June 2004

GCE ADVANCED SUBSIDIARY LEVEL AND ADVANCED LEVEL

MARK SCHEME

MAXIMUM MARK: 40

SYLLABUS/COMPONENT: 9702/06

PHYSICS Paper 6 (Options (A2))

Page 1	Mark Scheme	Syllabus	Paper
	A/AS LEVEL EXAMINATIONS - JUNE 2004	9702	06

Categorisation of marks

The marking scheme categorises marks on the MACB scheme.

B marks: These are awarded as <u>independent</u> 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 <u>method</u> 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 <u>compensatory</u> 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 <u>answer</u> 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.

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Option A – Astrophysics and Cosmology

1	(a)	In an infinite and static Universe every line of sight should end on a star (or spherical shells argument) so sky at night should be bright		M1 M1	[3]
	(b)	For expanding Universe finite age limits size (1) light from distant galaxies is red-shifted out of visible light from distant young stars not yet reached Earth Any two points, maximum 2 (1)		B2	[2]
2	(a)	1 pc = 3.26 ly (allow 3.3 ly) distance = 16/3.26 = 4.9 pc	Total	C1 A1	[5] [2]
	(b)	base line is 2 AU angle = 2 x 1/4.9 = 0.41 arc sec	Total	C1 B1	[2]
3	(a)	Universe is same everywhere/homogeneous/isotropic when considered on a sufficiently large scale	iotai	M1 A1	[4] [2]
	(b)	characteristic of (black body) 3 K radiation CMB is highly isotropic/same from all directions This indicates that the Universe is highly uniform	Total	B1 M1 A1	[3] [5]
4	(a)	e.g. planet observed by reflected light this is too faint (against the starlight) e.g. physically too small to be resolved (at such great distances) (any sensible suggestion (B1) with some further comment (B1) – I		B1 B1 B1 B1	[4]
	(b)	e.g. change in intensity of starlight as the star is eclipsed e.g. wobble in position of star (M1) as planet orbits star (A1) (any sensible suggestion plus some further comment – max 2)		M1 A2	[2]
Opt	tion F – The P	hysics of Fluids	Total		[6]
5	(a)	force = upthrust – weight of polystyrene in air $25 = V \times (1000 - 15) \times 9.8$ $V = 2.6 \times 10^{-3} \text{ m}^3$		C1 C1 A1	[3]
	(b)	boat will tend to right itself/float higher in the water if at positions B	Tatal	M1 A1	[2]
6	(a)	if air is streamline air above car moves faster than air below so (by Bernoulli) pressure above is lower than below and car experiences an upward force	Total	B1 M1 M1 A1	[5] [4]
	(b)	the spoiler causes turbulence turbulence prevents the lift force from developing	Total	M1 A1	[2] [6]

(b) (i) force on particle = 4/3 π² (ρ - ρ, μ)g = 4/3 x π (4.5 x 10² γ² x (2.9 x 10³) x 9.8 = 1.08(5) x 10² 4 x (4.5 x 10² γ² x (2.9 x 10³) x 9.8 = 1.08(5) x 10² 4 x (4.5 x 10² γ² x (2.9 x 10³) x 9.8 = 1.08(5) x 10² 4 x (4.5 x 10² γ² x (2.9 x 10³) x 9.8 = 1.08(5) x 10² 4 x (4.5 x 10² γ² x (4.5 x 10² γ		Page 3	3		Syllabus	Pap	
(b) (i) force on particle = 4/3 π/2 (ρ - ρ _w)g				A/A5 LEVEL EXAMINATIONS - JUNE 2004	9702	U)
				lines closer near top and bottom of sphere		A1	[2]
1.085 x 10 ⁻¹ x = 6 x π x (4.5 x 10 ⁻¹ x v v = 1.35 x 10 ⁻⁵ x s		(b)	(i)	force on particle = $4/3 \pi r^3 (\rho - \rho_w)g$		C1	
1.085 x 10 ⁻¹ x = 6 x π x (4.5 x 10 ⁻¹ x v v = 1.35 x 10 ⁻⁵ x s				= $4/3 \times \pi \times (4.5 \times 10^{-7})^3 \times (2.9 \times 10^3) \times 9$.8		
(ii) in 1.0 hours, particles move 1.35 x 10-6 x 3600 (= 4.85 x 10 ⁻³ m) B1 fraction = (8.0 - 4.85)/8.0 (= 0.39 (a)				$= 1.08(5) \times 10^{-14} \text{ N}$			
(ii) in 1.0 hours, particles move 1.35 x 10-6 x 3600 (= 4.85 x 10 ⁻³ m) B1 fraction = (8.0 - 4.85)/8.0 (= 0.39 (a)				$1.085 \times 10^{-14} = 6 \times \pi \times (4.5 \times 10^{-7}) \times 9.5 \times 10^{-4} \times V$			F.4
Fraction = (8,0 - 4,85)/8.0			(ii)	$V = 1.35 \times 10^{-6} \text{ m/s}^{-1}$ in 1.0 hours, particles move 1.35 x 10-6 x 3600 (= 4.85 x 10 ⁻³ m	n)		[4
(allow 2/3 for answer of 0.61) Total			(11)	fraction = $(8.0 - 4.85)/8.0$	')	C1	[3
petion M – Medical Physics (a) piezo-electric/quartz crystal across which is applied an alternating voltage crystal vibrates at its resonant frequency (b) (i) trace length = 4.0 mm distance = speed x time = 1450 x 0.4 x 10 x 10 %				(allow 2/3 for answer of 0.61)			
(a)	ntio	on M –	Medio	al Physics	Total		[9
across which is applied an alternating voltage crystal vibrates at its resonant frequency (b) (i) trace length = 4.0 mm distance = speed x time = 1450 x 0.4 x 10 x 10 ⁻⁶ = 5.8 x 10 ⁻³ m (ii) trace length = 5.2 cm thickness = 0.29 cm (iii) trace length = 5.2 cm thickness = 4.1 cm (iii) trace length = 5.2 cm thickness = 4.1 cm (iv) trace length = 5.2 cm thickness = 4.1 cm (iv) trace length = 5.2 cm (iv) trace length = 5.	-		mount	·			
Crystal vibrates at its resonant frequency B1 C1	8	(a)					
at its resonant frequency (b) (i) trace length = 4.0 mm distance = speed x time = 1450 x 0.4 x 10 x 10^-6 = 5.8 x 10^3 m C1 thickness = 0.29 cm A1 [1] trace length = 5.2 cm A1 [1] trace le							
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distance = speed x time = $1450 \times 0.4 \times 10 \times 10^{-6}$ = 5.8×10^{3} m C1 thickness = 0.29 cm A1 [ii) trace length = 5.2 cm A1 thickness = 4.1 cm A1 [iii) trace length = 5.2 cm A1 [ivident = 5.2		(b)	(i)	trace length = 4.0 mm		C1	
$ \begin{array}{c} = 5.8 \times 10^{3} \mathrm{m} \\ \text{thickness} = 0.29 \mathrm{cm} \\ \text{(ii)} \text{trace length} = 5.2 \mathrm{cm} \\ \text{thickness} = 4.1 \mathrm{cm} \\ \text{Total} \\ \end{array} $		(6)	(')			01	
(ii) trace length = 5.2 cm thickness = 4.1 cm (iii) da ability of eye to form focused images of objects at different distances from the eye (b) (i) 25 cm (allow ± 5 cm) to infinity				$= 5.8 \times 10^{-3} \text{ m}$			
thickness = 4.1 cm (a) ability of eye to form focused images of objects at different distances from the eye (b) (i) 25 cm (allow ± 5 cm) to infinity (ii) (for close-up vision), power = 1/0.25 – 1/1.2			<i>(</i>)				[3
to (a) ability of eye to form focused images of objects at different distances from the eye (b) (i) 25 cm (allow ± 5 cm) to infinity (ii) (for close-up vision), power = 1/0.25 – 1/1.2			(11)				[2
of objects at different distances from the eye (b) (i) 25 cm (allow ± 5 cm) to infinity (ii) (for close-up vision), power = 1/0.25 – 1/1.2 = 3.17 D (for distance vision), power = -0.25D (iii) use bifocal lenses further detail e.g. region of lens identified (iii) use bifocal lenses further detail e.g. region of lens identified (iii) loss of hearing at higher frequencies loss of sensitivity (at about 3 kHz) 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) Total (ii) Sun's energy incident per unit time per unit area on the cross-sectional area of the Earth (iii) solar constant = (3.9 x 10 ²⁶)(4π x {1.5 x 10 ¹¹ } ²) = 1380 W m ² (b) at C, greater thickness of atmosphere so more absorption also larger area (for beam of a particular width) explanation of 'larger area' (e.g. diagram or 1/cos θ, with θ clear) (iii) 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 (b) power demand may change suddenly pumped water scheme can be brought onto full load in a short time can use surplus energy at times of low demand to pump water 'back up' 81 [In the cross-section of a particular width or time can use surplus energy at times of low demand to pump water 'back up' 82 [In the cross-section of the Earth or time can use surplus energy at times of low demand to pump water 'back up' [In the cross-section of the Earth or the control of the can use surplus energy at times of low demand to pump water 'back up' [In the cross-section of the can be brought onto full load in a short time can use surplus energy at times of low demand to pump water 'back up'					Total		[á
(ii) (for close-up vision), power = 1/0.25 – 1/1.2)	(a)					[2
(ii) (for close-up vision), power = 1/0.25 – 1/1.2		(b)	(i)	25 cm (allow ± 5 cm) to infinity		В1	Į.
(for distance vision), power = -0.25D (iii) use bifocal lenses further detail e.g. region of lens identified Total I loss of hearing at higher frequencies loss of sensitivity (at about 3 kHz) 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) Total Option P – Environmental Physics I (a) (i) Sun's energy incident per unit time per unit area on the cross-sectional area of the Earth (ii) solar constant = (3.9 x 10 ²⁶)/(4π x {1.5 x 10 ¹¹ }²) C1 = 1380 W m² (b) at C, greater thickness of atmosphere so more absorption also larger area (for beam of a particular width) explanation of 'larger area' (e.g. diagram or 1/cos θ, with θ clear) Eq. (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 (b) power demand may change suddenly pumped water scheme can be brought onto full load in a short time can use surplus energy at times of low demand to pump water 'back up' I (a) I (a) (i) Sun's energy incident per unit time per unit area on the about 10 dB (or less) I (b) I (a) (ii) Sun's energy incident per unit time per unit area on the about 10 dB (or less) I (b) I (a) (ii) Sun's energy incident per unit time per unit area on the about 10 dB (or less) I (a) (ii) Sun's energy incident ger unit area on the about 10 dB (or less) I (a) (iii) Sun's energy incident ger unit area on the about 10 dB (or less) I (a) (iii) Sun's energy incident ger unit area on the about 10 dB (or less) I (a) (iii) Sun's energy incident ger unit area on the about 10 dB (or less) I (a) (iii) Sun's energy incident ger unit area on the about 10 dB (or less) I (a) (iii) Sun's energy incident ger unit area on the about 10 dB (or less) I (a) (iii) Sun's energy incident ger unit area on the about 10 dB (or less) I (a) (iii) Sun's energy incident ger unit area on the about 10 dB		(-)					٠
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on the cross-sectional area of the Earth (ii) solar constant = (3.9 x 10 ²⁶)/(4π x {1.5 x 10 ¹¹ } ²) = 1380 W m ² A1 (b) at C, greater thickness of atmosphere so more absorption also larger area (for beam of a particular width) explanation of 'larger area' (e.g. diagram or 1/cos θ, with θ clear) 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 (b) power demand may change suddenly pumped water scheme can be brought onto full load in a short time can use surplus energy at times of low demand to pump water 'back up' [5]	Opt	tion P -	- Envi	ronmental Physics			•
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 (b) at C, greater thickness of atmosphere so more absorption also larger area (for beam of a particular width)				on the cross-sectional area of the Earth			[2
 (b) at C, greater thickness of atmosphere so more absorption also larger area (for beam of a particular width)			(11)	solar constant = $(3.9 \times 10^{20})/(4\pi \times \{1.5 \times 10^{11}\}^2)$			
also larger area (for beam of a particular width) explanation of 'larger area' (e.g. diagram or 1/cos θ, with θ clear) Total 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 (b) power demand may change suddenly pumped water scheme can be brought onto full load in a short time can use surplus energy at times of low demand to pump water 'back up' B1 [Simple Programmes of low demand to pump water 'back up' B1 [Simple Programmes of low demand to pump water '				- 1360 W III		ΑI	L4
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(any reasonable response, 1 for daily, 1 for seasonal plus 1 more) 1 each, max 3 B3 [3 (b) power demand may change suddenly 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]	12	(a)		daily variations with TV programmes, cooking meals, lighti			L
1 each, max 3 B3 [3] (b) power demand may change suddenly 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]					vro)		
(b) power demand may change <u>suddenly</u> pumped water scheme can be brought onto full load in a short time can use surplus energy at times of low demand to pump water 'back up' B1				· · ·	re)	В3	F3
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 [١.
can use surplus energy at times of low demand to pump water 'back up' B1 [(b)			e		
							r.
Total [San ass surplus chargy at times of low definant to pump water	saon up	וט	Ľ
					Total		[6

13	(a)	(i)	work done	$= \rho \Delta V$		C1	
	` ,	• •		$= 55 \times 10^5 \times (150 - 40) \times 10^{-6}$		M1	
				= 605 J		A0	
		(ii)	energy wasted	= (2500 + 400) – (1020 + 605) = 1275 J		A1	
		(iii)	efficiency	= 1625/2900 = 0.56 or 56%		C1 A1	[5]
				0.00 01 00 70		, , ,	[~]
	(b)			compression/expansion are both adiabatic		B1	
			difference: e.g.	in petrol engine, energy input at constant volume	Total	B1	[2]
					TOtal		[7]
Opti	ion T -	Teleco	mmunications				
14	(a)		10 $\lg(P_1/P_2)$ or	10 $la(P_2/P_1)$		В1	[1]
	()		10.19(1.1/1.2)	. 5 (5 (- 2.7 1)			1.1
	(b)		10 lg(25.4/1.0) =			A1	
			above the refere	nce level		A1	[2]
	(c)	(i)	loss of signal pov	wer/energy		В1	
	` ,	(ii)	length = $14/3.2$	•		C1	
			= 4.4 km		Tatal	A1	[3]
15	(a)		amplitude of the	carrier wave varies	Total	M1	[6]
	()		•	the displacement of the information signal		A1	[2]
	(b)	(i)	hroadcast freque	ncv = 50 kHz		C1	
	(2)	(.,	broadcast freque $3.0 \times 10^8 = 50 \times 10^8$	10 ³ x λ		C1	
			$\lambda = 6000 \text{ m}$			A1	
		(ii)	bandwidth = 7.0			A1	
		(iii)	maximum freque	ncy = 3.5 kHz	Total	A1	[5] [7]
16	(a)		period (or orbit) i	s 24 hours	Total	В1	[,]
	` ,		equatorial (orbit)			B1	
			(satellite orbits) f	rom west to east		B1	[3]
	(b)	(i)	allow 2 GHz → 4	0 GHz		В1	
		(ii)	prevent swampin	g 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		ired	5.4	
			disadvantaga: a	(any sensible suggestion, 1 mark)		В1	
			disadvantage: e.	 g. noticeable time delay in messages reception difficult at Poles 			
				(any sensible suggestion, 1 mark)		B1	[2]
					Total		[7]

Mark Scheme

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Syllabus 9702

Paper

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