UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary and Advanced Level

MARK SCHEME for the June 2005 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 for Syllabus 9702 (Physics) in the June 2005 examination.

	maximum mark available	minimum mark required for grade:		
		A	B	E
Component 6	40	26	23	14

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.

June 2005

GCE A AND AS LEVEL

MARK SCHEME

MAXIMUM MARK: 40

SYLLABUS/COMPONENT: 9702/06

PHYSICS
Paper 6

UNIVERSITY of CAMBRIDGE
International Examinations

Option A - Astrophysics and Cosmology

1	**(a)**	position: on a spiral arm, between ½ and ¾ distance from centre	**B1**	**[1]**
	(b)	**(i)** allow 80 000 → 150 000 light-years	**B1**	
		(ii) allow 2 → 10 light-years	**B1**	**[2]**
	(c)	allow $10^7 \rightarrow 10^9$	**B1**	**[1]**
2	**(a)**	allow $10^8 \rightarrow 10^{10}$ K	**B1**	**[1]**
	(b)	position marked between 10^{12} s and 10^{13} s	**B1**	**[1]**
	(c)	result of X-bosons (allow 'bosons')	**B1**	
		at (very) early stages of development of the Universe	**B1**	
		(X-) boson decays into quarks	**M1**	
		(slightly) more slowly than its antiparticle decays	**A1**	**[4]**
3	**(a)**	**(i)** $H_0 = (60 \times 10^3)/(3.1 \times 10^{16} \times 10^6)$	**C1**	
		$= 1.9 \times 10^{-18}$ (s^{-1})	**C1**	
		age of Universe = $1/H_0$ (or clear substitution for H_0 shown)	**B1**	
		$= 5.2 \times 10^{17}$ s	**C1**	
		$= 1.6 \times 10^{10}$ years	**A1**	**[5]**
		(ii) fraction of time $= (12600 \times 10^6)/(1.6 \times 10^{10})$		
		$= 0.79$ or 63/80	**A1**	**[1]**
		(iii) light left galaxy when Universe was much younger	**B1**	
		(so) 'looking back' in time	**B1**	**[2]**
	(b)	limit set by how far light can travel	**M1**	
		during the lifetime of the Universe	**A1**	
		<u>or</u>		
		galaxies at very large distances are moving very fast		
		so Doppler shifted out of visible		**[2]**

Option F - The Physics of Fluids

4	**(a)**	pressure <u>difference</u> (between upper and lower surfaces)	**B1**	**[1]**
		allow 'upthrust provided by <u>displaced fluid</u>'		
	(b)	**(i)** mass = density × volume	**C1**	
		$= 920 \times 6.4 \times 10^4 \times (28 + d)$	**A1**	**[2]**
		(ii) either $920 \times 6.4 \times 10^4 \times (28 + d)$		
		<u>or</u> $1030 \times 6.4 \times 10^4 \times d$	**A1**	**[1]**
	(c)	**(i)** $920 \times 6.4 \times 10^4 \times (28 + d) = 1030 \times 6.4 \times 10^4 \times d$	**C1**	
		$d = 234$ m	**A1**	**[2]**
		(ii) fraction = 234/(234 + 28)		
		= 0.89	**A1**	**[1]**

5	(a)	fluid in which there is internal friction	B1	
		either resisting motion of an object through the fluid		
		or resisting movement between layers of fluid	B1	[2]
	(b)	there is no single value for the speed in the pipe	B1	
		(do not allow unqualified 'constant')		
		any other comment e.g. volume flow rate takes into account whole flow	B1	[2]
	(c)	(i) pressure (= ρgh) = $1.0 \times 10^3 \times 9.8 \times 9.1 \times 10^{-2}$	M1	
		= 890 Pa	A0	
		some explanation as to why this is the pressure difference	B1	[2]
		(ii) $1.5 \times 10^{-6} = (\pi \times \{0.9 \times 10^{-3}\}^4 \times 890)/(8 \times \eta \times 13 \times 10^{-2})$	C1	
		$\eta = 1.18 \times 10^{-3}$ N s m^{-2}	A1	[2]
6	(a)	(i) path taken by a particle of the fluid	B1	[1]
		(ii) each particle can follow only one path	B1	[1]
		(or in terms of tangent being direction of motion, and only one direction)		
	(b)	(in any tube of flow) Av = constant	M1	
		when lines converge, A becomes smaller	A1	
		(so) v must increase	B1	[3]

Option M - Medical Physics

7	(a)	large/uniform magnetic field applied (to patient)	(1)	
		pulse of radio-frequency waves	(1)	
		Causes H-atoms in patient to resonate or vibrate at Lamour frequency	(1)	
		H-atoms give off radio-frequency waves	(1)	
		RF detected and processed	(1)	
		to give positions of H-atoms	(1)	
		non-uniform magnetic field enables		
		positions of resonating atoms to be defined	(1)	
		[1 each, any five]	B5	[5]
	(b)	e.g. cost, portability of equipment, time taken		
		[any sensible suggestions, 1 each, max 2]	B2	[2]
8	(a)	(i) energy deposited in body	M1	
		per unit mass of (body) tissue	A1	[2]
		(ii) effects depend on density of deposition of energy/ionisation	B1	
		some radiations cause greater density of ionisation than others	B1	[2]
	(b)	Radiation has long-term effects	M1	
		any other relevant point e.g. life shortening, hereditary, cancer inducing	A1	[2]
9	(a)	(i) convex/converging	B1	[1]
		(ii) focal length (= 100/2.5) = 40 cm	B1	[1]
	(b)	(i) long sight (hypermetropia)	B1	[1]
		(ii) far point is at infinity	B1	
		normal nearpoint is distance 25 cm from eye	B1	
		$1/25 - 1/v = 1/40$	C1	
		v = 67 cm		
		nearpoint is 67 cm in front of the eye	A1	[4]

Option P - Environmental Physics

10	**(a)**	resources: total energy available/stored in Earth	**B1**	
		reserves: total energy that can be extracted (economically)	**B1**	
		reserves less than resources because some fossil fuels not recoverable/too expensive	**B1**	**[3]**
	(b)	formation takes place over millions/thousands of years	**B1**	
		fossil fuels will be exhausted in much less time than this	**B1**	**[2]**

11 (a)

induction	compression	power	*EXHAUST*
open	*CLOSED*	*CLOSED*	closed
CLOSED	*CLOSED*	*CLOSED*	open

[each column 1 mark, max 4] **B4** **[4]**

(b)	**(i)**	power is delivered (by a cylinder) on every stroke	**M1**	
		(so) smoother power output/torque	**A1**	**[2]**
	(ii)	improved flow of gases (in and out of cylinder)	**M1**	
		increases efficiency of engine	**A1**	**[2]**
12 (a)	**(i)**	any agent/substance/waste that is detrimental to health	**B1**	
		or the environment	**B1**	**[2]**
	(ii)	1 man-made: e.g. exhaust gases from cars (anything sensible)	**B1**	
		2 natural: e.g. volcanic emissions (anything sensible)	**B1**	**[2]**
	(b)	carbon dioxide absorbed (by plants) with release of oxygen	**B1**	
		(transpiration) replaces water vapour (in atmosphere)	**B1**	
		<u>either</u> increasing CO_2 levels would cause temperature changes <u>or</u> anything sensible e.g. reference to biodiversity, weather patterns	**B1**	**[3]**

Option T - Telecommunications

13	**(a)**	signal sampled at regular intervals	**B1**	
		signal voltage converted to a digital number	**B1**	
		transmitted as a series of groups of pulses	**B1**	
		pulses could be IR pulses in optic fibre (allow any sensible example)	**B1**	
		any other relevant physics (e.g. sample at twice max frequency, use parallel to series converter)	**B1**	**[5]**
	(b)	e.g. can be regenerated to remove noise data can be added to check for/correct errors [anything sensible, 1 each, max 2]	**B2**	**[2]**
14	**(a)**	**(i)** loss of energy/power (in the signal)	**B1**	**[1]**
		(ii) unwanted (random) signal	**B1**	**[1]**
	(b)	**(i)** power/dB = 10 lg(P_1/P_2)	**C1**	
		25 = 10 lg (P/(6.0 × 10^{-19}))	**M1**	
		P = 1.9 × 10^{-16} W	**A0**	**[2]**
		(ii) allowable loss = 10 lg(7.0 × 10^{-3})/(1.9 × 10^{-16})	**C1**	
		= 136 dB	**C1**	
		length = 136/1.7 = 80 km	**A1**	**[3]**
	(c)	signal amplifier/re-shaper <u>at intervals</u> along the fibre	**B1**	**[1]**

(d)	**(i)**	remains at one point above the Earth	**(1)**		
		orbits Earth above the Equator	**(1)**		
		period of orbit is 24 hours	**(1)**		
		rotates from west to east	**(1)**		
		[any two, 1 each]		**B2**	**[2]**
	(ii)	for satellite, time to travel ($2 \times 3.6 \times 10^4$ km) = 0.24 s		**B1**	
		for fibre, time to travel 18000 km = 0.06 s $\rightarrow$ 0.09 s		**B1**	
		advantage: less built-in delay for conversation		**B1**	**[3]**