CAMBRIDGE
INTERNATIONAL EXAMINATIONS

November 2003

GCE ADVANCED SUBSIDIARY LEVEL AND ADVANCED LEVEL

MARK SCHEME

MAXIMUM MARK: 40

SYLLABUS/COMPONENT: 9702/06

PHYSICS
Paper 6 (Options (A2))

UNIVERSITY of CAMBRIDGE
Local Examinations Syndicate

Categorisation of marks

The marking scheme categorises marks on the *MACB* scheme.

B marks: These are awarded as independent 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 method 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 compensatory 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 answer 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) galaxy very distant
light (reaching Earth) very faint
light absorption in Earth's atmosphere (do not allow refraction)
light pollution
light scattered…… (*1 each, any 4*)..... B4 [4]

(b) 1 arc sec at 6.9 x 10^5 pc corresponds to 6.9 x 10^5 AU C1
1 ly = 6.3 ($\pm$0.3) x 10^4 AU or other valid conversion C1
hence distance = 11 light-years ..... A1 [3]

2 (a) If Universe is (static and) infinite B1
every line of sight would end on a star M1
entire sky would be equally bright ..... A1 [3]

(b) shows infinite (static) Universe to be incorrect
(allow back-credit to (a) for initial supposition B1
does not 'prove' Big Bang model ..... B1 [2]

3 (a) (i) electromagnetic radiation B1
either characteristic of black body at 3 K *or* isotropic ..... B1 [2]

(ii) finite age for Universe B1
indicated by cooling Universe B1
any further detail e.g. irregularities required for galaxy formation ..... B1 [3]

(b) radiation takes millions of years to reach Earth B1
provides evidence for higher temperature in the past B1
(Universe is cooling) as it expands ..... B1 [3]

Option F – The Physics of Fluids

4 (a) point where line of action of the upthrust or vertical line through centre of buoyancy meets centre line of ship ..... B1 [2]

(b) (when submarine surfaces), water replaced by air <u>in tanks</u> B1
centre of mass <u>and</u> centre of buoyancy will move M1
causing change in separation of these points ..... A1 [3]

5 (a) (Bernoulli:) higher speed, lower pressure M1
so A at higher pressure ..... A1 [2]

(b) $Av = A_N v_N$ or statement (e.g. incompressible) B1
v_N/v (= A/A_N) = $2.4^2/0.8^2$ or other correct substitution B1
ratio = 9.0 ..... A0 [2]

(c) $p_1 - p_2 = \Delta p = \frac{1}{2}\rho(v_2^2 = v_1^2)$ C1
740 = ½ x 990 x ($81v^2 - v^2$) C1
v = 0.14 m s^{-1} ..... A1 [3]

6 (a) (i) upthrust = 4/3 x $\pi r^3 \rho_F g$ B1

(ii) resultant downward force = 4/3 x $\pi r^3 (\rho_S - \rho_F)g$
or 4/3 x $\pi r^3 (\rho_S - \rho_F)g$ – *viscous force*..... B1 [2]

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(b) $6\pi r\eta v_t = 4/3 \times \pi r^3 (\rho_S - \rho_F)g$ M1
hence, $v_t = kr^2$ A0
constant k discussed ..... A1 [2]

(c) **(i)** e.g. find speed near 'top' and near 'bottom' of tube M1
using equally spaced markers (or other detail) A1

(ii) oil flowing past wall of tube B1
would cause extra drag ..... B1 [4]

Option M – Medical Physics

7 large uniform magnetic field B1
with superimposed non-uniform field B1
r.f. pulse applied B1
r.f. pulse (from atoms) detected and processed B1
plus any two (one each) from
hydrogen atoms
nuclei have spin and behave as tiny magnets
atoms precess around magnetic field
resonant (Lamour) frequency depends on B-field
de-excitation detected
r.f. pulse detected and processed ..... B1 [6]

8 **(a)** **(i)** $1/u + 1/v = 1/f$ = power C1
power = $1/0.10 + 1/(17 \times 10^{-3})$ C1
power = 68.8 D A1

(ii) least distance of distinct vision = 25 cm (allow 20 cm → 50 cm) .. C1
power = $1/0.25 + 1/(17 \times 10^{-3})$
power = 62.8 D .... A1 [5]

(b) **(i)** change = 6.0 D N.b. answer is (i) – (ii) B1

(ii) focal length = 16.7 cm B1
convex/converging lens ..... B1 [3]

9 **(a)** **(i)** lower limit of frequency range correct (15 to 40 Hz) B1
upper limit of frequency range correct (13 to 20 kHz) B1

(ii) intensity 1.0×10^{-12} W m^{-2} B1
at about 2 kHz (allow 1 kHz → 3 kHz) ..... B1 [4]

(b) line 'above' that already drawn B1
both frequency limits showing more limited range ..... B1 [2]

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Option P – Environmental Physics

10 (a) source of (useful) energy ..... B1 [1]

(b) e.g. less pollution
finite reserves
chemical feedstock etc ……(*1 each, max 3)*..... B3 [3]

11 (a) dam <u>across</u> river mouth/estuary..... B1
water retained as tide goes out..... B1
at low tide, water is released..... B1
through turbines... ..... B1 [4]

(b) mass of water = $8.0 \times 200 \times 10^6 \times 1000$ kg C1
change in p.e = $1.6 \times 10^{12} \times 9.8 \times 4$
= 6.27×10^{13} J C1
power = $6.27 \times 10^{13}/(3 \times 3600)$
= 5.8×10^9 W ..... A1 [3]

(c) e.g. silting up
feeding grounds of birds etc ……(1 each, max 2)..... B2 [2]

12 (a)

open	closed
closed	closed
closed	closed
closed	open…….(*-1 each error or omission)* ..... B2 [2]

(b) (i) at end of compression stroke or at beginning of power stroke B1

(ii) at moment when exhaust valve opens B1
(and during) exhaust stroke ..... B1 [3]

(c) efficient mixing with air or increase surface area..... B1
faster burning .... B1 [2]

Option T – Telecommunications

13 (a) multiple reflections with $i = r$ ..... B1 [1]

(b) all rays to have same path length/prevent (multipath) dispersion
OR easier to store/handle ..... B1 [1]

(c) e.g. greater bandwidth
no cross-talk or reduced noise
smaller size and weight
cheaper
security
suited to digital transmission…….. (*1 each, max 3*) ..... A3 [3]

14 (a) amplitude of carrier wave varies..... M1
in synchrony with (displacement of information) signal ..... A1 [2]

(b) three vertical lines B1
symmetrical with smaller sidebands..... B1
at frequencies 70, 75 and 80 kHz..... B1 [3]

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(c) bandwidth = 10 kHz B1

15 **(a)** **(i)** loss of power/energy/amplitude (not signal) B1

(ii) unwanted energy/power B1
that is random or that covers whole spectrum ..... B1 [3]

(b) number of dB = 10 lg(P_{OUT}/P_{IN}) C1
63 = 10 lg (P_{OUT} /(2.5 x 10^{-6}) C1
P_{OUT} = 5.0 W .... A1 [3]

(c) attenuation = 10 lg(5/3.5 x 10^{-8}) C1
= 81.5 dB C1
length = 81.5/12 = 6.8 km ..... A1 [3]

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