June 2004

GCE ADVANCED SUBSIDIARY LEVEL AND ADVANCED LEVEL

MARK SCHEME

MAXIMUM MARK: 40

SYLLABUS/COMPONENT: 9702/06

PHYSICS
Paper 6 (Options (A2))

UNIVERSITY of CAMBRIDGE
International Examinations

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.

© University of Cambridge International Examinations 2004

Option A – Astrophysics and Cosmology

1	**(a)**	In an infinite and static Universe		M1	
		every line of sight should end on a star		M1	
		(or spherical shells argument)			
		so sky at night should be bright		A1	**[3]**
	(b)	For expanding Universe			
		finite age limits size	(1)		
		light from distant galaxies is red-shifted out of visible	(1)		
		light from distant young stars not yet reached Earth	(1)		
		Any two points, maximum 2		B2	**[2]**
			Total		**[5]**
2	**(a)**	1 pc = 3.26 ly (allow 3.3 ly)		C1	
		distance = 16/3.26 = 4.9 pc		A1	**[2]**
	(b)	base line is 2 AU		C1	
		angle = 2 x 1/4.9			
		= 0.41 arc sec		B1	**[2]**
			Total		**[4]**
3	**(a)**	Universe is same everywhere/homogeneous/isotropic		M1	
		when considered on a sufficiently large scale		A1	**[2]**
	(b)	characteristic of (black body) 3 K radiation		B1	
		CMB is highly isotropic/same from all directions		M1	
		This indicates that the Universe is highly uniform		A1	**[3]**
			Total		**[5]**
4	**(a)**	e.g. planet observed by reflected light		B1	
		this is too faint (against the starlight)		B1	
		e.g. physically too small		B1	
		to be resolved (at such great distances)		B1	**[4]**
		(any sensible suggestion (B1) with some further comment (B1) – max 4)			
	(b)	e.g. change in intensity of starlight		M1	
		as the star is eclipsed		A2	**[2]**
		e.g. wobble in position of star (M1)			
		as planet orbits star (A1)			
		(any sensible suggestion plus some further comment – max 2)			
			Total		**[6]**

Option F – The Physics of Fluids

5	**(a)**	force = upthrust – weight of polystyrene in air		C1	
		25 = V x (1000 – 15) x 9.8		C1	
		$V = 2.6 \times 10^{-3}$ m^3		A1	**[3]**
	(b)	boat will tend to right itself/float higher in the water		M1	
		if at positions B		A1	**[2]**
			Total		**[5]**
6	**(a)**	if air is streamline		B1	
		air above car moves faster than air below		M1	
		so (by Bernoulli) pressure above is lower than below		M1	
		and car experiences an upward force		A1	**[4]**
	(b)	the spoiler causes turbulence		M1	
		turbulence prevents the lift force from developing		A1	**[2]**
			Total		**[6]**

7	**(a)**	symmetrical pattern on above/below sphere	M1	

© University of Cambridge International Examinations 2004

			lines closer near top and bottom of sphere	A1	**[2]**
	(b)	**(i)**	force on particle = 4/3 πr^3 ($\rho - \rho_w$)g	C1	
			= 4/3 x π x $(4.5 \times 10^{-7})^3$ x (2.9×10^3) x 9.8		
			= 1.08(5) x 10^{-14} N	C1	
			$1.085 \times 10^{-14} = 6 \times \pi \times (4.5 \times 10^{-7}) \times 9.5 \times 10^{-4} \times v$	C1	
			$v = 1.35 \times 10^{-6}$ m s^{-1}	A1	**[4]**
		(ii)	in 1.0 hours, particles move 1.35 x 10-6 x 3600 (= 4.85×10^{-3} m)	B1	
			fraction = (8.0 – 4.85)/8.0	C1	
			= 0.39	A1	**[3]**
			(allow 2/3 for answer of 0.61)		
			Total		**[9]**

Option M – Medical Physics

8	**(a)**		piezo-electric/quartz crystal	B1	
			across which is applied an <u>alternating</u> voltage	B1	
			crystal vibrates	B1	
			at its resonant frequency	B1	**[4]**
	(b)	**(i)**	trace length = 4.0 mm	C1	
			distance = speed x time = 1450 x 0.4 x 10 x 10^{-6}		
			= 5.8×10^{-3} m	C1	
			thickness = 0.29 cm	A1	**[3]**
		(ii)	trace length = 5.2 cm	C1	
			thickness = 4.1 cm	A1	**[2]**
			Total		**[9]**
9	**(a)**		ability of eye to form focused images	M1	
			of objects at different distances from the eye	A1	**[2]**
	(b)	**(i)**	25 cm (allow $\pm$ 5 cm) to infinity	B1	**[1]**
		(ii)	(for close-up vision), power = 1/0.25 – 1/1.2	C1	
			= 3.17 D	A1	
			(for distance vision), power = -0.25D	A1	**[3]**
		(iii)	use bifocal lenses	B1	
			further detail e.g. region of lens identified	B1	**[2]**
			Total		**[8]**
10			loss of hearing at higher frequencies	B1	
			loss of sensitivity (at about 3 kHz)	B1	
			further comment on either e.g. upper limit should be about 15 kHz, at 3 kHz, I.L. should be about 10 dB (or less)	B1	**[3]**
			Total		**[3]**

Option P – Environmental Physics

11	**(a)**	**(i)**	Sun's energy incident per unit time per unit area	M1	
			on the cross-sectional area of the Earth	A1	**[2]**
		(ii)	solar constant = $(3.9 \times 10^{26})/(4\pi \times \{1.5 \times 10^{11}\}^2)$	C1	
			= 1380 W m^{-2}	A1	**[2]**
	(b)		at C, greater thickness of atmosphere so more absorption	B1	
			also larger area (for beam of a particular width)	B1	
			explanation of 'larger area' (e.g. diagram or 1/cosθ, with θ clear)	B1	**[3]**
			Total		**[7]**
12	**(a)**		e.g. daily variations as industry opens up/closes down daily variations with TV programmes, cooking meals, lighting seasonal variations with heating/AC, length of day		
			(any reasonable response, 1 for daily, 1 for seasonal plus 1 more)		
			1 each, max 3	B3	**[3]**
	(b)		power demand may change <u>suddenly</u>	B1	
			pumped water scheme can be brought onto full load in a short time	B1	
			can use surplus energy at times of low demand to pump water 'back up'	B1	**[3]**
			Total		**[6]**

© University of Cambridge International Examinations 2004

13	**(a)**	**(i)**	work done	= $\rho\Delta V$	C1		
				= 55 x 10^5 x (150 – 40) x 10^{-6}	M1		
				= 605 J	A0		
		(ii)	energy wasted	= (2500 + 400) – (1020 + 605) = 1275 J	A1		
		(iii)	efficiency	= 1625/2900	C1		
				= 0.56 or 56%	A1		**[5]**
	(b)		similarity:	e.g. compression/expansion are both adiabatic	B1		
			difference:	e.g. in petrol engine, energy input at constant volume	B1		**[2]**
				Total			**[7]**

Option T - Telecommunications

14	**(a)**		10 lg(P_1/P_2) or 10 lg(P_2/P_1)		B1		**[1]**
	(b)		10 lg(25.4/1.0) = 14 dB		A1		
			above the reference level		A1		**[2]**
	(c)	**(i)**	loss of signal power/energy		B1		
		(ii)	length = 14/3.2		C1		
			= 4.4 km		A1		**[3]**
				Total			**[6]**
15	**(a)**		amplitude of the carrier wave varies		M1		
			in synchrony with the displacement of the information signal		A1		**[2]**
	(b)	**(i)**	broadcast frequency = 50 kHz		C1		
			3.0 x 10^8 = 50 x 10^3 x λ		C1		
			λ = 6000 m		A1		
		(ii)	bandwidth = 7.0 kHz		A1		
		(iii)	maximum frequency = 3.5 kHz		A1		**[5]**
				Total			**[7]**
16	**(a)**		period (or orbit) is 24 hours		B1		
			equatorial (orbit)		B1		
			(satellite orbits) from west to east		B1		**[3]**
	(b)	**(i)**	allow 2 GHz → 40 GHz		B1		
		(ii)	prevent swamping of the (low power) signal received from Earth		B1		**[2]**
	(c)		advantage: e.g.	fewer satellites required aerials point is fixed direction/no tracking required (any sensible suggestion, 1 mark)	B1		
			disadvantage: e.g.	noticeable time delay in messages reception difficult at Poles (any sensible suggestion, 1 mark)	B1		**[2]**
				Total			**[7]**

© University of Cambridge International Examinations 2004