UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2006 question paper

9702 PHYSICS

9702/06 Paper 6 (Options), maximum raw mark 40

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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.

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UNIVERSITY of CAMBRIDGE
International Examinations

Option A – Astrophysics and Cosmology

1	**(a)**	gaseous/rocky/icy/approx. spherical object	B1	
		that orbits the Sun / a star	B1	**[2]**
	(b)	Venus must have passed between Sun and Earth	B1	
		1 AU is (mean) distance between Earth and Sun	B1	**[2]**
2	**(a)**	(light of a particular wavelength as observed) when source is moving away		
		(from observer)	M1	
		has a longer wavelength	A1	
		than when source is stationary (with respect to observer)	B1	**[3]**
	(b)	(extent of) redshift depends on v/c	B1	
		can only be observed when v is significant when compared to c	B1	**[2]**
3	**(a)**	v is speed of separation of (any two) galaxies	B1	
		d is the separation of the galaxies	B1	**[2]**
		(*max 1 mark if refers to Earth*)		
	(b)	1 Mpc = 3.09×10^{19} km (*allow 3.0 → 3.2*)	C1	
		age = $1 / H_0$	C1	
		age = $(3.09 \times 10^{19}) / 60$		
		= 5.2×10^{17} s	A1	**[3]**
4	**(a)**	e.g. dark matter does not emit light		
		dark matter does not reflect light		
		(*any two sensible suggestions, 1 each*)	B2	**[2]**
	(b)	e.g. estimate of mass unreliable	M1	
		because there are neutrinos	A1	
		e.g. do not know extent of Universe	M1	
		due to redshift / intensity of light	A1	**[4]**
		(*any sensible suggestion (M1) with reason (A1)*)		

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Option F – The Physics of Fluids

5 (a) symmetrical pattern 'above' and 'below' B1
lines closest together at widest part of object B1
smooth lines tending towards initial separation B1 **[3]**

(b) *either* separation of lines is not constant *or* path lengths differ B1 **[1]**

6 (a) centre of buoyancy is above the centre of mass B1
(if displaced sideways) weight and upthrust provide couple to keep tube upright B1 **[2]**
(*do not allow argument in terms of metacentre*)

(b) *either* force on base = $L\rho g \times A$ *or* weight of liquid displaced = ρLAg M1
this equals weight Mg this equals weight Mg A1
hence $L = M/A\rho$ hence $L = M/A\rho$ A0 **[2]**

(c) $M/A = L\rho$ = constant C1
new length = $12.1 \times (0.99/1.11) = 10.8$ cm C1
change in length = 1.3 cm A1 **[3]**

7 (a) (apparent) weight acts downwards B1
drag force acts upwards B1
resultant force = weight - kv OR drag $\propto v$ B1
as speed increases, resultant force / acceleration becomes less B1
(so) speed increases to a constant value B1 **[5]**

(b) fluid is dragged along by the surface of the (spinning) sphere B1
on one 'side' speed of fluid is greater than on other M1
this difference in speed creates a pressure difference / difference in drag / turbulence A1
so sphere moves sideways (in direction of lower pressure) A1 **[4]**

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Option M – Medical Physics

8 (a) pulse of ultrasound B1
reflected at boundary (between any two media) B1
reflected pulse detected by (piezo-electric) crystal B1
signal from crystal amplified / processed and displayed B1 **[4]**

(b) crystals are at different orientations B1
signals from all crystals are combined B1
to build up a (2D) image B1 **[3]**

9 (a) (i) process by which objects at different distances from the eye M1
are brought to a focus (on the retina) A1 **[2]**

(ii) ciliary muscles alter shape of lens B1
this alters the power/focal length of the lens B1 **[2]**

(b) pupil varies in diameter C1
power (intensity) admitted is proportional to diameter^2 B1
either variation of diameter is small / small factor
or variation of light intensity is large / (very) large factor B1 **[3]**

10 (a) $IL = 10 \lg(I/I_0)$
$= 10 \lg(\{1.6 \times 10^{-10}\} / \{1 \times 10^{-12}\})$ C1
$= 22$ dB A1
range is from 100 Hz B1
to 10 kHz B1 **[4]**

(b) e.g. threshold intensity rises
upper frequency (limit) decreases
lower frequency (limit) rises
(*any two suggestions, 1 each, max 2*) B2 **[2]**
(*allow 1 mark for 'line closes up' / smaller frequency range*)

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Option P – Environmental Physics

11 (a)	**(i)**	slows down neutrons	M1	
		to enable further fission reactions	A1	**[2]**
	(ii)	absorbs neutrons	M1	
		to control rate of reaction / power	A1	**[2]**
	(iii)	acts as a biological shield	B1	
		maintains coolant around the core / containment vessel	B1	**[2]**
(b)		kinetic energy of fission fragments	B1	
		causes heating of the core / fuel rods	B1	
		this thermal energy is carried away by the coolant	B1	**[3]**
(c)		e.g. *either* minimal / no release of CO_2 into the atmosphere *or* minimal / no release of gases causing global warming no huge storage areas required at the power station maintenance possible whilst on full load (*any two suggestions, 1 each, max 2*)	B2	**[2]**
12 (a)		incident power = $960 \times 2.5 \times 10^{-4}$ = 0.24 W	C1	
		efficiency = $(30 \times 10^{-3}) / 0.24 = 0.13$	A1	**[2]**
(b)	**(i)**	large (surface) area required	B1	
	(ii)	connect many cells in <u>series</u> for higher <u>voltage</u>	B1	
		connect many cells in <u>parallel</u> for larger <u>current</u>	B1	**[3]**
13 (a)		30% delivered to motor	C1	
		cost = $5.4 \times (100/30) \times 5$ = 90 cents	A1	**[2]**
		(*allow 1 mark for answer 100 cents*)		
(b)		(for both,) there is a need to heat water / for heat energy	B1	
		this energy provided from '<u>production losses</u>' (so reducing overall costs)	B1	**[2]**

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Option T – Telecommunications

14 (a) satellite with orbit having period 24 hours B1
orbits above the Equator B1
from west to east / orbits in same sense B1 **[3]**

(b) loss = 10 lg(P_2 / P_1) C1
-170 = 10 lg(P_2 / 2400) C1
P_2 = 2.4×10^{-14} W A1 **[3]**

(c) amplified otherwise power too low to be picked up on Earth B1
either frequency changed to prevent swamping / interference of signal received (from Earth)
or prevent feedback B1 **[2]**

15 (a) variations in either amplitude or frequency of a wave B1
either in synchrony with displacement of information signal
or in order to carry information on the wave B1 **[2]**

(b) **(i)** 9 kHz B1 **[1]**
(ii) LW frequency range is 30 kHz → 300 kHz C1
number = 270 / 9 C1
= 30 A1 **[3]**

(c) sketch: carrier frequency as vertical line and two sidebands M1
reasonable symmetry A1
sideband indicating approx. 4500 Hz range B1 **[3]**
(*if sidebands shown as vertical lines, allow max. 1 mark*)

16 (a) e.g. link between house and exchange for a telephone
(*any one suggestion, 1 mark*) B1 **[1]**

(b) e.g. greater bandwidth
less noise
less attenuation
(*any two suggestions, 1 each, max 2*) B2 **[2]**

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