

## MARK SCHEME for the June 2004 question papers

### 9702 PHYSICS

9702/01	Paper 1 (Multiple Choice (AS)), maximum mark 40
9702/02	Paper 2 (Structured Questions (AS)), maximum mark 60
9702/03	Paper 3 (Practical (AS)), maximum mark 25
9702/04	Paper 4 (Structured Questions (A2 Core)), maximum mark 60
9702/05	Paper 5 (Practical (A2)), maximum mark 30
9702/06	Paper 6 (Options (A2)), maximum mark 40

These mark schemes are published as an aid to teachers and students, to indicate the requirements of the examination. They show the basis on which Examiners were initially instructed to award marks. They do 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 June 2004 question papers for most IGCSE and GCE Advanced Level syllabuses.



**Grade thresholds** taken for Syllabus 9702 (Physics) in the June 2004 examination.

	maximum mark available	minimum mark required for grade:		
		A	B	E
Component 1	40	34	32	22
Component 2	60	45	41	27
Component 3	25	19	17	11
Component 4	60	40	33	17
Component 5	30	24	22	14
Component 6	40	21	18	10

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.

**June 2004**

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

**June 2004**

**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 - JUNE 2004	9702	02

### 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.

Page 2	Mark Scheme	Syllabus	Paper
	A/AS LEVEL EXAMINATIONS - JUNE 2004	9702	02

1 (a)	scalar: magnitude only vector: magnitude and direction ( <i>allow scalar with direction</i> ) ( <i>allow 1 mark for scalar has no direction, vector has direction</i> )	B1 B1	[2]
(b)	diagram has correct shape with arrows in correct directions resultant = $13.2 \pm 0.2$ N ( <i>allow 2 sig. fig</i> ) ( <i>for 12.8 <math>\rightarrow</math> 13.0 and 13.4 <math>\rightarrow</math> 13.6, allow 1 mark</i> ) ( <i>calculated answer with a correct sketch, allow max 4 marks</i> ) ( <i>calculated answer with no sketch – no marks</i> )	M1 A1 A2	[4]
		<b>Total</b>	<b>[6]</b>
2 (a) (i)	$\lambda = 0.6$ m	B1	
(ii)	frequency (= $v/\lambda$ ) = $330/0.60$ = 550 Hz ( <i>use of <math>c = 3 \times 10^8</math> ms<sup>-1</sup> scores no marks</i> )	C1 A1	[3]
(b)	amplitude shown as greater than $a$ but less than $2a$ and constant correct phase ( <i>wave to be at least three half-periods, otherwise -1 overall</i> )	B1 B1	[2]
		<b>Total</b>	<b>[5]</b>
3 (a) (i)	scatter of points (about the line)	B1	
(ii)	intercept (on $t^2$ axis) ( <i>note that answers must relate to the graph</i> )	B1	[2]
(b) (i)	gradient = $\Delta y/\Delta x = (100 - 0)/(10.0 - 0.6)$ gradient = $10.6$ (cm s <sup>-2</sup> ) ( <i>allow <math>\pm 0.2</math></i> ) ( <i>Read points to within <math>\pm \frac{1}{2}</math> square. Allow 1 mark for 11 cm s<sup>-2</sup></i> ) <i>i.e. 2 sig fig, -1. Answer of 10 scores 0/2 marks</i>	C1 A1	[2]
(ii)	$s = ut + \frac{1}{2}at^2$ so acceleration = 2 x gradient acceleration = $0.212$ m s <sup>-2</sup>	B1 B1 B1	[3]
		<b>Total</b>	<b>[7]</b>
4 (a) (i)	( $p =$ ) $mv$	B1	
(ii)	$E_k = \frac{1}{2}mv^2$ algebra leading to $E_k = p^2/2m$	B1 M1 A0	[3]
(b) (i)	$\Delta p = 0.035$ (4.5 + 3.5) OR $a = (4.5 + 3.5)/0.14$ = 0.28 N s = 57.1 m s <sup>-2</sup> force = $\Delta p/\Delta t$ (= $0.28/0.14$ ) OR $F = ma$ (= $0.035 \times 575.1$ ) ( <i>allow e.c.f.</i> ) = 2.0 N <i>Note: candidate may add <math>mg = 0.34</math> N to this answer, deduct 1 mark upwards</i>	C1 C1 A1	[4]
(ii)	loss = $\frac{1}{2} \times 0.035 (4.5^2 - 3.5^2)$ = 0.14 J ( <i>No credit for <math>0.28^2/(2 \times 0.035) = 1.12</math> J</i> )	C1 A1	[2]
(c)	e.g. plate (and Earth) gain momentum <i>i.e. discusses a 'system'</i> equal and opposite to the change for the ball <i>i.e. discusses force/momentum</i> so momentum is conserved <i>i.e. discusses consequence</i>	B1 M1 A1	[3]
		<b>Total</b>	<b>[12]</b>

Page 3	Mark Scheme	Syllabus	Paper
	A/AS LEVEL EXAMINATIONS - JUNE 2004	9702	02

5	(a)	(i)	distance = $2\pi nr$	B1	[2]
		(ii)	work done = $F \times 2\pi nr$ (accept e.c.f.)	B1	
	(b)	total work done = $2 \times F \times 2\pi nr$ but torque $T = 2Fr$ hence work done = $T \times 2\pi n$	B1 B1 A0	[2]	
(c)	power = work done/time (= $470 \times 2\pi \times 2400$ )/60 = $1.2 \times 10^5$ W	A1	[2]		
				<b>Total</b>	<b>[6]</b>
6	(a)	When two (or more) waves meet (not 'superpose' or 'interfere') resultant <u>displacement</u> is the sum of individual (displacements)		B1 M1 A1	[3]
	(b)	(i)	any correct line through points of intersection of crests	B1	[2]
		(ii)	any correct line through intersections of a crest and a trough	B1	
(c)	(i)	$\lambda = ax/D$ OR $\lambda = a \sin \theta$ and $\theta = x/D$ $650 \times 10^{-9} = (a \times 0.70 \times 10^{-3})/1.2$ $a = 1.1 \times 10^{-3}$ m	C1 C1 A1	[3]	
	(ii)	1 no change 2 brighter 3 no change (accept stay/remain dark)	B1 B1 B1	[3]	
				<b>Total</b>	<b>[11]</b>
7	(a)	(i)	$P = VI$ current = $60/240 = 0.25$ A	C1 A1	[3]
		(ii)	$R (= V/I) = 240/0.25$ = $960 \Omega$	M1 A0	
	(b)	$R = \rho L/A$ (wrong formula, 0/3) $960 = (7.9 \times 10^{-7} \times L)/(\pi \times \{6.0 \times 10^{-6}\}^2)$ $L = 0.137$ m (use of $A = 2\pi r$ , then allow 1/3 marks only for resistivity formula)	C1 C1 A1	[3]	
(c)	e.g. the filament must be coiled/it is long for a lamp (allow any sensible comment based on candidate's answer for L)		B1	[1]	
				<b>Total</b>	<b>[7]</b>
8	(a)	$V/E = R/R_{\text{tot}}$	or	$0.5 = I \times 3900$	C1
		$1.0/1.5 = R/(R + 3900)$	or	$1.0 = 0.5R/3900$	M1
		$R = 7800\Omega$ .	or	$R = 7800\Omega$	A0
(b)	$V = 1.5 \times (7800/\{7800 + 1250\})$ = $1.29$ V..	or	$I = 1.5/(7800 + 1250)$ $V = IR = 1.29$ V	C1 A1	[2]
(c)	Combined resistance of R and voltmeter is $3900 \Omega$ reading at $0^\circ\text{C}$ is $0.75$ V		C1 A1	[2]	
				<b>Total</b>	<b>[6]</b>



**June 2004**

**GCE ADVANCED SUBSIDIARY LEVEL AND ADVANCED LEVEL**

**MARK SCHEME**

**MAXIMUM MARK: 25**

**SYLLABUS/COMPONENT: 9702/03**

**PHYSICS  
Paper 3 (Practical (AS))**

Page 1	Mark Scheme	Syllabus	Paper
	A/AS LEVEL EXAMINATIONS - JUNE 2004	9702	03

(a)	Pointer B reading to the nearest half millimetre or millimetre Extension correct and to nearest millimetre Condone negative values (i.e. do not penalise 'upside down' rule)	1
(b)	Calculation of spring constant to 2 or 3 sf $k = 0.98/x$ answer must be given in $\text{N m}^{-1}$ . Ignore any negative signs. Do not allow fractions	1
(c)	(i) Diameter of one mass to at least 3 sf Accept value $\pm 0.2$ mm of Supervisor's value	1
	(ii) Percentage uncertainty in diameter One mark for $\Delta d$ (either 0.1 mm or 0.2 mm). One mark for correct ratio and multiplication by 100.	2
	(iii) Cross-sectional area One mark for $A = \pi r^2$ . One mark for correct substitution into $A = \pi r^2$ . ECF from (c)(i). Do not allow the second mark if diameter substituted into $A = \pi r^2$ . Wrong formula scores zero in this section.	2
(d)	(iv) Measurements Expect to see six sets of results in the table (one mark). $l$ must be correct; check a value (one mark). If correct, then tick. If incorrect, then do not award the second mark, and write in the correct value. If pointer reading not shown then this mark cannot be scored. Minor help given by Supervisor, -1. Major help, then -2.	2
	Column headings for $d$ and $l$ (one mark for each correct heading). Expect to see a quantity and a correct unit. There must be a distinguishing feature between the quantity and the unit.	2
	Consistency of $d$ and $l$ readings. Values should be given to the nearest mm. One mark each.	2
(e)	(iii) Gradient is negative. No ecf from misread rule if gradient is positive.	1
	Gradient calculation. $\Delta$ used must be greater than half the length of the drawn line. Check the read-offs (must be correct to half a small square). Ratio must be correct (i.e. $\Delta y / \Delta x$ and not $\Delta x / \Delta y$ ).	1
<b>Graph</b>	Axes Scales must be such that the plotted points occupy at least half the graph grid in both the $x$ and $y$ directions (i.e. at least 6 large squares on the longer side of the grid and at least 4 squares on the shorter side of the grid). Scales must be labelled. Do not allow awkward scales (e.g. 3:10, 6:10 etc.). Allow reversed axes (penalise in section (f))	1
	Plotting of points Count the number of plots and write as a ringed total on the graph grid. All the observations must be plotted or this mark cannot be scored. Check a suspect plot. Circle and tick if correct. If incorrect, show correct position with arrow, and -1. Work to half a small square.	1
	Line of best fit There must be at least 5 trend plots for this mark to be scored. There must be a reasonable balance of points about the line of best fit.	1

Page 2	Mark Scheme	Syllabus	Paper
	A/AS LEVEL EXAMINATIONS - JUNE 2004	9702	03

	Curved trend cannot score this mark.	
	Quality of results	1
	Judge by scatter of points about the line of best fit.	
	There must be at least 5 trend plots for this mark to be scored.	
	Incorrect trend (i.e. positive gradient) will not score this mark.	
(f)	Gradient equated with $\frac{-\rho_w Ag}{k}$ . Condone misuse of negative sign.	1
	Value in range 800 – 1200 kg m <sup>-3</sup> (or 0.80 to 1.20g cm <sup>-3</sup> )	1
	This mark cannot be scored if the gradient has not been used.	
	This mark will not be scored if there is a Power Of Ten error in the working or reversed axes.	
	Unit correct (kg m <sup>-3</sup> )	1
	If another unit has been given then it must be consistent with the value.	
	Significant figures in $\rho_w$	1
	Accept 2 or 3 sf only. Ignore trailing zeros (except $\rho_w = 1000$ )	
(g)	Difficulty	1
	e.g. hard to see the water surface/surface tension problems/refraction effects/parallax errors. Do not allow vague 'human error'.	
	Improvement	1
	e.g. use calibrated beakers or masses/paper behind/mirror behind/travelling microscope	
	Do not allow 'use dye'/repeat readings.	

**25 marks in total**

Page 3	Mark Scheme	Syllabus	Paper
	A/AS LEVEL EXAMINATIONS - JUNE 2004	9702	03

June 2004

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	Syllabus	Paper
	A/AS LEVEL EXAMINATIONS - JUNE 2004	9702	04

### Categorisation of marks

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**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**

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Page 2	Mark Scheme	Syllabus	Paper
	A/AS LEVEL EXAMINATIONS - JUNE 2004	9702	04

1	(a)	charge is quantised/enabled electron charge to be measured	B1	[1]
	(b)	<u>all</u> are (approximately) $n \times (1.6 \times 10^{-19} \text{ C})$ so $e = 1.6 \times 10^{-19} \text{ C}$ (allow 2 sig. fig. only <i>summing charges and dividing ten, without explanation scores 1/2</i> )	M1 A1	[2]
		<b>Total</b>		[3]
2	(a)	<u>mean</u> (value of the) <u>square</u> of the speeds (velocities) of the atoms/particles/molecules	M1 A1	[2]
	(b)	(i) $\rho = \frac{1}{3} \rho < c^2 >$ $< c^2 > = 3 \times 2 \times 10^5 / 2.4 = 2.5 \times 10^5$ r.m.s speed = $500 \text{ ms}^{-1}$	C1 C1 A1	[3]
		(ii) new $< c^2 > = 1.0 \times 10^6$ or $< c^2 >$ increases by factor of 4 $< c^2 > \propto T$ or $3/2 kT = 1/2 m < c^2 >$ $T = \{(1.0 \times 10^6) / (2.5 \times 10^5)\} \times 300$ $= 1200 \text{ K}$	C1 C1 A1	[3]
		<b>Total</b>		[8]
3	(a)	(i) (force) = $GM_1M_2/(R_1 + R_2)^2$ (ii) (force) = $M_1R_1\omega^2$ or $M_2R_2\omega^2$	B1 B1	[2]
	(b)	$\omega = 2\pi/(1.26 \times 10^8)$ or $2\pi/T$ $= 4.99 \times 10^{-8} \text{ rad s}^{-1}$ <i>allow 2 s.f.: <math>1.59\pi \times 10^{-8}</math> scores 1/2</i>	C1 A1	[2]
	(c)	(i) reference to either taking moments (about C) or same (centripetal) force $M_1R_1 = M_2R_2$ or $M_1R_1\omega^2 = M_2R_2\omega^2$ hence $M_1/M_2 = R_2/R_1$	B1 B1 A0	[2]
		(ii) $R_2 = 3/4 \times 3.2 \times 10^{11} \text{ m} = 2.4 \times 10^{11} \text{ m}$ $R_1 = (3.2 \times 10^{11}) - R_2 = 8.0 \times 10^{10} \text{ m}$ (allow vice versa) <i>if values are both wrong but have ratio of four to three, then allow 1/2</i>	A1 A1	[2]
	(d)	(i) $M_2 = \{(R_1 + R_2)^2 \times R_1 \times \omega^2\} / G$ (any subject for equation) $= (3.2 \times 10^{11})^2 \times 8.0 \times 10^{10} \times (4.99 \times 10^{-8})^2 / (6.67 \times 10^{-11})$ $= 3.06 \times 10^{29} \text{ kg}$	C1 C1 A1	[4]
		(ii) less massive (only award this mark if reasonable attempt at (i)) ( $9.17 \times 10^{29} \text{ kg}$ for more massive star)	B1	[4]
		<b>Total</b>		[12]
4	(a)	e.g. amplitude is not constant or wave is damped <i>do not allow 'displacement constant'</i> should be (-)cos, (not sin)	B1 B1	[2]
	(b)	$T = 0.60 \text{ s}$ $\omega = 2\pi/T = 10.5 \text{ rad s}^{-1}$ (allow $10.4 \rightarrow 10.6$ )	C1 A1	[2]
	(c)	same period displacement always less amplitude reducing appropriately <i>for 2<sup>nd</sup> and 3<sup>rd</sup> marks, ignore the first quarter period</i>	B1 M1 A1	[3]
		<b>Total</b>		[7]

Page 3	Mark Scheme	Syllabus	Paper
	A/AS LEVEL EXAMINATIONS - JUNE 2004	9702	04

5	(a)	the (value of the) direct current	M1	[2]
		that dissipates (heat) energy at the same rate (in a resistor) <i>allow 'same power' and 'same heating effect'</i>	A1	
	(b)	$\sqrt{2}I_{\text{rms}} = I_0$	B1	[1]
	(c)	(i) power $\propto I^2$ or $P = I^2R$ or $P = VI$ ratio = 2.0 (allow 1 s.f.)	C1	[2]
		(ii) advantage: e.g. easy to change the voltage disadvantage: e.g. cables require greater insulation ..... rectification – with some justification	B1	
	(d)	(i) 3.0 A (allow 1 s.f.)	A1	[2]
		(ii) 3.0 A (allow 1 s.f.)	A1	
			<b>Total</b>	<b>[9]</b>
6		0 - + (-1 for each error)	B2	[6]
		+ + 0 (-1 for each error)	B2	
		+ + 0 (-1 for each error)	B2	
			<b>Total</b>	<b>[6]</b>
7	(a)	$\lambda = h/p$ or $\lambda = h/mv$ with $\lambda$ , $h$ and (or $mv$ ) $p$ identified	M1	[2]
			A1	
	(b)	$E = \frac{1}{2}mv^2$ $= p^2/2m$ or $v = \sqrt{(2E/m)}$ , <u>hence</u> $\lambda = h/\sqrt{(2mE)}$	C1 M1 A0	[2]
	(c)	$E = qV$ $(0.4 \times 10^{-9})^2 \times 2 \times 9.11 \times 10^{-31} \times 1.6 \times 10^{-19} \times V = (6.63 \times 10^{-34})^2$ $V = 9.4 \text{ V}$ (2 s.f. scores 2/3)	C1 C1 A1	[3]
			<b>Total</b>	
				<b>[7]</b>
8	(a)	S shown at the peak	B1	[1]
	(b)	(i) Kr and U on right of peak in correct relative positions	B1	[1]
		(ii)1 binding energy of U-235 = $2.8649 \times 10^{-10} \text{ J}$ binding energy of Ba-144 = $1.9211 \times 10^{-10} \text{ J}$ binding energy of Kr-90 = $1.2478 \times 10^{-10} \text{ J}$ energy release = $3.04 \times 10^{-11} \text{ J}$ (-1 if 1 or 2 s.f.)	C2 A1	[3]
	2	$E = mc^2$ $m = (3.04 \times 10^{-11})/(3.0 \times 10^8)^2 = 3.38 \times 10^{-28} \text{ kg}$ (ignore s.f.)	C1 A1	[2]
	(iii)	e.g. neutrons are single particles, neutrons have no binding energy per nucleon	B1	[1]
			<b>Total</b>	<b>[8]</b>

**June 2004**

**GCE ADVANCED SUBSIDIARY LEVEL AND ADVANCED LEVEL**

**MARK SCHEME**

**MAXIMUM MARK: 30**

**SYLLABUS/COMPONENT: 9702/05**

**PHYSICS  
Paper 5 (Practical (A2))**



Page 1	Mark Scheme	Syllabus	Paper
	A/AS LEVEL EXAMINATIONS - JUNE 2003	9702	05

### Question 1

- (a) (v) Sensible use of fiducial marker placed at centre of oscillation/mean position/  
equilibrium position 1
- (a) (vi) Measurements 3  
 6 sets 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 values for  $T^2d$  &  $d^2$ . Tick if correct.  
 One mark each. If incorrect, write in correct values. Ignore small rounding errors.  
 Impossible values of  $d$  or  $t$ , -1. Misread stopwatch -1.  
 Minor help from the Supervisor, -1. Major help, then -2.
- Repeats 1  
 Expect to see at least two sets of readings of raw times.
- At least half the raw times > 20 s 1
- Column heading for  $T^2d$  1  
 The column heading must contain a quantity and a unit (e.g.  $s^2 m$  or  $s^2 cm$ ).  
 There must be some distinguishing mark between the quantity and the unit.
- Consistency 1  
 Apply to  $d$  (all values of  $d$  must be given to the nearest millimetre).
- SF in  $d^2$  1  
 Check by row in the table; compare with raw values of  $d$ .  
 The number of significant figures in  $d^2$  must be the same as, or one better than,  
 the number of significant figures in  $d$ .
- (a) (vii) Justification of sf in  $d^2$  1  
 Answer must relate the number of sf in  $d$ .  
 Do not allow answers in terms of decimal places.

Page 2	Mark Scheme	Syllabus	Paper
	A/AS LEVEL EXAMINATIONS - JUNE 2003	9702	05

<b>(b) (i)</b>	<p><b>Axes</b> <span style="float: right;"><b>1</b></span></p> <p>The axes must be labelled with the quantities plotted. Ignore units on the axes.  The plotted points must occupy at least half the graph grid in both the <math>x</math> and <math>y</math> directions (i.e. 4 large squares in the <math>x</math>-direction and 6 large squares in the <math>y</math>-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, 8:10 etc.).  If axes reversed (i.e. <math>d^2</math> against <math>T^2d</math>) then zero and ecf.</p> <p><b>Plotting of points</b> <span style="float: right;"><b>1</b></span></p> <p>All the observations must be plotted.  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 score zero. Allow errors up to and including half a small square.</p> <p><b>Line of best fit</b> <span style="float: right;"><b>1</b></span></p> <p>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.</p> <p><b>Quality of results</b> <span style="float: right;"><b>1</b></span></p> <p>Judge by scatter of points about the line of best fit.  5 trend plots can score this mark. Curved trend scores zero.  This mark can only be scored if a graph of <math>d^2</math> against <math>T^2d</math> or <math>T^2d</math> against <math>d^2</math> has been plotted.</p>
<b>(b) (iii)</b>	<p><b>Gradient</b> <span style="float: right;"><b>1</b></span></p> <p>Ignore any units given with the value.  Hypotenuse of <math>\Delta</math> must be <math>&gt;</math> half the length of line drawn.  Check the read-offs. Work to half a small square. <math>\Delta x/\Delta y</math> gets zero.  Values taken from the table that lie on the line to within half a small square are acceptable.</p> <p><b>y-intercept</b> <span style="float: right;"><b>1</b></span></p> <p>The value must be read to the nearest half square.  Allow calculation from <math>y = mx + c</math></p>
<b>(c)</b>	<p><b><math>k =</math> gradient of line of best fit</b> <span style="float: right;"><b>1</b></span></p> <p>A numerical value is expected. Substitution method scores zero.</p> <p><b><math>A =</math> candidate's value for the y-intercept</b> <span style="float: right;"><b>1</b></span></p> <p>A numerical value is expected. Substitution method scores zero.</p> <p><b>Unit of <math>A</math> correct and consistent with value (e.g. <math>s^2 \text{ m}</math> or <math>s^2 \text{ cm}</math>)</b> <span style="float: right;"><b>1</b></span></p> <p>If incorrect allow ecf from column heading in table.</p>
<b>(d)</b>	<p><b>Value of <math>T</math> when <math>d = 1.0 \text{ cm}</math></b> <span style="float: right;"><b>1</b></span></p> <p>Must be in range 3 – 8 s.  A power of ten error anywhere in the working will result in this mark not being scored.  Working must be checked. Bald answer scores zero.</p>

**20 marks in total**

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## Question 2

- A1** Sensible choice of equipment and basic idea OK 1  
Source/magnetic field/detector  
Inappropriate choice of apparatus cannot score this mark.  
Ignore lead or aluminium plates at this stage.
- A2** Method of measuring angle of deflection 1  
(e.g. detector at edge of large protractor/lengths & trig ratio used)  
Do not allow vague 'use a protractor'.  
This mark can be awarded even if the detector has not been specified.
- A3** Use Hall probe/search coil/current balance to measure field strength 1  
Allow Helmholtz coils expression if Helmholtz coils used.  
Allow a current or voltage measurement as indication of field strength (as  $I \propto B$ )
- B1** Method of removing  $\alpha$  radiation or statement that  $\alpha$  radiation almost undeflected 1  
Use paper or distance to detector > few cm/air to absorb alpha  
Could be shown on the diagram. Do not allow lead/aluminium plate.  
Allow  $\alpha$  to be shown deflecting in the opposite direction to  $\beta$  on the diagram.
- B2**  $\gamma$  -radiation undeflected/deflect beta particles using electric field 1  
Can be shown on diagram. Do not allow 'absorb gamma with lead plate'.
- B3** Workable procedure for uniform fields 1  
Measure deflection and field strength; change current in coils and repeat.
- C1/2** Any two safety precautions 2  
e.g. use source handling tool  
store source in lead lined box when not in use  
do not point source at people/do not look directly at source  
place lead sheet at 'end of experiment' to absorb unwanted rays
- D1/2** Any good/further detail. Examples of creditworthy points might be: 2  
Type of detector (GM tube/film/screen/scintillation counter). N/a cloud chamber/CRO  
Repeat readings to allow for randomness of activity  
Correct deflection of beta on diagram/left hand rule ideas (diagram or written)  
Separation of coils = radius of coils for uniform field  
Discussion of count rate (and not just count)  
Plane of semiconductor slice is perpendicular to field lines  
Calibrate Hall probe  
Detail of calibration  
Collimation ideas  
Allow other valid points. Any two, one mark each.  
B1 = B2 = B3 = 0 if lead or aluminium plate is placed in front of the source. Allow thin  
(less than 1 mm) sheet or foil

**10 marks in total.**

June 2004

GCE ADVANCED SUBSIDIARY LEVEL AND ADVANCED LEVEL

MARK SCHEME

MAXIMUM MARK: 40

SYLLABUS/COMPONENT: 9702/06

PHYSICS  
Paper 6 (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 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.

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### Option A – Astrophysics and Cosmology

1 (a)	In an infinite and static Universe every line of sight should end on a star (or spherical shells argument) so sky at night should be bright	M1 M1 A1	[3]
(b)	For expanding Universe finite age limits size (1) light from distant galaxies is red-shifted out of visible (1) light from distant young stars not yet reached Earth (1) <i>Any two points, maximum 2</i>	B2	[2]
		<b>Total</b>	<b>[5]</b>
2 (a)	1 pc = 3.26 ly (allow 3.3 ly) distance = $16/3.26 = 4.9$ pc	C1 A1	[2]
(b)	base line is 2 AU angle = $2 \times 1/4.9$ = 0.41 arc sec	C1 B1	[2]
		<b>Total</b>	<b>[4]</b>
3 (a)	Universe is same everywhere/homogeneous/isotropic when considered on a sufficiently large scale	M1 A1	[2]
(b)	characteristic of (black body) 3 K radiation CMB is highly isotropic/same from all directions This indicates that the Universe is highly uniform	B1 M1 A1	[3]
		<b>Total</b>	<b>[5]</b>
4 (a)	e.g. planet observed by reflected light this is too faint (against the starlight) e.g. physically too small to be resolved (at such great distances) (any sensible suggestion (B1) with some further comment (B1) – max 4)	B1 B1 B1 B1	[4]
(b)	e.g. change in intensity of starlight as the star is eclipsed e.g. wobble in position of star (M1) as planet orbits star (A1) (any sensible suggestion plus some further comment – max 2)	M1 A2	[2]
		<b>Total</b>	<b>[6]</b>

### Option F – The Physics of Fluids

5 (a)	force = upthrust – weight of polystyrene in air $25 = V \times (1000 - 15) \times 9.8$ $V = 2.6 \times 10^{-3} \text{ m}^3$	C1 C1 A1	[3]
(b)	boat will tend to right itself/float higher in the water if at positions B	M1 A1	[2]
		<b>Total</b>	<b>[5]</b>
6 (a)	if air is streamline air above car moves faster than air below so (by Bernoulli) pressure above is lower than below and car experiences an upward force	B1 M1 M1 A1	[4]
(b)	the spoiler causes turbulence turbulence prevents the lift force from developing	M1 A1	[2]
		<b>Total</b>	<b>[6]</b>

7 (a)	symmetrical pattern on above/below sphere	M1	
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		lines closer near top and bottom of sphere	A1	[2]
(b)	(i)	force on particle = $\frac{4}{3} \pi r^3 (\rho - \rho_w)g$ $= \frac{4}{3} \times \pi \times (4.5 \times 10^{-7})^3 \times (2.9 \times 10^3) \times 9.8$ $= 1.08(5) \times 10^{-14} \text{ N}$ $1.085 \times 10^{-14} = 6 \times \pi \times (4.5 \times 10^{-7}) \times 9.5 \times 10^{-4} \times v$ $v = 1.35 \times 10^{-6} \text{ m s}^{-1}$	C1 C1 C1	
	(ii)	in 1.0 hours, particles move $1.35 \times 10^{-6} \times 3600 (= 4.85 \times 10^{-3} \text{ m})$ fraction = $(8.0 - 4.85)/8.0$ $= 0.39$ (allow 2/3 for answer of 0.61)	A1 B1 C1 A1	[4]
			A1	[3]
			<b>Total</b>	<b>[9]</b>
<b>Option M – Medical Physics</b>				
8	(a)	piezo-electric/quartz crystal across which is applied an <u>alternating</u> voltage crystal vibrates at its resonant frequency	B1 B1 B1 B1	[4]
	(b)	(i) trace length = 4.0 mm distance = speed x time = $1450 \times 0.4 \times 10 \times 10^{-6}$ $= 5.8 \times 10^{-3} \text{ m}$ thickness = 0.29 cm	C1 C1 A1	[3]
	(ii)	trace length = 5.2 cm thickness = 4.1 cm	C1 A1	[2]
			<b>Total</b>	<b>[9]</b>
9	(a)	ability of eye to form focused images of objects at different distances from the eye	M1 A1	[2]
	(b)	(i) 25 cm (allow $\pm 5$ cm) to infinity (ii) (for close-up vision), power = $1/0.25 - 1/1.2$ $= 3.17 \text{ D}$ (for distance vision), power = $-0.25 \text{ D}$	B1 C1 A1 A1	[1] [3]
	(iii)	use bifocal lenses further detail e.g. region of lens identified	B1 B1	[2]
			<b>Total</b>	<b>[8]</b>
10		loss of hearing at higher frequencies loss of sensitivity (at about 3 kHz) further comment on either e.g. upper limit should be about 15 kHz, at 3 kHz, I.L. should be about 10 dB (or less)	B1 B1 B1	[3]
			<b>Total</b>	<b>[3]</b>
<b>Option P – Environmental Physics</b>				
11	(a)	(i) Sun's energy incident per unit time per unit area on the cross-sectional area of the Earth (ii) solar constant = $(3.9 \times 10^{26})/(4\pi \times \{1.5 \times 10^{11}\}^2)$ $= 1380 \text{ W m}^{-2}$	M1 A1 C1 A1	[2] [2]
	(b)	at C, greater thickness of atmosphere so more absorption also larger area (for beam of a particular width) explanation of 'larger area' (e.g. diagram or $1/\cos\theta$ , with $\theta$ clear)	B1 B1 B1	[3]
			<b>Total</b>	<b>[7]</b>
12	(a)	e.g. daily variations as industry opens up/closes down daily variations with TV programmes, cooking meals, lighting seasonal variations with heating/AC, length of day (any reasonable response, 1 for daily, 1 for seasonal plus 1 more) 1 each, max 3	B3	[3]
	(b)	power demand may change <u>suddenly</u> pumped water scheme can be brought onto full load in a short time can use surplus energy at times of low demand to pump water 'back up'	B1 B1 B1	[3]
			<b>Total</b>	<b>[6]</b>

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13	(a)	(i)	work done	= $\rho\Delta V$	C1	
				= $55 \times 10^5 \times (150 - 40) \times 10^{-6}$	M1	
				= 605 J	A0	
		(ii)	energy wasted	= $(2500 + 400) - (1020 + 605) = 1275 \text{ J}$	A1	
		(iii)	efficiency	= $1625/2900$	C1	
				= 0.56 or 56%	A1	[5]
	(b)		similarity:	e.g. compression/expansion are both adiabatic	B1	
			difference:	e.g. in petrol engine, energy input at constant volume	B1	[2]
			<b>Total</b>			[7]

#### Option T - Telecommunications

14	(a)		$10 \lg(P_1/P_2)$ or $10 \lg(P_2/P_1)$	B1	[1]	
		(b)	$10 \lg(25.4/1.0) = 14 \text{ dB}$ above the reference level	A1 A1	[2]	
	(c)	(i)	loss of signal power/energy	B1		
		(ii)	length = $14/3.2$ = 4.4 km	C1 A1	[3]	
				<b>Total</b>	[6]	
15	(a)		amplitude of the carrier wave varies in synchrony with the displacement of the information signal	M1 A1	[2]	
		(b)	(i)	broadcast frequency = 50 kHz $3.0 \times 10^8 = 50 \times 10^3 \times \lambda$ $\lambda = 6000 \text{ m}$	C1 C1 A1	
			(ii)	bandwidth = 7.0 kHz	A1	
			(iii)	maximum frequency = 3.5 kHz	A1	[5]
				<b>Total</b>	[7]	
16	(a)		period (or orbit) is 24 hours equatorial (orbit) (satellite orbits) from west to east	B1 B1 B1	[3]	
		(b)	(i)	allow 2 GHz $\rightarrow$ 40 GHz	B1	
			(ii)	prevent swamping of the (low power) signal received from Earth	B1	[2]
	(c)		advantage: e.g. fewer satellites required aerials point in fixed direction/no tracking required (any sensible suggestion, 1 mark)	B1		
			disadvantage: e.g. noticeable time delay in messages reception difficult at Poles (any sensible suggestion, 1 mark)			
			<b>Total</b>	B1	[2]	
					[7]	