**UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS**

GCE Advanced Level

# MARK SCHEME for the November 2005 question paper

## 9702 PHYSICS

**9702/06 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 initially instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began. Any substantial changes to the mark scheme that arose from these discussions will be recorded in the published *Report on the Examination*.

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 minimum marks in these components needed for various grades were previously published with these mark schemes, but are now instead included in the Report on the Examination for this session.

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## Option A - Astrophysics and Cosmology

| | | | | | |
|---|---|---|---|---|---|
| **1** | **(a)** | **(i)** | (mean) distance between Earth and Sun | B1 | [1] |
| | | **(ii)** | distance at which 1 AU subtends an angle of one arc-second | M1<br>A1 | [2] |
| | **(b)** | | arc = $r\theta$ | C1 | |
| | | | $1.5 \times 10^{11} = r \times 2\pi / (360 \times 60 \times 60)$ | M1 | |
| | | | 1.0 pc = $3.09 \times 10^{16}$ m | A1 | [3] |
| **2** | **(a)** | | e.g. 3 K microwave background radiation<br>redshift of light from galaxies<br>*any two sensible suggestions, 1 each, max 2* | B2 | [2] |
| | **(b)** | | If Universe is static and infinite | B1 | |
| | | | then every line of sight would end on a star | M1 | |
| | | | so night would be as bright as day | A1 | [3] |
| | **(c)** | | depends on (mean) density of matter in the Universe | B1 | |
| | | | greater than a certain value, Universe will expand and then contract | B1 | |
| | | | below this certain value, Universe will expand indefinitely | B1 | [3] |
| **3** | **(a)** | | e.g. absorption of IR by water vapour in atmosphere<br>much stray IR at Earth's surface<br>*any two sensible suggestions, 1 each, max 2* | B2 | [2] |
| | **(b)** | | e.g. distant galaxies | B1 | |
| | | | moving so fast that they are red-shifted into IR | B1 | |
| | | | e.g. cool objects (brown dwarfs) | B1 | |
| | | | give off IR but not visible light<br>*allow any two sensible suggestions (2) + reasoning (1 + 1)* | B1 | [4] |

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## Option F - The Physics of Fluids

**4 (a)** e.g. incompressible fluid / constant density
horizontal flow
non-viscous
streamline
*any three, 1 each, max 3* B3 [3]

**(b)** force = $A\Delta p$ C1
= $25 \times ½ \times 1.2 \times (85^2 - 75^2)$ C1
= $2.4 \times 10^4$ N A1 [3]

**5 (a) (i)** centre of mass of displaced fluid B1 [1]
**(ii)** B shown at centre of submerged section B1 [1]
**(iii)** upthrust acts upwards through B B1
weight acts downwards through C B1
these two forces provide a restoring couple B1 [3]

**(b) (i)** becomes less B1 [1]
**(ii)** decrease B1 [1]
**(iii)** increases B1 [1]

**(c)** C and B coincide M1
no longer providing a restoring couple A1 [2]

**6 (a)** non-steady / haphazard flow of fluid B1 [1]

**(b)** turbulence represents (continuous) transfer of kinetic energy B1
this transfer of energy per unit time represents power B1
power = $F_D \times$ speed so more power means larger $F_D$ B1 [3]

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## Option M - Medical Physics

**7 (a)** electrons accelerated / high speed electrons B1
bombard <u>metal</u> target B1
electrons decelerated greatly → e.m. radiation B1
wide range of decelerations gives continuous spectrum B1
electrons in target atoms excited B1
de-excitation of these electrons gives line spectrum B1 [6]

**(b) (i)** sharpness: ease with which edges of structures can be seen B1 [1]
**(ii)** contrast: difference in blackening between structures B1 [1]

**8 (a)** short sight (myopia) B1 [1]

**(b) (i)** concave lens drawn B1 [1]
**(ii)** rays diverge after passing through the concave lens B1
rays converge on the retina B1 [2]

**9 (a) (i)** *intensity*: energy per unit area per unit time (normal to area) B1
*loudness*: subjective response (of a person) to (a given) intensity B1
**(ii)** ability to distinguish between two different intensities of sound B1 [3]

**(b)** intensity level = $10 \lg(I / I_0)$
$89 = 10 \lg I / (1.0 \times 10^{-12})$ C1
$I_{89} = 7.94 \times 10^{-4}$ W m$^{-2}$ C1
$92 = 10 \lg I / (1.0 \times 10^{-12})$
$I_{92} = 1.58 \times 10^{-3}$ W m$^{-2}$ C1
ratio = $I_{89} / (I_{92} - I_{89})$ C1
= 1.0 A1 [5]

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## Option P - Environmental Physics

**10 (a)** diagram: closed box with glass top B1
metal base and water tubing B1
blackened interior B1 [3]

**(b)** largest area normal to sunlight B1 [1]

**(c)** power = flow rate $\times$ $c \times \Delta\theta$ C1
$800 \times 0.35 \times 1.4$ = flow rate $\times$ $4200 \times 15$ C1
flow rate = $6.2 \times 10^{-3}$ kg $s^{-1}$ A1 [3]

**11 (a) (i)** change in pressure and volume (and temperature) M1
without any (thermal) energy entering or leaving the system A1 [2]
**(ii)** the change takes place rapidly B1
no time for energy to flow in/out of the gas B1 [2]

**(b) (i)** correct direction shown (clockwise) B1 [1]
**(ii)** correct section marked (vertical section on left of diagram) B1 [1]

**12 (a)** the lead compounds are released as air pollution B1
any further comment e.g. cause mental disorders, enter food chain via plants B1 [2]

**(b)** e.g. noise, visual
*any two sensible suggestions, 1 each, max 2* B2 [2]

**(c) (i)** available without using (fossil) fuels B1 [1]
**(ii)** e.g. do not produce air pollution, no mining/transportation
*any two sensible suggestions, 1 each, max 2* B2 [2]

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## Option T - Telecommunications

**13 (a)** signal is in the form of a series of pulses of light/IR B1
pulses pass along a glass fibre B1
as a result of total internal reflection B1 [3]

**(b)** technological: e.g. greater bandwidth, less noise, less power loss per unit length
*any two sensible suggestions, 1 each, max 2* B2
social: e.g. increased security, cheaper, less bulky
*any two sensible suggestions, 1 each, max 2* B2 [4]

**14 (a) (i)** thermal energy (in the cable) / resistance B1 [1]
**(ii)** loss = 10 lg(0.55 / 0.60) C1
= (-) 0.38 dB C1
loss per unit length = $0.38 / 75 \times 10^{-3}$ C1
= 5.0 dB $km^{-1}$ A1 [4]

**(b) (i)** unwanted (random) signal power B1 [1]
**(ii)** e.g. molecular/lattice vibrations, pick-up of e.m. signals
*any two sensible suggestions, 1 each, max 2* B2 [2]

**15** digital more reliable than analogue
fewer people employed in telephone industry
greater multiplexing means reduced cost per call
reduced costs means available to more people
huge expansion international calls
huge expansion of non-voice communications
development/expansion of internet
introduction of multichannel cable TV companies
*any five sensible statements, 1 each, max 5* B5 [5]

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