This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. This 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.

- CIE will not enter into discussion or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the November 2004 question papers for most IGCSE and GCE Advanced Level syllabuses.
**Grade thresholds** taken for Syllabus 9702 (Physics) in the November 2004 examination.

<table>
<thead>
<tr>
<th>Component</th>
<th>maximum mark available</th>
<th>minimum mark required for grade:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Component 6</td>
<td>40</td>
<td>30</td>
</tr>
</tbody>
</table>

The thresholds (minimum marks) for Grades C and D are normally set by dividing the mark range between the B and the E thresholds into three. For example, if the difference between the B and the E threshold is 24 marks, the C threshold is set 8 marks below the B threshold and the D threshold is set another 8 marks down. If dividing the interval by three results in a fraction of a mark, then the threshold is normally rounded down.
<table>
<thead>
<tr>
<th>MARK SCHEME</th>
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<tbody>
<tr>
<td>MAXIMUM MARK: 40</td>
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SYLLABUS/COMPONENT: 9702/06

PHYSICS
Paper 6
### Option A – Astrophysics and Cosmology

**1**  
- Diameter of the Sun: B1  
- Nearest (neighbour) star/Proxima Centauri: B1  
- Diameter of (Milky Way) galaxy: B1  

**2**  
- E.g. Atmospheric absorption/scattering: M1  
  - Means light is too faint: A1  
- Light pollution: M1  
- Irregular atmospheric refraction/thermal currents: (M1)  
  - Means small objects blurred/not seen: (A1)  
  - (Any two sensible suggestions {M1 x 2} plus some further detail of each {A1 x 2})

**3 (a)(i) e.g.**  
- Either density such that Universe will not collapse or expand indefinitely  
  - Greater density than $\rho_0$ means collapse (OR vice versa): B1  
- Or determines whether Universe is ‘open’ or ‘closed’  
  - Greater density than $\rho_0$ means ‘closed’  
  - OR smaller density than $\rho_0$ means ‘open’: (B1) [2]

**3 (a)(ii) e.g.**  
- (If Universe is closed eventually all) kinetic energy of galaxies will be converted to (gravitational) potential energy  
  - (Gravitational) potential energy involves the gravitational constant $G$: B1 [2]

**3 (b)(i) e.g.**  
- (Sensible straight line and) one or two points chosen with attempt at antilogs: B1  
  - $H_0 = 100 \text{ km s}^{-1} \text{ Mpc}^{-1}$ (allow 80 $\rightarrow$ 125 km s$^{-1}$ Mpc$^{-1}$): A1  
  - $1 \text{ Mpc} = 3.1 \times 10^{19} \text{ km}$: C1  
- $H_0 = 100/(3.1 \times 10^{19}) = 3.2 \times 10^{-18} \text{ s}^{-1}$  
  - Age $= 1/H_0 = 3.1 \times 10^{17} \text{ s}$: A1 [4]

**3 (b)(ii) e.g.**  
- $\rho_0 = (3 \times 10^{-18})^2 / (8 \times \pi \times 6.67 \times 10^{-11})$  
  - $= 1.86 \times 10^{-26} \text{ kg m}^{-3}$: C1 [2]  
- Number density $= (1.86 \times 10^{-26}) / (1.66 \times 10^{27})$  
  - $\approx 10$: A1 [2]
Option F – The Physics of Fluids

4 (a) M shown near base of stem 

(b)(i) density = mass/volume  
volume submerged in liquid of density 1.0 g cm\(^{-3}\) = 165 cm\(^3\)  
volume submerged in liquid of density 1.1 g cm\(^{-3}\) = 150 cm\(^3\)  
change in volume = 15 cm\(^3\)  

(ii) distance (= 15/0.75) = 20 cm

5 (a) arrows longer at centre than edges  
arrows parallel and correct relative lengths

(b)(i) no unique value of (linear) speed

(ii) volume flow rate doubles

(iii) new radius = 1.05 r  
new flow rate = 1.05\(^4\) \times 2  
= 2.4(3) times greater

6 (a) (fluid) flow/movement  
that is erratic/has eddies  
i.e. speed varies continuously (in magnitude and direction) with time

(b)(i) for turbulent flow, \(F_D/\nu^2\)  
\(\nu = 58 \text{ m s}^{-1}\)
Option M – Medical Physics

7 (a) pulse of ultrasound reflected from boundaries received (at surface) and processed time for pulse to return gives depth of boundary reflected intensity gives information on nature of boundary [5]

(b) fraction = \( e^{-23 \times 0.055} \)
\[ = 0.28 \] A1 [2]

(c) fraction = 0.28 \( \times \) 0.35 \( \times \) 0.28
\[ = 0.027 \] A1 [2]
(or 0.35\( e^{-23 \times 0.11} \) = 0.028)

8 (a)(i) rays from S converge to point behind retina B1

(ii) range of image distances such that image is tolerably in focus B1 [3]

(b) for the same size of patch on the retina focused image is further from the retina (so) depth of focus is increased B1 [3]

9 (a) intensity = \( (0.33 \times 10^{-6}) / (65 \times 10^{-6}) \)
\[ = 5.1 \times 10^{-3} \text{ W m}^{-2} \]
\[ \text{I.L.} = 10 \log (5.08 \times 10^{-3}) / (1.0 \times 10^{-12}) \]
\[ = 97 \text{ dB} \] C1 [4]

(b) (long-term exposure) could cause deafness OR (short-term exposure) could cause tinnitus B1 [1]
Option P – Environmental Physics

10 (a) massive nucleus/named appropriate nucleus splits into two approximately equal parts/named components with the release of neutrons and energy [3]

(b) moderator: slows down (high speed) neutrons so that further fissions are more likely/will take place control rods absorb neutrons to provide control over the rate of fission [4]

11 (a)(i) water moved from (area of) trough to crest to form wave potential energy = mgh

\[ = \frac{1}{2} \lambda Aw \rho g \times A \]

(must be laid out so that substitutions are obvious) [3]

(ii) there are \( V/\lambda \) wavecrests passing a point per unit time power = \( \frac{1}{2} wA^2 \rho g V/\lambda \)

\[ = \frac{1}{2} wA^2 \rho g V \]

[2]

(b) e.g hazard to shipping, unsightly, upset to shoaling fish etc. (any sensible suggestion) [1]

12 (a) input shown clearly as 1140 W four outputs labeled correctly arrows having approximately correct ratio of widths [3]

(b) electrical heating more efficient at transferring energy to water very little thermal energy escapes because plastic is an insulator gas ring much less efficient because of thermal energy losses to the air thermal energy losses due to conduction as kettle is metal [4]
Option T – Telecommunications

13 (a) box for 1 m – 10 cm labeled T  
      (b) box for 10 cm – 1 cm labeled S  

14 (a) frequency of carrier wave varies (in synchrony) with information signal  
      constant amplitude OR carrier frequency >> signal frequency  
      change in frequency measures displacement of information signal  
      rate at which carrier frequency varies gives frequency of information signal  

(b)(i) period = 0.8 μs  
      frequency = 1.25 MHz  

(b)(ii) 125 kHz  

(c) advantage: e.g. better quality/less interference  
    disadvantage: e.g. more transmitters/more expensive  

15 (a)(i) sampled every 0.5 ms  
      frequency = 2.0 kHz  

(b) needs sampling time shorter than smallest peak-trough interval  
    any suggestion of about (0.2 ms or about) 5 kHz (allow 5 kHz → 10 kHz)  
    needs voltage interval less than peak-trough height  
    any suggestion at about 0.3 V (allow 0.1 V → 0.4 V)  
    so either 12/0.3 = 40 OR 11/0.3 = 37 OR 10/0.3 = 34 etc.  
    (ignore binary nature of the ADC and the DAC)