(ii)	3.0 A (allow 1 s.f.)	A1	**[2]**
			Total		**[9]**
6			0 - + (-1 for each error)	B2	
			+ + 0 (-1 for each error)	B2	
			+ + 0 (-1 for each error)	B2	**[6]**
			Total		**[6]**
7	**(a)**		$\lambda = h/p$ or $\lambda = h/mv$	M1	
			with λ, *h* and (or mv) p identified	A1	**[2]**
	(b)		$E = \frac{1}{2}mv^2$	C1	
			$= p^2/2m$ or $v = \sqrt{(2E/m)}$, <u>hence</u>	M1	
			$\lambda = h/\sqrt{(2mE)}$	A0	**[2]**
	(c)		$E = qV$	C1	
			$(0.4 \times 10^{-9})^2 \times 2 \times 9.11 \times 10^{-31} \times 1.6 \times 10^{-19} \times V = (6.63 \times 10^{-34})^2$	C1	
			$V = 9.4$ V *(2 s.f. scores 2/3)*	A1	**[3]**
			Total		**[7]**
8	**(a)**		S shown at the peak	B1	**[1]**
	(b)	**(i)**	Kr and U on right of peak in correct relative positions	B1	**[1]**
		(ii)1	binding energy of U-235 = 2.8649×10^{-10} J		
			binding energy of Ba-144 = 1.9211×10^{-10} J		
			binding energy of Kr-90 = 1.2478×10^{-10} J	C2	
			energy release = 3.04×10^{-11} J *(-1 if 1 or 2 s.f.)*	A1	**[3]**
		2	$E = mc^2$	C1	
			$m = (3.04 \times 10^{-11})/3.0 \times 10^8)^2 = 3.38 \times 10^{-28}$ kg (ignore s.f.)	A1	**[2]**
		(iii)	e.g. neutrons are single particles,		
			neutrons have no binding energy per nucleon	B1	**[1]**
			Total		**[8]**