**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

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 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 = $3.09 \times 10^{19}$ km (*allow 3.0 → 3.2*) C1
age = $1 / H_0$ C1
age = $(3.09 \times 10^{19}) / 60$
= $5.2 \times 10^{17}$ 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)*)

**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 = $\rho LAg$ 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]**

**Option M – Medical Physics**

**8 (a)** pulse of ultrasound
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*)

**Option P – Environmental Physics**

| | | | | |
| --- | --- | --- | --- | --- |
| **11 (a)** | **(i)** | slows down neutrons | | |
| | | to enable further fission reactions | A1 | |
| | **(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<br>*or* minimal / no release of gases causing global warming<br>no huge storage areas required at the power station<br>maintenance possible whilst on full load<br>(*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 = $5.4 \times (100/30) \times 5$<br>= 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]** |

**Option T – Telecommunications**

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

**(b)** loss = 10 lg($P_2$ / $P_1$) C1
-170 = 10 lg($P_2$ / 2400) C1
$P_2$ = $2.4 \times 10^{-14}$ 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]**