

JUNE 2002

GCE Advanced Level

MARK SCHEME

MAXIMUM MARK : 40

SYLLABUS/COMPONENT :9702 /6

**PHYSICS
(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 bracket information in order to earn the available marks.

UNDERLINING

In the marking scheme, underlining indicates information that is essential for marks to be awarded.

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Option A

- 1 (a) $1.50 \times 10^{11} \text{ m}$ (accept $1.49 \times 10^{11} \text{ m}$) B1 [1]
- (b) (i) distance at which 1 AU M1
subtends an angle of 1 second of arc A1
- (ii) arc = $r\theta$ C1
1 arc second = $2\pi / (360 \times 3600) = (4.85 \times 10^{-6}) \text{ rad}$ C1
1 pc = $(1.5 \times 10^{11}) / (4.85 \times 10^{-6}) = 3.09 \times 10^{16} \text{ m}$ A1 [5]
(accept $3.1 \times 10^{16} \text{ m}$)
- 2 (a) sketch: straight line through origin B1 [1]
- (b) galaxies are moving away from each other B1
(so) at one time, must have been close together
OR max. speed close to c , so finite time B1 [2]
- (c) on sufficiently large scale, Universe is homogeneous
OR mentions 'Cosmological Principle' B1
so, no matter where positioned, galaxies are moving away B1 [2]
- (d) (i) $H_0 = v/d$ C1
this is the gradient of the graph A1
- (ii) (d/v is the time for galaxies to separate i.e.) $1/\text{gradient}$ B1 [3]
(allow $1/H_0$ if H_0 stated to be the gradient)
- 3 (a) allow $10^2 \text{ s} - 10^4 \text{ s}$ B1 [1]
- (b) allow $10^{12} \text{ s} - 10^{14} \text{ s}$ B1 [1]
- (c) later than (b) but about $10^{13} \text{ s} - 10^{14} \text{ s}$ B1 [1]
- 4 e.m. radiation received is very faint C1
radiation is absorbed by atmosphere B1
so use detection systems in Earth orbit B1 [3]

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Option F

- 5 (a) (i) reasonable position B1
(ii) reasonable construction with M marked B1 [2]
- (b) restoring couple increases (1)
ship is more stable (1)
so ship less likely to move with the waves or
more likely to act as rigid wall against waves (1)
any two, 1 each max 2 B2 [2]
- 6 (a) (i) $A_1 v_1$ B1
(ii) $\rho A_1 v_1$ B1 [2]
- (b) (i) $E_k = \frac{1}{2} m v^2$ C1
 $\frac{1}{2} \rho A_2 v_2^3 - \frac{1}{2} \rho A_1 v_1^3$ A1
(ii) work done = $p \Delta V$ C1
 $p_1 A_1 v_1 - p_2 A_2 v_2$ A1 [4]
(allow answer to (i) without comment for 2/2)
- (c) (i) $p_1 A_1 v_1 - p_2 A_2 v_2 = \frac{1}{2} \rho A_2 v_2^3 - \frac{1}{2} \rho A_1 v_1^3$ B1
now $A_1 v_1 = A_2 v_2$ B1
 $p_1 - p_2 = \frac{1}{2} \rho v_2^2 - \frac{1}{2} \rho v_1^2$ A0
(ii) assumption: horizontal flow/streamline/non-viscous B1 [3]
- 7 (a) graph: curve from origin M1
approaches/reaches constant speed A1 [2]
- (b) weight, upthrust and drag act on sphere B1
accelerating force = (apparent) weight - drag
OR = weight - upthrust - drag B1
as speed increases, drag increases B1
so acceleration decreases M1
reaches a constant/terminal speed A1 [5]

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Option M

- 8 (a) pulse of ultrasound B1
 reflected (at boundaries) B1
 (on return, detected and) processed B1
 time delay gives depth B1
 strength of echo indicates nature of boundary B1 [5]
- (b) (i) 1. (high μ means) low penetration (do not allow 'absorbed') B1
 also much reflection (at muscle/bone interface) B1
 2. ultrasound absorbed in bone B1
 causes a heating effect B1 [4]
- (ii) $(I/I_0)_{\text{muscle}} = e^{-23x}$ C1
 $(I/I_0)_{\text{bone}} = e^{-130x}$ C1
 substitution of value for x or use of indices C1
 ratio = 2.9 A1 [3]
- 9 (a) short sight / myopia B1 [1]
- (b) power = $-1/0.75 + 1/\infty$ C1
 $= -1.33 \text{ D}$ A1 [2]
- (c) there is greater magnification B1
 because able to focus when closer to eye B1 [2]
- 10 (a) $I.L. = 10 \lg(I/I_0)$ with I_0 explained B1 [1]
- (b) loss of sensitivity at about 3 kHz B1
 loss of hearing at higher frequencies (- cut-off should be about 15 kHz) ... B1 [2]

Option P

- 11 (a) e.g. energy from tidal flow / stores excess electrical energy B2
 dependent on time of tides / available to meet peak demands B2 [4]
- (b) (i) $77 \text{ m}^3 \text{ s}^{-1} = 77 \times 10^3 \text{ kg s}^{-1}$ C1
 energy = mgh C1
 power = $77 \times 10^3 \times 9.8 \times 180$
 $= 140 \text{ MW}$ A1

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- 11 (b) (ii) Answer in (i) must be greater than 100 MW B1
because water falling has k.e. (or other valid point) B1 [5]
(calculation of efficiency as 74% - allow 1/2)
- 12 (a) mass of air per unit time = $\pi r^2 \rho v$ B1
kinetic energy = $\frac{1}{2}mv^2$ B1
 $E = \frac{1}{2}\pi r^2 \rho v \cdot v^2$ M1
= $\frac{1}{2}\pi r^2 \rho v^3$ A0 [3]
- (b) $E = 0.55 \times \frac{1}{2} \times \pi \times 12^2 \times 1.2 \times 4.5^3$ C1
= 13.6 kW A1 [2]
- (c) high speeds cause large stresses (in blades etc) B1
blades are 'feathered' B1 [2]
- 13 (a) not true - visual pollution B1
- pollution during building B1 [2]
(allow any two valid points – give credit for justifying 'no pollution' claim)
- (b) Many generators required over a large area B1
other valid point e.g. weather dependence etc B1 [2]

Option T

- 14 (a) amplitude modulated B1 [1]
- (b) (i) 10 waves in 200 μ s C1
 $f = 50$ kHz A1
(ii) frequency = 5 kHz A1 [3]
- (c) graph: three vertical lines B1
carrier longer than equal sidebands B1
frequencies shown correctly B1 [3]

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- 15 (a) number of dB = $10 \lg(P_1/P_2)$ C1
 $25 = 10 \lg(P / (7.3 \times 10^{-5}))$ M1
 $P = 0.023 \text{ W}$ A0 [2]
- (b) change in signal power = $10 \lg(5.8/0.023)$ C1
 $= 24 \text{ dB}$ C1
length = $24 / 4.8 = 5.0 \text{ km}$ A1 [3]
- (c) e.g. less interference
greater uninterrupted length
no cross-talk etc (any valid points, 1 each) B2 [2]
- 16 (a) e.g. weather forecasting
prospecting etc (any two valid points, 1 each) B2 [2]
- (b) e.g. weather monitoring
telephone communication (any two valid points, 1 each) B2 [2]
- (c) (i) allow 1 cm $\rightarrow$ 20 cm B1
(ii) e.g. prevent swamping of incoming signal B1 [2]