CAMBRIDGE
INTERNATIONAL EXAMINATIONS

June 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.

Option A – Astrophysics and Cosmology

1 (a) large mass of gas (allow H and He) B1
giving off e.m. radiation (allow light) B1
held together by gravitational forces, or other good physics ..... B1 [3]

(b) group of (many) stars B1
any further detail e.g. some dimension, shape, etc ..... B1 [2]

(c) rocky or gaseous object B1
orbiting a star B1
seen by reflected light ..... B1 [3]

2 measure wavelength of light received from galaxy B1
measure wavelength of light in laboratory/on Earth B1
(fractional) change in wavelength related to speed
or Doppler shift gives speed ..... B1 [3]

3 (a) $v = H_0 d$
$H_0 = (1.8 \times 10^4)/430$ C1
$= 42$ km s^{-1} Mpc^{-1} ..... A1 [2]

(b) (i) 1 pc = 3.1×10^{16} m B1
age = $1/H_0$
$= (3.1 \times 10^{22})/(42 \times 10^3)$ C1
$= 7.4 \times 10^{17}$ s A1

(ii) Earth-Moon distance = 3.8×10^5 km (allow $2 - 7 \times 10^5$ km) C1
speed $= (3.8 \times 10^8)/(7.4 \times 10^{17})$
$= 5.1 \times 10^{-10}$ m s^{-1} ..... A1 [5]

(c) This is local gravitational attraction B1
On wider scale, galaxies are receding ..... B1 [2]

Option F – The Physics of Fluids

4 (a) (i) equal B1

(ii) density of ice is less ..... B1 [2]

(b) mass of ice becomes equal mass of water (allow weight) M1
melted ice fills space of water displaced by ice M1
so level does not change ..... A1 [3]

5 (a) e.g. streamline, incompressible
non-viscous, horizontal flow……(1 each, max 3) ..... B3 [3]

(b) air close to train moves at the speed of the train/air dragged along by train B1
air at some distance from the train is stationary/velocity is less ... B1
(so) air pressure is lower close to the train M1
pressure difference could force passengers into side of train ..... A1 [4]

6 (a) (i) random/irregular movement (of fluid) B1
any other detail, e.g. eddies, pattern always changing B1

(ii) kinetic energy given to air to cause turbulence or work needed to overcome drag force M1
energy comes from car so fuel consumption increases ..... A1 [4]

(b) (i) drag coefficient/drag constant B1

(ii) power = Fv and hence M1
$P = \frac{1}{2}C_D\rho Av^3$ A0

(iii) $120 \times 10^3 - \frac{1}{2} \times 0.3 \times 1.2 \times 2.5 \times v^3$ C1
$v^3 = 2.67 \times 10^5$
$v = 64$ m s^{-1} ..... A1 [4]

Option M – Medical Physics

7 (a) electrons fired at <u>metal</u> target B1
electrons decelerated giving off (e.m.) radiation B1
range of decelerations, so <u>continuous spectrum</u> B1
also, electrons in inner orbits are excited B1
de-excitation gives characteristic <u>line spectrum</u> ..... B1 [5]

(b) (i) increase cathode/tube current B1

(ii) increase anode voltage B1

(iii) use aluminium filter (allow metal filter) ..... B1 [3]

(c) $I = I_0e^{-\mu x}$ C1
$\ln 2 = 0.40\mu$
$\mu = 1.733$ cm^{-1} or $= \ln 2/0.4$ C1
$0.1 = e^{-1.733x}$
$x = 1.33$ cm ..... A1 [3]

8 (a) produces greater intensity (at focus)
limits region of cell damage
allows for accurate guidance ..... B2 [2]

(b) laser beam cauterises tissue
can produce coagulation
vaporisation of water in cells ..... B2 [2]
{in (a) and (b), allow 1 mark each up to max of 3 in either, total not to exceed 4}

9 (a) ability to detect (small) changes in loudness/intensity B1
depends on $I / \Delta I$ ..... B1 [2]

(b) $\Delta I.L. = 10 \lg(\Delta I / I)$ or $I.L. = 10\lg(I/I_0)$ C1
$3.0 = 10 \lg (I_2 / (4.5 \times 10^{-5})$ C1
$I_2 = 9.0 \times 10^{-5}$ Wm^{-2}, $\Delta I = 4.5 \times 10^{-5}$ W m^{-2} ..... A1 [3]

Option P – Environmental Physics

10 (a) source of (useful) energy B1
derived from (incomplete) decay of organic matter ..... B1 [2]

(b) resources: total deposits of fossil fuels B1
reserves: fossil fuels that can be extracted (economically) ..... B1 [2]

11 (a) heavy nucleus/heavy atom/U-235, etc B1
bombarded by neutron B1
produces two fragments of about equal mass B1
plus neutrons and energy ..... B1 [4]

(b) (i) slows down neutrons B1

(ii) absorbs neutrons. B1

(iii) maintains coolant around reactor core B1
provides biological shield/prevents radiation leakage ..... B1 [4]

12 (a) $E_{MAX} = (1 - T_L/T_H)$. C1
$= (1 - 313/813)$ C1
$= 0.61$ ..... A1 [3]

(b) (i) e.g. heat loss in exhaust gases/cooling towers B1

(ii) e.g. pre-heat water entering boiler, either increase T_H or decrease T_L
re-heat steam in multistage turbine, CHP system…(1 each, max 2) .... B2 [3]

(c) e.g. thermal, visual, etc……..(1 each, max 2)..... B2 [2]

Option T – Telecommunications

13 (a) correct signal voltages…….(-1 each error or omission) B2
corresponding binary numbers...(-1 each error or omission)..... B2 [4]

(b) signal changes at correct positions B1
correct levels .... B1 [2]

(c) (use ADC and DAC with) larger number of bits M1
makes smaller 'step height' A1
sample more frequently M1
makes smaller 'step depth' ..... A1 [4]

14 (a) central conductor with outer screening B1
insulation between inner and outer and also as cladding ..... B1 [2]

(b) e.g. greater bandwidth
immune to e.m. interference
radiates less e.m. power
less cross-talk
lower noise levels……. (1 each, max 3)..... B3 [3]

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10 m → 100 m	worldwide
more than 100 m	1000 km
less than 10 m	line of sight or worldwide using satellites

(-1 each error or omission)..... B5 [5]