

November 2003

GCE ADVANCED SUBSIDIARY LEVEL AND ADVANCED LEVEL

MARK SCHEME
MAXIMUM MARK: 40
SYLLABUS/COMPONENT: 9702/01 PHYSICS Paper 1 (Multiple Choice (AS))

<i>Question Number</i>	<i>Key</i>	<i>Question Number</i>	<i>Key</i>
1	C	21	D
2	C	22	C
3	A	23	A
4	D	24	D
5	D	25	D
6	B	26	A
7	B	27	D
8	A	28	B
9	C	29	B
10	B	30	D
11	D	31	A
12	A	32	A
13	C	33	C
14	B	34	B
15	B	35	D
16	C	36	B
17	D	37	D
18	B	38	C
19	B	39	B
20	A	40	C

November 2003

GCE ADVANCED SUBSIDIARY LEVEL AND ADVANCED LEVEL

MARK SCHEME
MAXIMUM MARK: 60
SYLLABUS/COMPONENT: 9702/02 PHYSICS Paper 2 (Structured Questions (AS))

Page 1	Mark Scheme	Syllabus	Paper
	A/AS LEVEL EXAMINATIONS - NOVEMBER 2003	970	1

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.

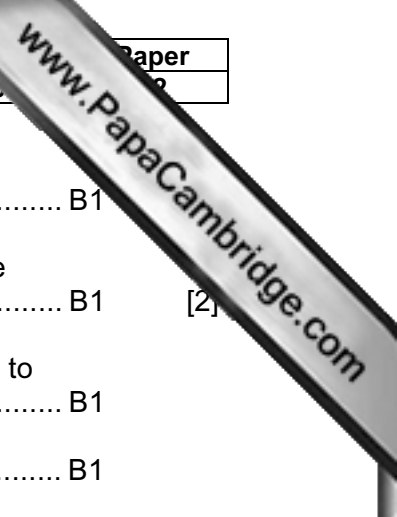
Conventions within the marking scheme

BRACKETS

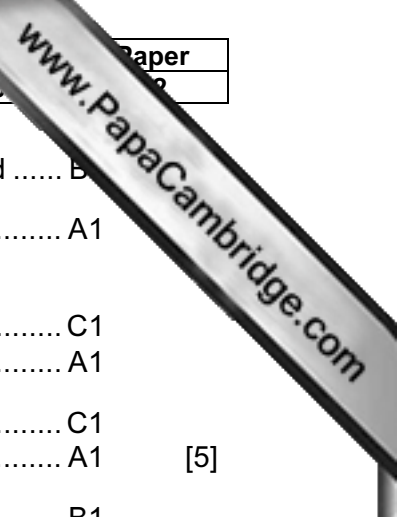
Where brackets are shown in the marking scheme, the candidate is not required to give the bracketed information in order to earn the available marks.

UNDERLINING

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



1	(a)	(i)	acceleration (allow a definition of acceleration).....	B1	
		(ii)	the velocity is decreasing or force/acceleration is in negative direction – accept ‘body is decelerating’/‘slowing down’	B1	[2]
	(b)	(i)	e.g. separation of dots becomes constant/does not continue to increase (must make a reference to the diagram)	B1	
		(ii)1	distance = 132 cm.....	B1	
		(ii)2	at constant speed, distance travelled in 0.1 s = 25 cm (allow ± 1 cm).....	C1	
			distance = 132 + (4 x 25)		
			= 232 cm	A1	[4]
	(c)		$s = ut + \frac{1}{2}at^2$		
			$1.6 = \frac{1}{2} \times 9.8 \times t^2$ (allow $g = 10 \text{ m s}^{-2}$	C1	
			$t = 0.57 \text{ s}$	C1	
			hence 6 photographs (‘bald’ answer scores 2 marks only).....	A1	[3]
2	(a)		mass: measure of body’s resistance/inertia to changes in velocity/motion	B1	
			weight: effect of gravitational field on mass or force of gravity	B1	
			any further comment e.g. mass constant, weight varies/ weight = mg/scalar and vector	B1	[3]
	(b)		e.g. where gravitational field strength changes (change) in fluid surrounding body.... 1 each, max 2	B2	[2]
3	(a)		force x perpendicular distance	M1	
			(of the force) from the pivot.....	A1	[2]
	(b)		no resultant force (in any direction).....	B1	
			no resultant moment (about any point).....	B1	[2]
	(c)	(i)	correct direction in both.....	B1	[1]
		(ii)1	moment = 150 x 0.3 = 45 N m (1 sig. fig. -1).....	A1	
		(ii)2	torque = 45 N m i.e. same as (i).....	A1	
		(ii)3	$45 = 0.12 \times T$	C1	
			$T = 375 \text{ N}$	A1	[4]
4	(a)	(i)1	amplitude = 0.4(0) mm	A1	
		(i)2	wavelength = $7.5 \times 10^{-2} \text{ m}$ (1 sig. fig. -1 unless already penalised).....	A1	
		(i)3	period = 0.225 ms	C1	
			frequency = $1/T = 4400 \text{ Hz}$	A1	
		(i)4	$v = f\lambda$		
			= $4400 \times 7.5 \times 10^{-2}$	C1	
			= 330 m s^{-1}	A1	[6]



	(a)	(ii)	reasonable shape, same amplitude and wavelength doubled	B1	
	(b)	(i)	$1.7(2) \mu\text{m}$	A1	
		(ii)	$d \sin 2 = n\lambda$ (double slit formula scores 0/2) $1.72 \times 10^{-6} \times \sin 2 = 590 \times 10^{-9}$	C1	
			$2 = 20.1^\circ$ (allow 20°)	A1	
		(iii)	$\frac{1}{2}L = 1.5 \tan 20.1$	C1	
			$L = 1.1 \text{ m}$	A1	[5]
5	(a)	(i)	arrow from B towards A	B1	
		(ii)	$E = V/d$ $= 450/(9.0 \times 10^{-2})$	C1	
			$= 5.0 \times 10^3 \text{ N C}^{-1}$ (accept 1 sig. fig)	A1	[3]
	(b)	(i)	energy = qV or Eqd	C1	
			$= 1.6 \times 10^{-19} \times 450$	A1	
			$= 7.2 \times 10^{-17} \text{ J}$	A0	
		(ii)	$E_k = \frac{1}{2}mv^2$ $7.2 \times 10^{-17} = \frac{1}{2} \times 9.1 \times 10^{-31} \times v^2$	C1	
			$v = 1.26 \times 10^7 \text{ m s}^{-1}$	A1	[4]
	(c)		line from origin, curved in correct direction but not 'level out'	B1	[1]
6	(a)	(i)	26 protons	B1	
		(ii)	30 neutrons	B1	[2]
	(b)	(i)	mass = $56 \times 1.66 \times 10^{-27}$	C1	
			(allow $\times 1.67 \times 10^{-27}$ but 0/2 for use of 26 or 30) $= 9.3 \times 10^{-26} \text{ kg}$	A1	
		(ii)	density = mass/volume where volume = $\frac{4}{3} \times \pi \times r^3$	C1	
			$= (9.3 \times 10^{-26}) / (\frac{4}{3} \times \pi \times \{5.7 \times 10^{-15}\}^3)$ $= 1.2 \times 10^{17} \text{ kg m}^{-3}$	A1	[4]
	(c)		nucleus occupies only very small fraction of <u>volume of atom</u> or 'lot of empty space inside atom'	B1	
			(do not allow spacing between atoms) any further good physics e.g. nuclear material is very dense	B1	[2]
7	(a)	(i)	$P = Vi$	C1	
			$1200 = 240 \times i$	M1	
			$i = 5.0 \text{ A}$	A0	
		(ii)	$V = iR$ $240 = 5.0 \times R$	C1	
			$R = 48\Omega$	A1	[4]
	(b)	(i)	p.d. = $(5.0 \times 4.0 =) 20 \text{ V}$	A1	
		(ii)	mains voltage = $(240 + 20 =) 260 \text{ V}$	A1	
		(iii)	$P = (20 \times 5.0 =) 100 \text{ W}$	A1	[3]
	(c)		power input = $1200 + 100 = 1300 \text{ W}$	C1	
			efficiency = $1200/1300 = 0.92$	A1	[2]

November 2003

GCE ADVANCED SUBSIDIARY LEVEL AND ADVANCED LEVEL

MARK SCHEME

MAXIMUM MARK: 25

SYLLABUS/COMPONENT: 9702/03

PHYSICS
Paper 3 (Practical (AS))

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- (c) (ii) Percentage uncertainty in first value of d
 Uncertainty = 1 mm or 2 mm scores 1 mark.
 Ratio idea correct scores 1 mark.
- (e) (i) Readings 3/2/1/0
 6 sets of values for d/T scores 1 mark.
 Check a value for T . Underline checked value. Tick if correct and score 1 mark.
 Ignore rounding errors. If incorrect, write in correct value and do not award the mark.
 If there is no record of the number of oscillations then do not award this mark.
 If there are no raw times do not award this mark.
 If t for T then do not award this mark and ecf into the calculation for d/T .
 Check a value for d/T . Underline this value. Tick if correct and score 1 mark.
 Ignore rounding errors.
 If incorrect, write in correct value and do not award the mark. ecf for T .
 Help given by Supervisor, then -1. Excessive help then -2.
 Misread stopwatch -1.
- (e) (i) Repeated readings 1
 For each value of d there must be at least two values of t .
 Do not award this mark if all of the repeats are identical.
- (e) (i) Reasonable time used for oscillations 1
 At least half of the raw times must be greater than 20 s.
 If there are no raw times do not award this mark.
- (e) (i) Quality of results 2/1/0
 Judge by scatter of points about the line of best fit.
 6 trend plots with little scatter scores 2 marks.
 5 trend plots with little scatter scores 1 mark.
 Wrong trend of plots cannot score these marks (i.e. t increases as d increases)
- (e) (i) Column headings 1
 Apply to d/T only.
- (e) (i) Consistency 1
 Apply to d only. All the values of d must be given to the nearest millimetre.
- (e) (i) Significant figures 1
 Apply to d/T only.
 d/T must be given to the same number, or one more than, the number of significant figures as the least accurate data. Check each value by row.
- (e) (ii) Justification for sf in d/T 2/1/0
 Answer must relate sf in d (and t) to sf in d/T .
 Do not allow answers in terms of decimal places.
 'Raw data' ideas or reference to T instead of t can score 1/2 marks.
- (f) (i) Axes 1
 Scales must be such that the plotted points occupy at least half the graph grid in both the x and y directions. Scales must be labelled with the quantities plotted.
 Do not allow awkward scales (e.g. 3:10, 6:10, 7:10 etc.). Ignore unit.
 Do not allow large gaps in the scale (i.e. 4 large squares or more).
- (f) (i) Plotting of points 1
 Count the number of plots and write as a ringed number on the grid.
 All observations must be plotted. There must be at least 5 plots on the grid.
 Check a suspect plot. Circle and tick if correct. If incorrect, show correct position with arrow, and do not award the mark. Work to half a small square.

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- (f) (i) Line of best fit
There must be a reasonable balance of points about the line of best fit.
Only a straight line drawn through a linear trend is allowable.
- (f) (ii) Determination of gradient 1
 Δ used must be greater than half the length of the drawn line.
 $\Delta x/\Delta y$ scores zero. The value must be negative (if the line has a negative gradient).
Check the read-offs. Work to half a small square.
- (f) (ii) y-intercept 1
The value may be read directly or calculated using $y = mx + c$ and a point on the line.
- (g₁) Gradient equated with $-\pi^2/g$ 1
- (g₂) Value of g 1
Accept $9.3 \text{ m s}^{-2} < g < 10.3 \text{ m s}^{-2}$.
This mark can only be scored if the gradient has been used.
- (g₃) Unit of g 1
Must be consistent with the working.
- (g₄) Intercept equated with T_0 1
A numerical value is expected. Allow ecf from candidate's value in (f) (ii).
- (g₅) Unit of T_0 1
- (h) Suggested improvement; e.g. 1
Measure the time for a greater number of oscillations: Use a thinner rod/knife edge for the stop: Use a fiducial marker/projection on screen: Use an electronic timing method (e.g. light gates & timer/datalogger & motion sensor/laser & timer)
Use larger values of d . Do not allow 'repeat readings', 'more sensitive stopwatch', 'do the experiment in a vacuum', switch the fans off, 'use heavier bob', 'avoid parallax error' or 'use a computer'.

25 marks in total.

November 2003

GCE ADVANCED SUBSIDIARY LEVEL AND ADVANCED LEVEL

MARK SCHEME

MAXIMUM MARK: 60

SYLLABUS/COMPONENT: 9702/04

PHYSICS

Paper 4 (Structured Questions (A2 Core))

Page 1	Mark Scheme	Paper
	A/AS LEVEL EXAMINATIONS - NOVEMBER 2003	9701

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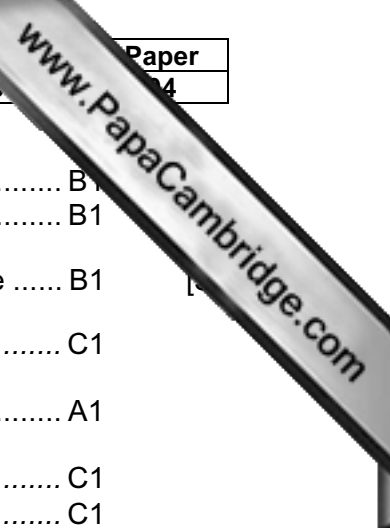
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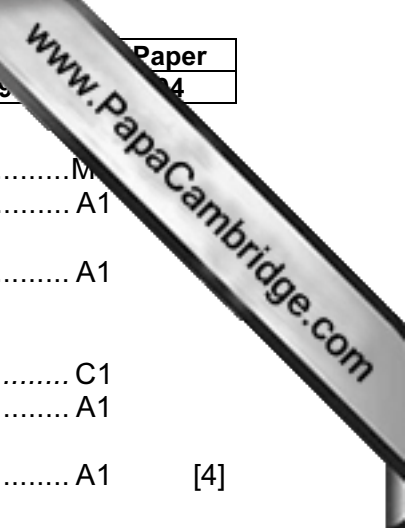
UNDERLINING

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1 (a) (i)	radial lines.....	B1	
	pointing inwards.....	B1	
(ii)	no difference OR lines closer near surface of smaller sphere	B1	
(b) (i)	$F_G = GMm/R^2$	C1	
	$= (6.67 \times 10^{-11} \times 5.98 \times 10^{24}) / (6380 \times 10^3)^2$		
	$= 9.80 \text{ N}$	A1	
(ii)	$F_C = mR\omega^2$	C1	
	$\omega = 2\pi/T$	C1	
	$F_C = (4\pi^2 \times 6380 \times 10^3) / (8.64 \times 10^4)^2$		
	$= 0.0337 \text{ N}$	A1	
(iii)	$F_G - F_C = 9.77 \text{ N}$	A1	[6]
(c)	because acceleration (of free fall) is (resultant) force per unit mass	B1	
	acceleration = 9.77 m s^{-2}	B1	[2]
2 (a) (i)	a, ω and x identified	B2	(-1 each error or omission)
(ii)	(-)ve because a and x in opposite directions OR a directed towards mean position/centre.....	B1	[3]
(b) (i)	forces in springs are $k(e + x)$ and $k(e - x)$	C1	
	resultant = $k(e + x) - k(e - x)$	M1	
	$= 2kx$	A0	[2]
(ii)	$F = ma$	B1	
	$a = -2kx/m$	A0	
	(-)ve sign explained.....	B1	[2]
(iii)	$\omega^2 = 2k/m$	C1	
	$(2\pi f)^2 = (2 \times 120) / 0.90$	C1	
	$f = 2.6 \text{ Hz}$	A1	[3]
(c)	atom held in position by attractive forces atom oscillates, not just two forces OR 3D not 1D force not proportional to x <i>any two relevant points, 1 each, max 2</i>	B2	[2]
3 (a)	$pV/T = \text{constant}$	C1	
	$T = (6.5 \times 10^6 \times 30 \times 300) / (1.1 \times 10^5 \times 540)$	C1	
	$= 985 \text{ K}$	A1	[3]
	<i>(if uses °C, allow 1/3 marks for clear formula)</i>		
3 (b) (i)	$\Delta U = q + w$ symbols identified correctly	M1	
	directions correct.....	A1	[2]
(ii)	q is zero	B1	
	w is positive OR $\Delta U = w$ and U increases	B1	
	ΔU is rise in kinetic energy of <u>atoms</u>	M1	
	and mean kinetic energy $\propto T$	A1	[4]
	<i>(allow one of the last two marks if states 'U increases so T rises')</i>		



4	(a)	single diode..... M1 in series with R OR in series with a.c. supply A1	
	(b)	(i)1 5.4 V (allow ± 0.1 V)..... A1	
		(i)2 $V = iR$ $I = 5.4/1.5 \times 10^3$ C1 $= 3.6 \times 10^{-3}$ A A1	
		(i)3 time = 0.027 s A1	[4]
		(ii)1 $Q = it$ $= 3.6 \times 10^{-3} \times 0.027$ C1 $= 9.72 \times 10^{-5}$ C A1	
		(ii)2 $C = \Delta Q/\Delta V$ (allow C – Q/V for this mark) C1 $= (9.72 \times 10^{-5})/1.2$ $= 8.1 \times 10^{-5}$ F A1	[4]
	(c)	line: reasonable shape with less ripple..... B1	[1]
5	(a)	field producing force of 1.0 N m^{-1} on wire OR $B = F/IL\sin\theta$ M1 carrying current of 1.0 A normal to field OR symbols explained ... A1	[2]
	(b)	(i) $\phi = BA$ $= 1.8 \times 10^{-4} \times 0.60 \times 0.85$ C1 $= 9.18 \times 10^{-5}$ Wb A1	[2]
		(ii)1 $\Delta\phi = 9.18 \times 10^{-5}$ Wb..... A1	
		(ii)2 $e = (N\Delta\phi)/\Delta t$ $= (9.18 \times 10^{-5})/0.20$ C1 $= 4.59 \times 10^{-4}$ V A1	[3]
		(iii) there is an e.m.f. and a complete circuit OR no resultant e.m.f. from other three sides OR no e.m.f. in AB so yes B1	[1]
6	(a)	packet/quantum of energy M1 energy = hf A1	[2]
	(b)	e.g. threshold frequency outlined max. k.e. independent of intensity max. k.e. dependent on frequency (n.b. NOT proportional) photoelectric current depends on intensity instantaneous emission (1 each, max 3)..... B3	[3]
	(c)	(i) photons have same energy so E_{\max} unchanged intensity OR number of photons per unit time is halved, so $\frac{1}{2}n$ OR n reduced B1 (allow 1 mark for statement that E_{\max} unchanged and n reduced)	
		(ii) photons have higher energy so E_{\max} increases B1 but fewer photons per unit time so n decreases B1 (allow 1 mark for statement that E_{\max} increases and n reduced) (allow any argument based on increased efficiency)	[4]

November 2003

GCE ADVANCED SUBSIDIARY LEVEL AND ADVANCED LEVEL

MARK SCHEME

MAXIMUM MARK: 30

SYLLABUS/COMPONENT: 9702/05

PHYSICS
Paper 5 (Practical (A2))

Question 1

- (b) Temperature of ice/water mixture (-1 to $+2^{\circ}\text{C}$; ignore unit and sf) 1
- (d₁) Readings 3/2/1/0
 6 values of $\ln I$ scores one mark.
 Allow more than 6 sets without penalty.
 Write the number of readings as a ringed total by the table.
 Choose a row in the table.
 Check a value for $\ln(I/A)$. Tick if correct and score one mark.
 If incorrect, write in correct value and do not award the mark.
 Ignore small rounding errors.
 No help from Supervisor scores one mark. Minor help zero. Major help -1 .
 If help has been given then write SR at the top of the front page of the script,
 and give a brief explanation of the type of help that has been given by the
 table of results.
- (d₂) Quality of results 2
 Judge by scatter of points about the line of best fit.
 6 trend scores 2 marks; 5 trend scores one mark; no trend scores zero.
 Allow very shallow curve.
 If an incorrect graph has been plotted these marks cannot be awarded.
 Allow quality marks if the negative signs of $\ln I$ have been omitted.
- (d₃) Column headings 1
 Each column heading must contain a quantity and a unit.
 There must be some distinguishing feature between the quantity and the unit.
 Ignore unit with column heading for $\ln I$.
- (d₄) Consistency of raw readings 2
 All the raw readings of V should be given to the same number of d.p.
 All the raw readings of I should be given to the same number of d.p.
 One mark each. Do not allow 'added zeros'.
- (e₁) Axes 1
 The axes must be labelled with $\ln I$ and V .
 Ignore units on the axes.
 The plotted points must occupy at least half the graph grid in both the x and y
 directions (i.e. 4 large squares in the x -direction and 6 large squares in the y -direction).
 Do not allow more than 3 large squares between the labels on an axis.
 Do not allow awkward scales (e.g. 3:10, 6:10 etc.).

- (e₂) Plotting of points
 All the observations must be plotted.
 Count the number of plots and ring this total on the grid.
 Do not allow plots in the margin area.
 Check one suspect plot. Circle this plot. Tick if correct. If incorrect, mark the correct position with a small cross and use an arrow to indicate where the plot should have been, and do not award the mark. Allow errors up to and including half a small square.
- (e₃) Line of best fit 1
 Only a drawn straight line through a linear trend is allowable for this mark.
 This mark can only be awarded for 5 or more plots on the grid.
 There must be a reasonable balance of points about the drawn line.
 Do not allow a line of thickness greater than half a small square.
 Allow this mark if the trend of plots is a very shallow curve.
- (e₄) Gradient 1
 Ignore any units given with the value.
 Hypotenuse of Δ must be $>$ half the length of line drawn.
 Check the read-offs. Work to half a small square. $\Delta x/\Delta y$ gets zero.
 Values taken from the table that lie on the line to within half a small square are acceptable.
- (e₅) y-intercept 1
 The value may be read from the y-axis or calculated from a point on the line using $y = mx + c$.
- (f₁) $e/kT = \text{gradient}$ 1
 Can be implied in the working.
- (f₂) Value for e 1
 A numerical value is expected. Method of working must be correct.
 1.6×10^{-19} C with no working scores zero.
 Gradient and kelvin must be used and the value of e must be $\dots \times 10^{-19}$ or $\dots \times 10^{-20}$.
- (f₃) Value for I_0 1
 Working must be checked (i.e. $I_0 = e^{y\text{-intercept}}$)
- (f₄) Units of both correct e and I_0 1
 (i.e. a unit of charge and a unit of current)
- (f₅) SF in e 1
 Allow 2 of 3 sf only
- (g) Correct working to give I when $V = 1.0$ V and $T = 373$ K 1
 Method of working must be correct. Ignore unit and sf.
 Do not allow gradient value to be substituted.

20 marks in total.

Question 2

- A1** Procedure OK (i.e. find m_B and acc^n of A or B; change m_B and repeat).
An experiment must have been described for this mark to be awarded.
This mark can be scored even if the method is unworkable.
- A2** Diagram of workable arrangement to find acceleration 1
(e.g. object falls between two markers/light gates/smart pulley at top)
If the diagram is not very detailed refer to text.
- A3** Measurement of mass m_B (e.g. using balance/Newton meter/calibrations on masses) 1
- B1** Valid method of measuring time 1
Accept stopwatch; ticker-tape; light gates; motion sensors and dataloggers; smart pulley etc..
Unworkable methods will not score this mark.
- B2** Correct measurements taken to find acceleration 1
(e.g. measure a distance and $u = 0$ (if distance/time method used)
spacing of successive dots on ticker-tape
some detail of sampling rate if motion sensor/datalogger used)
- B3** Use of results to calculate acceleration 1
(e.g. substitute into $s = ut + \frac{1}{2}at^2$; $a = 25(x_2 - x_1)$ etc..)
If motion sensor used then acceleration obtained from monitor.
- C1** Any one safety precaution 1
(e.g. Catch falling mass in bucket of sand
Care needed to prevent mass B from coming over the top of the pulley
Whiplash from breaking wires etc.
Clamp retort stand to prevent it from falling over.
Do not allow vague 'safety goggles'. Insist on a reason being given.
- D1/2/3** Any further good design features 3
Some of these might be:
Method of supporting the pulley
Mention of friction in the pulley/oil pulley/smooth pulley
Use large distance (to reduce percentage uncertainty)
Limitations of stopwatch methods
Vary s and measure t ; use graph to find a
Repeat the experiment to find values of a for each value of m_B
Some detail about the timing circuit (e.g. stop terminals on timer connected to double pole switch and electromagnet).

10 marks in total.

November 2003

GCE ADVANCED SUBSIDIARY LEVEL AND ADVANCED LEVEL

MARK SCHEME
MAXIMUM MARK: 40
SYLLABUS/COMPONENT: 9702/06 PHYSICS Paper 6 (Options (A2))

Page 1	Mark Scheme	Paper
	A/AS LEVEL EXAMINATIONS - NOVEMBER 2003	06

Categorisation of marks

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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 bracketed information in order to earn the available marks.

UNDERLINING

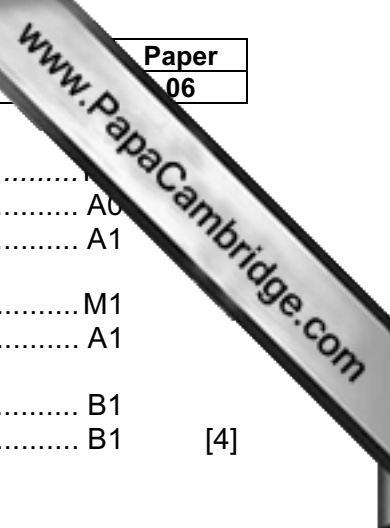
In the marking scheme, underlining indicates information that is essential for marks to be awarded.

Option A – Astrophysics and Cosmology

- 1 (a) galaxy very distant
light (reaching Earth) very faint
light absorption in Earth's atmosphere (do not allow refraction)
light pollution
light scattered..... (1 each, any 4)..... B4 [4]
- (b) 1 arc sec at 6.9×10^5 pc corresponds to 6.9×10^5 AU C1
1 ly = $6.3 (\pm 0.3) \times 10^4$ AU or other valid conversion C1
hence distance = 11 light-years A1 [3]
- 2 (a) If Universe is (static and) infinite B1
every line of sight would end on a star M1
entire sky would be equally bright A1 [3]
- (b) shows infinite (static) Universe to be incorrect
(allow back-credit to (a) for initial supposition B1
does not 'prove' Big Bang model B1 [2]
- 3 (a) (i) electromagnetic radiation B1
either characteristic of black body at 3 K *or* isotropic B1 [2]
- (ii) finite age for Universe B1
indicated by cooling Universe B1
any further detail e.g. irregularities required for galaxy
formation B1 [3]
- (b) radiation takes millions of years to reach Earth B1
provides evidence for higher temperature in the past B1
(Universe is cooling) as it expands B1 [3]

Option F – The Physics of Fluids

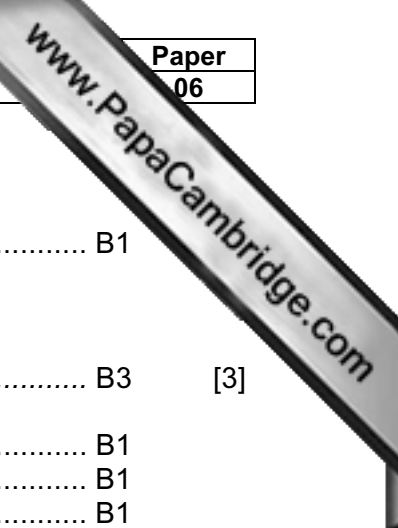
- 4 (a) point where line of action of the upthrust or vertical line through
centre of buoyancy meets centre line of ship B1 [2]
- (b) (when submarine surfaces), water replaced by air in tanks B1
centre of mass and centre of buoyancy will move M1
causing change in separation of these points A1 [3]
- 5 (a) (Bernoulli:) higher speed, lower pressure M1
so A at higher pressure A1 [2]
- (b) $Av = A_N v_N$ or statement (e.g. incompressible) B1
 $v_N/v (= A/A_N) = 2.4^2/0.8^2$ or other correct substitution B1
ratio = 9.0 A0 [2]
- (c) $p_1 - p_2 = \Delta p = \frac{1}{2} \rho (v_2^2 - v_1^2)$ C1
 $740 = \frac{1}{2} \times 990 \times (81v^2 - v^2)$ C1
 $v = 0.14 \text{ m s}^{-1}$ A1 [3]
- 6 (a) (i) upthrust = $\frac{4}{3} \times \pi r^3 \rho_F g$ B1
- (ii) resultant downward force = $\frac{4}{3} \times \pi r^3 (\rho_S - \rho_F) g$
or $\frac{4}{3} \times \pi r^3 (\rho_S - \rho_F) g - \text{viscous force} \dots$ B1 [2]



- (b) $6\pi r\eta v_t = 4/3 \times \pi r^3 (\rho_S - \rho_F)g$ A0
hence, $v_t = kr^2$ A1
constant k discussed A1
- (c) (i) e.g. find speed near 'top' and near 'bottom' of tube M1
using equally spaced markers (or other detail) A1
- (ii) oil flowing past wall of tube B1
would cause extra drag B1 [4]

Option M – Medical Physics

- 7 large uniform magnetic field B1
with superimposed non-uniform field B1
r.f. pulse applied B1
r.f. pulse (from atoms) detected and processed B1
plus any two (one each) from
hydrogen atoms
nuclei have spin and behave as tiny magnets
atoms precess around magnetic field
resonant (Lamour) frequency depends on B-field
de-excitation detected
r.f. pulse detected and processed B1 [6]
- 8 (a) (i) $1/u + 1/v = 1/f = \text{power}$ C1
power = $1/0.10 + 1/(17 \times 10^{-3})$ C1
power = 68.8 D A1
- (ii) least distance of distinct vision = 25 cm (allow 20 cm → 50 cm) .. C1
power = $1/0.25 + 1/(17 \times 10^{-3})$
power = 62.8 D A1 [5]
- (b) (i) change = 6.0 D N.b. answer is (i) – (ii) B1
- (ii) focal length = 16.7 cm B1
convex/converging lens B1 [3]
- 9 (a) (i) lower limit of frequency range correct (15 to 40 Hz) B1
upper limit of frequency range correct (13 to 20 kHz) B1
- (ii) intensity $1.0 \times 10^{-12} \text{ W m}^{-2}$ B1
at about 2 kHz (allow 1 kHz → 3 kHz) B1 [4]
- (b) line 'above' that already drawn B1
both frequency limits showing more limited range B1 [2]

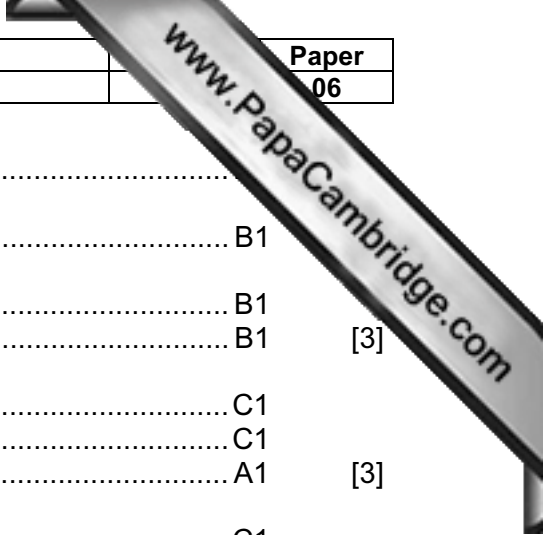


Option P – Environmental Physics

- 10 (a) source of (useful) energy B1
- (b) e.g. less pollution
finite reserves
chemical feedstock etc(1 each, max 3)..... B3 [3]
- 11 (a) dam across river mouth/estuary B1
water retained as tide goes out..... B1
at low tide, water is released..... B1
through turbines... B1 [4]
- (b) mass of water = $8.0 \times 200 \times 10^6 \times 1000 \text{ kg}$ C1
change in p.e = $1.6 \times 10^{12} \times 9.8 \times 4$
= $6.27 \times 10^{13} \text{ J}$ C1
power = $6.27 \times 10^{13} / (3 \times 3600)$
= $5.8 \times 10^9 \text{ W}$ A1 [3]
- (c) e.g. silting up
feeding grounds of birds etc(1 each, max 2)..... B2 [2]
- 12 (a) open closed
closed closed
closed closed
closed open.....(-1 each error or omission)..... B2 [2]
- (b) (i) at end of compression stroke or at beginning of power stroke B1
(ii) at moment when exhaust valve opens B1
(and during) exhaust stroke B1 [3]
- (c) efficient mixing with air or increase surface area..... B1
faster burning B1 [2]

Option T – Telecommunications

- 13 (a) multiple reflections with $i = r$ B1 [1]
- (b) all rays to have same path length/prevent (multipath) dispersion
OR easier to store/handle B1 [1]
- (c) e.g. greater bandwidth
no cross-talk or reduced noise
smaller size and weight
cheaper
security
suited to digital transmission..... (1 each, max 3)..... A3 [3]
- 14 (a) amplitude of carrier wave varies..... M1
in synchrony with (displacement of information) signal A1 [2]
- (b) three vertical lines B1
symmetrical with smaller sidebands B1
at frequencies 70, 75 and 80 kHz..... B1 [3]



- (c) bandwidth = 10 kHz.....
- 15 (a) (i) loss of power/energy/amplitude (not signal)..... B1
- (ii) unwanted energy/power B1
that is random or that covers whole spectrum..... B1 [3]
- (b) number of dB = $10 \lg(P_{OUT}/P_{IN})$ C1
 $63 = 10 \lg (P_{OUT} / (2.5 \times 10^{-6}))$ C1
 $P_{OUT} = 5.0 \text{ W}$ A1 [3]
- (c) attenuation = $10 \lg(5/3.5 \times 10^{-8})$ C1
= 81.5 dB C1
length = $81.5/12 = 6.8 \text{ km}$ A1 [3]