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 (1.6×10^{-19} C) — M1
so $e = 1.6 \times 10^{-19}$ 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
$< c^2 > = 3 \times 2 \times 10^5 / 2.4 = 2.5 \times 10^5$ — C1
r.m.s speed = 500 ms^{-1} — A1 **[3]**

(ii) new $< c^2 > = 1.0 \times 10^6$ or $< c^2 >$ increases by factor of 4 — C1
$< c^2 > \propto T$ or $3/2\ kT = 1/2\ m < c^2 >$ — C1
$T = \{(1.0 \times 10^6) / (2.5 \times 10^5)\} \times 300$
$= 1200$ 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) $\omega = 2\pi/(1.26 \times 10^8)$ or $2\pi/T$ — C1
$= 4.99 \times 10^{-8}$ rad s^{-1} — A1 **[2]**
allow 2 s.f.: $1.59\pi \times 10^{-8}$ 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) $R_2 = 3/4 \times 3.2 \times 10^{11}$ m $= 2.4 \times 10^{11}$ m — A1
$R_1 = (3.2 \times 10^{11}) - R_2 = 8.0 \times 10^{10}$ m (allow *vice versa)* — A1 **[2]**
if values are both wrong but have ratio of four to three, then allow 1/2

(d) (i) $M_2 = \{(R_1 + R_2)^2 \times R_1 \times \omega^2\}\ I\ G$ (any subject for equation) — C1
$= (3.2 \times 10^{11})^2 \times 8.0 \times 10^{10} \times (4.99 \times 10^{-8})^2 / (6.67 \times 10^{-11})$ — C1
$= 3.06 \times 10^{29}$ kg — A1

(ii) less massive (only award this mark if reasonable attempt at **(i)**) — B1 **[4]**
(9.17×10^{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
$\omega = 2\pi/T = 10.5$ 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 $v = \sqrt{(2E/m)}$, hence		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]**