

MARK SCHEME for the October/November 2006 question paper

9702 PHYSICS

9702/06

Paper 6 (Options), maximum raw mark 40

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began.

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.

The grade thresholds for various grades are published in the report on the examination for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses.

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Option A – Astrophysics and Cosmology

- 1 (a)** gaseous/rocky/icy/approx. spherical object that orbits the Sun / a star B1 B1 [2]
- (b)** Venus must have passed between Sun and Earth 1 AU is (mean) distance between Earth and Sun B1 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 (max 1 mark if refers to Earth) [2]
- (b)** $1 \text{ Mpc} = 3.09 \times 10^{19} \text{ km}$ (allow 3.0 \rightarrow 3.2) C1
age = $1 / H_0$ C1
age = $(3.09 \times 10^{19}) / 60$
= $5.2 \times 10^{17} \text{ s}$ A1 [3]
- 4 (a)** e.g. dark matter does not emit light B2 dark matter does not reflect light [2] (any two sensible suggestions, 1 each)
- (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 (any sensible suggestion (M1) with reason (A1)) [4]

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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 = $\rho LA g$ M1
this equals weight Mg this equals weight Mg A1
hence $L = M/A\rho$ hence $L = M/A\rho$ A0 [2]
- (c) $M/A = L\rho = \text{constant}$ C1
new length = $12.1 \times (0.99/1.11) = 10.8 \text{ cm}$ 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 diameter² 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
 $= 22 \text{ dB}$ 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
to enable further fission reactions M1
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 CO₂ 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 = $960 \times 2.5 \times 10^{-4} = 0.24 \text{ W}$ C1
efficiency = $(30 \times 10^{-3}) / 0.24 = 0.13$ A1 [2]
- (b)**
- (i) large (surface) area required B1
 - (ii) connect many cells in series for higher voltage B1
connect many cells in parallel for larger current 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 'production losses' (so reducing overall costs) B1 [2]

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Option T – Telecommunications

- 14 (a)** satellite with orbit having period 24 hours
orbits above the Equator
from west to east / orbits in same sense
B1
B1
B1 [3]
- (b)** loss = $10 \lg(P_2 / P_1)$
-170 = $10 \lg(P_2 / 2400)$
 $P_2 = 2.4 \times 10^{-14} \text{ W}$
C1
C1
A1 [3]
- (c)** amplified otherwise power too low to be picked up on Earth
either frequency changed to prevent swamping / interference of signal received (from Earth)
or prevent feedback
B1
B1 [2]
- 15 (a)** variations in either amplitude or frequency of a wave
either in synchrony with displacement of information signal
or in order to carry information on the wave
B1
B1 [2]
- (b) (i)** 9 kHz
B1 [1]
- (ii)** LW frequency range is 30 kHz → 300 kHz
number = $270 / 9$
= 30
C1
C1
A1 [3]
- (c)** sketch: carrier frequency as vertical line and two sidebands
reasonable symmetry
sideband indicating approx. 4500 Hz range
(if sidebands shown as vertical lines, allow max. 1 mark)
M1
A1
B1 [3]
- 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]