

**UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS**

GCE Advanced Subsidiary and Advanced Level

**MARK SCHEME for the November 2004 question paper**

**9702 PHYSICS**

**9702/06**

**Paper 6, maximum mark 40**

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. This shows the basis on which Examiners were initially instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began. Any substantial changes to the mark scheme that arose from these discussions will be recorded in the published *Report on the Examination*.

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*.

- CIE will not enter into discussion or correspondence in connection with these mark schemes.

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**Grade thresholds** taken for Syllabus 9702 (Physics) in the November 2004 examination.

	maximum mark available	minimum mark required for grade:		
		A	B	E
Component 6	40	30	27	15

The thresholds (minimum marks) for Grades C and D are normally set by dividing the mark range between the B and the E thresholds into three. For example, if the difference between the B and the E threshold is 24 marks, the C threshold is set 8 marks below the B threshold and the D threshold is set another 8 marks down. If dividing the interval by three results in a fraction of a mark, then the threshold is normally rounded down.



November 2004

GCE A AND AS LEVEL

**MARK SCHEME**

**MAXIMUM MARK: 40**

**SYLLABUS/COMPONENT: 9702/06**

**PHYSICS**  
**Paper 6**



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### Option A – Astrophysics and Cosmology

1	diameter of the Sun		B1	
	nearest (neighbour) star/Proxima Centauri		B1	
	diameter of (Milky Way) galaxy		B1	
	extent of (visible) Universe (allow diameter/radius)		B1	[4]
2	e.g. Atmospheric absorption/scattering		M1	
	means light is too faint		A1	
	Light pollution		M1	
	means light cannot be distinguished against background		A1	[4]
	Irregular atmospheric refraction/thermal currents	(M1)		
	means small objects blurred/not seen	(A1)		
	<i>(any two sensible suggestions {M1 x 2} plus some further detail of each {A1 x 2})</i>			
3 (a)(i)	<i>either</i> density such that Universe will not collapse or expand indefinitely		B1	
	greater density than $\rho_0$ means collapse (OR vice versa)		B1	
	<i>or</i> determines whether Universe is 'open' or 'closed'	(B1)		
	greater density than $\rho_0$ means 'closed'			
	OR smaller density than $\rho_0$ means 'open'	(B1)		[2]
	(ii) (if Universe is closed eventually all) kinetic energy <u>of galaxies</u> will be converted to (gravitational) potential energy		B1	
	(gravitational) potential energy involves the gravitational constant G		B1	[2]
(b)(i)1	(sensible straight line and) one or two points chosen with attempt at antilogs		B1	
	$H_0 = 100 \text{ km s}^{-1} \text{ Mpc}^{-1}$ (allow $80 \rightarrow 125 \text{ km s}^{-1} \text{ Mpc}^{-1}$ )		A1	
	$1 \text{ Mpc} = 3.1 \times 10^{19} \text{ km}$		C1	
	$H_0 = 100 / (3.1 \times 10^{19}) = 3.2 \times 10^{-18} \text{ s}^{-1}$			
	Age = $1/H_0 = 3.1 \times 10^{17} \text{ s}$		A1	[4]
(i)2	$\rho_0 = (3 \times 10^{-18})^2 / (8 \times \pi \times 6.67 \times 10^{-11})$		C1	
	$= 1.86 \times 10^{-26} \text{ kg m}^{-3}$		A1	[2]
(ii)	number density = $(1.86 \times 10^{-26}) / (1.66 \times 10^{27})$		C1	
	$\approx 10$		A1	[2]

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### Option F – The Physics of Fluids

- 4 (a)** M shown near base of stem B1 [1]
- (b)(i)** density = mass/volume C1  
 volume submerged in liquid of density  $1.0 \text{ g cm}^{-3} = 165 \text{ cm}^3$  C1  
 volume submerged in liquid of density  $1.1 \text{ g cm}^{-3} = 150 \text{ cm}^3$  C1  
 change in volume =  $15 \text{ cm}^3$  A1
- (ii)** distance (=  $15/0.75$ ) = 20 cm A1 [5]
- 5 (a)** arrows longer at centre than edges M1  
 arrows parallel and correct relative lengths A1 [2]
- (b)(i)** no unique value of (linear) speed B1 [1]  
**(ii)1** volume flow rate doubles A1  
**(ii)2** new radius =  $1.05 r$   
 new flow rate =  $1.054 \times 2$  C1  
 = 2.4(3) times greater A1 [3]
- 6 (a)** (fluid) flow/movement B1  
 that is erratic/has eddies B1  
 i.e. speed varies continuously (in magnitude and direction) with time B1 [3]
- (b)(i)** for turbulent flow,  $F_D/v^2$  C1  
 $v = 58 \text{ m s}^{-1}$  A1 [2]

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### Option M – Medical Physics

- 7 (a)** pulse of ultrasound B1  
reflected from boundaries B1  
received (at surface) and processed B1  
time for pulse to return gives depth of boundary B1  
reflected intensity gives information on nature of boundary B1 [5]
- (b)** fraction =  $e^{-23 \times 0.055}$  C1  
= 0.28 A1 [2]
- (c)** fraction =  $0.28 \times 0.35 \times 0.28$  C1  
= 0.027 A1 [2]  
(or  $0.35e^{-23 \times 0.11} = 0.028$ )
- 8 (a)(i)** rays from S converge to point behind retina B1
- (ii)** range of image distances B1  
such that image is tolerably in focus B1 [3]
- (b)** for the same size of patch on the retina M1  
focused image is further from the retina A1  
(so) depth of focus is increased B1 [3]
- 9 (a)** intensity =  $(0.33 \times 10^{-6}) / (65 \times 10^{-6})$  C1  
=  $5.1 (5.08) \times 10^{-3} \text{ W m}^{-2}$  C1  
*I.L.* =  $10 \lg (5.08 \times 10^{-3}) / (1.0 \times 10^{-12})$  C1  
= 97 dB A1 [4]
- (b)** (long-term exposure) could cause deafness OR  
(short-term exposure) could cause tinnitus B1 [1]

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### Option P – Environmental Physics

<b>10 (a)</b>	massive nucleus/named appropriate nucleus splits into two approximately equal parts/named components with the release of neutrons and energy	B1 B1 B1	[3]
<b>(b)</b>	moderator: slows down (high speed) neutrons so that further fissions are more likely/will take place control rods absorb neutrons to provide control over the rate of fission	M1 A1 M1 A1	[4]
<b>11 (a)(i)</b>	water moved from (area of) trough to crest to form wave potential energy = $mgh$ $= \frac{1}{2} \lambda Aw\rho \times g \times A$ <i>(must be laid out so that substitutions are obvious)</i> $= \frac{1}{2} wA^2 \lambda \rho g$	B1 M1  M1 A0	[3]
<b>(ii)</b>	there are $V/\lambda$ wavecrests passing a point per unit time power = $\frac{1}{2} wA^2 \lambda \rho g \times V/\lambda$ $= \frac{1}{2} wA^2 \rho g V$	M1 A1 A0	[2]
<b>(b)</b>	e.g hazard to shipping, unsightly, upset to shoaling fish etc. (any sensible suggestion)	B1	[1]
<b>12 (a)</b>	input shown clearly as 1140 W four outputs labeled correctly arrows having approximately correct ratio of widths	B1 M1 A1	[3]
<b>(b)</b>	electrical heating more efficient at transferring energy to water very little thermal energy escapes because plastic is an insulator gas ring much less efficient because of thermal energy losses to the air thermal energy losses due to conduction as kettle is metal	B1 B1 B1 B1	[4]

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### Option T – Telecommunications

- 13 (a)** box for 1 m – 10 cm labeled T B1
- (b)** box for 10 cm – 1 cm labeled S B1 [2]
- 14 (a)** frequency of carrier wave varies (in synchrony) with information signal B1  
constant amplitude OR carrier frequency >> signal frequency B1  
change in frequency measures displacement of information signal B1  
rate at which carrier frequency varies gives frequency of information signal B1 [4]
- (b)(i)** period = 0.8  $\mu$ s C1  
frequency = 1.25 MHz A1
- (ii)** 125 kHz A1 [3]
- (c)** advantage: e.g. better quality/less interference B1  
disadvantage: e.g. more transmitters/more expensive B1 [2]  
(any sensible suggestions, 1 each)
- 15 (a)(i)** sampled every 0.5 ms C1  
frequency = 2.0 kHz A1
- (ii)** at 1.0 V intervals B1
- (iii)** 4 bits B1 [4]
- (b)** needs sampling time shorter than smallest peak-trough interval B1  
any suggestion of about (0.2 ms or about) 5 kHz (*allow 5 kHz  $\rightarrow$  10 kHz*) A1  
needs voltage interval less than peak-trough height B1  
any suggestion at about 0.3 V (*allow 0.1 V  $\rightarrow$  0.4 V*) C1  
so either  $12/0.3 = 40$  OR  $11/0.3 = 37$  OR  $10/0.3 = 34$  etc. A1  
(ignore binary nature of the ADC and the DAC)