

June 2003

GCE ADVANCED SUBSIDIARY LEVEL AND ADVANCED LEVEL

MARK SCHEME
MAXIMUM MARK: 40
SYLLABUS/COMPONENT: 9702/06 PHYSICS Paper 6 (Options (A2))

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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
 $= 42 \text{ km s}^{-1} \text{ Mpc}^{-1}$ A1 [2]
- (b) (i) $1 \text{ pc} = 3.1 \times 10^{16} \text{ m}$ B1
age = $1/H_0$
 $= (3.1 \times 10^{22})/(42 \times 10^3)$ C1
 $= 7.4 \times 10^{17} \text{ s}$ A1
- (ii) Earth-Moon distance = $3.8 \times 10^5 \text{ km}$ (allow $2 - 7 \times 10^5 \text{ km}$)..... C1
speed = $(3.8 \times 10^8)/(7.4 \times 10^{17})$
 $= 5.1 \times 10^{-10} \text{ m s}^{-1}$ 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
 $v^3 = 2.67 \times 10^5$
 $v = 64 \text{ m s}^{-1}$ A1 [4]

Option M – Medical Physics

- 7 (a) electrons fired at metal target B1
electrons decelerated giving off (e.m.) radiation..... B1
range of decelerations, so continuous spectrum B1
also, electrons in inner orbits are excited B1
de-excitation gives characteristic line spectrum B1 [5]
- (b) (i) increase cathode/tube current..... B1
- (ii) increase anode voltage B1
- (iii) use aluminium filter (allow metal filter) B1 [3]
- (c) $I = I_0 e^{-\mu x}$ C1
 $\ln 2 = 0.40\mu$
 $\mu = 1.733 \text{ cm}^{-1}$ or $= \ln 2 / 0.4$ C1
 $0.1 = e^{-1.733x}$
 $x = 1.33 \text{ cm}$ 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
 $I_2 = 9.0 \times 10^{-5} \text{ W m}^{-2}$, $\Delta I = 4.5 \times 10^{-5} \text{ W m}^{-2}$ A1 [3]

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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, <u>either</u> 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]
15		10 m → 100 m worldwide more than 100 m 1000 km less than 10 m line of sight <u>or</u> worldwide using satellites (-1 each error or omission)..... B5	[5]