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*.

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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 Al
Light pollution M1
means light cannot be distinguished against background Al [4]
Irregular atmospheric refraction/thermal currents (M1)
means small objects blurred/not seen (Al)
(any two sensible suggestions {M1 x 2} plus some further detail of each {A1 x 2})

3 (a)(i) *either* density such that Universe will not collapse or expand indefinitely B1
greater density than ρ_0 means collapse (OR vice versa) B1
or determines whether Universe is 'open' or 'closed' (B1)
greater density than ρ_0 means 'closed'
OR smaller density than ρ_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 km s^{-1} Mpc^{-1} (allow 80 → 125 km s^{-1} Mpc^{-1}) A1
1 Mpc = 3.1×10^{19} km C1
$H_0 = 100/(3.1 \times 10^{19}) = 3.2 \times 10^{-18}$ s^{-1}
Age = $1/H_0 = 3.1 \times 10^{17}$ s A1 [4]

(i)2 $\rho_0 = (3 \times 10^{-18}\}^2) / (8 \times \pi \times 6.67 \times 10^{-11})$ C1
$= 1.86 \times 10^{-26}$ kg m^{-3} A1 [2]

(ii) number density = $(1.86 \times 10^{-26}) / (1.66 \times 10^{27})$ C1
≈ 10 A1 [2]

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 g cm^{-3} = 165 cm^3	C1	
		volume submerged in liquid of density 1.1 g cm^{-3} = 150 cm^3	C1	
		change in volume = 15 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 = 1.054×2	C1	
		= 2.4(3) times <u>greater</u>	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 m s^{-1}	A1	[2]

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) $\times 10^{-3}$ 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]

Option P – Environmental Physics

10 (a) massive nucleus/named appropriate nucleus splits B1
into two approximately equal parts/named components B1
with the release of neutrons and energy B1 [3]

(b) moderator: slows down (high speed) neutrons M1
so that further fissions are more likely/will take place A1
control rods absorb neutrons M1
to provide control over the rate of fission A1 [4]

11 (a)(i) water moved from (area of) trough to crest to form wave B1
potential energy = mgh M1
$= \frac{1}{2} \lambda A w \rho \times g \times A$
(must be laid out so that substitutions are obvious) M1
$= \frac{1}{2} w A^2 \lambda \rho g$ A0 [3]

(ii) there are V/λ wavecrests passing a point per unit time M1
power $= \frac{1}{2} w A^2 \lambda \rho g \times V/\lambda$ A1
$= \frac{1}{2} w A^2 \rho g V$ A0 [2]

(b) e.g hazard to shipping, unsightly, upset to shoaling fish etc.
(any sensible suggestion) B1 [1]

12 (a) input shown clearly as 1140 W B1
four outputs labeled correctly M1
arrows having approximately correct ratio of widths A1 [3]

(b) electrical heating more efficient at transferring energy to water B1
very little thermal energy escapes because plastic is an insulator B1
gas ring much less efficient because of thermal energy losses to the air B1
thermal energy losses due to conduction as kettle is metal B1 [4]

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 μs	C1	
	frequency = 1.25 MHz	A1	
(ii)	125 kHz	A1	[3]
(c)	advantage: e.g. better quality/less interference	B1	
	disadvatange: 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 → 10 kHz)*	A1	
	needs voltage interval less than peak-trough height	B1	
	any suggestion at about 0.3 V *(allow 0.1 V → 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)		