## UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Level and GCE Advanced Subsidiary Level

## MARK SCHEME for the May/June 2006 question paper

## 9702 PHYSICS

9702/04

Paper 4

Maximum raw mark 60

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.

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

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Page 1Mark SchemeSyllabusPaperGCE A/AS Level - May/June 20069702041(a) centripetal force is provided by gravitational forceB1 $m^2/r = GMm/r$ B1hence $v = V(GM/r)$ A0(b) (i) $E_x (= 1/2m)^2) = GMm/2r$ B1(ii) $E_F = -GMm/r$ B1(iii) $E_F = -GMm/r$ B1(iii) $E_T = -GMm/r + GMm/2r$ C1 $= -GMm/2r$ C1		<b>D</b> -			amicpaper		7
1(a) centripetal force is provided by gravitational force $m^2/r = GMm/r^2$ hence $v = \sqrt{(GM/r)}$ B11(a) centripetal force is provided by gravitational force $m^2/r = GMm/r^2$ B1(b) (i) $E_x (= \sqrt{m^2}) = GMm/2r$ B1(ii) $E_r = -GMm/r$ B1(iii) $E_r = -GMm/r$ B1(iii) $E_r = -GMm/r$ B1(iii) $E_r = -GMm/r$ C1(iii) $E_r = -GMm/r$ C1(iii) $E_r = -GMm/r$ C1(i) $f_r$ decreases then - $GMm/2r$ becomes more negative or $GMm/2r$ and $r$ decreases(ii) $E_x = GMm/2r$ and $r$ decreases(ii) $E_x = GMm/2r$ and $r$ decreases(iii) $v$ lower of gas at $1.85 \times 10^5$ Pa $= (2.5 \times 10^7 \times 4.00 \times 10^4)/(1.85 \times 10^5)$ $= (2.5 \times 10^7 \times 4.00 \times 10^4 \times 10^6)/(8.31 \times 290)$ $= 415$ mol(ii) volume of gas at $1.85 \times 10^5$ Pa $= (2.5 \times 10^7 \times 4.00 \times 10^4)/(1.85 \times 10^5)$ $= 5.41 \times 10^6$ cm <sup>3</sup> $x_0 > 5.41 \times 10^6 = 4.00 \times 10^4 + 7.24 \times 10^3$ (i) $x_0 = 420$ for fails to allow for gas in cylinder, max 2/3)(ii) acceleration to $rais to allow for gas in cylinder, max 2/3)$ (b) $2040 \pm 20 \Omega$ corresponds to $15.0 \pm 0.2 \simeq C$ $T/K = T/^{1/5} C + 273.15$ (allow $273.2$ )temperature is $288.2$ K(ii) (i) $1.0$ (ii) acceleration $= 4\pi^2 f$ a $= (80m)^2 \times 42 \times 10^3$ $= 16$ for $1^{-1}$ (iii) acceleration $= 4\pi^2 f$ a $= (60m)^2 \times 42 \times 10^3$ $= 2650$ m s <sup>2</sup> <t< th=""><th>_</th><th>Page</th><th>91</th><th></th><th></th><th></th><th>_</th></t<>	_	Page	91				_
(ii) $E_p = -GMm / r$ B1[1](iii) $E_p = -GMm / r + GMm / 2r$ C1 $= -GMm / 2r$ C1(c)(i)if $E_1$ decreases than $-GMm / 2r$ becomes more negative or $GMm / 2r$ becomes larger so $r$ decreasesM1(c)(i)if $E_1$ decreases than $-GMm / 2r$ becomes more negative or $GMm / 2r$ becomes largerM1(ii) $E_k = GMm / r$ and $r$ decreasesM1(iii) $E_k = GMm / r$ $r$ decreases(iii) $E_k = GMm / r$ and $r$ decreasesM1(iii) $e.g.$ fixed mass/ amount of gas ideal gas (any two, 1 each)E2(i)(i) $n = pV / RT$ $= (2.5 \times 10^7 \times 4.00 \times 10^4 + 7.24 \times 10^5) / (8.31 \times 290)$ C1 $= 5.41 \times 10^6$ cm³(ii)volume of gas at 1.85 \times 10^6 Pa $= (2.5 \times 10^7 \times 4.00 \times 10^4) / (1.85 \times 10^6)$ $= 5.41 \times 10^6$ cm³C1 $R = 7.41 \times 10^6$ cm³(ii)volume of gas at 1.85 \lambda 10^6 Pa $= (2.5 \times 10^7 \times 4.00 \times 10^4) / (1.85 \times 10^6)$ $= 5.41 \times 10^6$ cm³C1 $R = 7.41 \times 10^6$ cm³(iii)volume of gas at 1.85 \lambda 10^6 Pa $= (2.5 \times 10^7 \times 4.00 \times 10^4) / (1.85 \times 10^6)$ $= 5.41 \times 10^6$ cm³C1 $R = 7.41 \times 10^6$ (iii)volume of gas at 1.85 \lambda 10^6 Pa $= (2.5 \times 10^7 \times 4.00 \times 10^4) / (1.85 \times 10^6)$ $= 5.41 \times 10^6$ cm³C1 $R = 7.41 \times 10^6$ (ii)argulatent of graph is (a measure of) the sensitivity the gradient varies with temperature $R = 1/7 \times 10^6$ cm²C1 $R = 1/7 \times 10^6$ cm²(b)(0)1.0E1[1] (ii)40 Hz(c)(i)speed $= 2\pi fa$ $= (26\pi)^7 \times 4.02 \times 10^3$ $= 2650  $	1	n		centripetal force is provided by gravitational force $nv^2 / r = GMm / r^2$			
(iii) $E_{T} = -GMm / r + GMm / 2r$ (iii) $E_{T} = -GMm / 2r$ . (c) (i) if $E_{T}$ decreases then $-GMm / 2r$ becomes more negative or $GMm / 2r$ becomes larger so $r$ decreases (ii) $E_{K} = GMm / 2r$ and $r$ decreases so $(E_{K}$ and $v$ increases (iii) $E_{K} = GMm / 2r$ and $r$ decreases so $(E_{K}$ and $v$ increases (any two, 1 each) (b) (i) $n = pV/RT$ $= (2.5 \times 10^{7} \times 4.00 \times 10^{4} \times 10^{6}) / (8.31 \times 290)$ = 415  mol (ii) volume of gas at $1.85 \times 10^{5} \text{ Pa} = (2.5 \times 10^{7} \times 4.00 \times 10^{4}) / (1.85 \times 10^{5})$ $= 5.41 \times 10^{6} \text{ cm}^{3}$ (ii) volume of gas at $1.85 \times 10^{5} \text{ Pa} = (2.5 \times 10^{7} \times 4.00 \times 10^{4}) / (1.85 \times 10^{5})$ $= 5.41 \times 10^{6} \text{ cm}^{3}$ (iii) volume of gas at $1.85 \times 10^{5} \text{ Pa} = (2.5 \times 10^{7} \times 4.00 \times 10^{4}) / (1.85 \times 10^{5})$ $= 5.41 \times 10^{6} \text{ cm}^{3}$ (ii) volume of gas at $1.85 \times 10^{5} \text{ Pa} = (2.5 \times 10^{7} \times 4.00 \times 10^{4}) / (1.85 \times 10^{5})$ $= 5.41 \times 10^{6} \text{ cm}^{3}$ (iii) volume of gas at $1.85 \times 10^{5} \text{ Pa} = (2.5 \times 10^{7} \times 4.00 \times 10^{4}) / (1.85 \times 10^{5})$ $= 5.41 \times 10^{6} \text{ cm}^{3}$ (iv) $n = 741$ (answer 740  or fails to allow for gas in cylinder, max 2/3) (b) $2040 \pm 20 \Omega$ corresponds to $15.0 \pm 0.2 \degree C$ $T/K = T/\degree C + 273.15$ (allow 273.2) temperature is $288.2 \text{ K}$ (c) (i) speed $= 2\pi fa$ $= (20\pi)^{3} \times 42 \times 10^{3}$ $= 10.6 \text{ m s}^{-1}$ (c) (i) S marked correctly (on 'horizontal line through centre of wheel) B1 (c) (i) S marked correctly (on 'horizontal line through centre of wheel)		(b)	(i)	$E_{\rm K} (= \frac{1}{2}mv^2) = GMm / 2r$		B1	[1]
= -GMm / 2r. $ = -GMm / 2r. $ $ = -GMm / 2r. $ $ = -GMm / 2r becomes larger so r decreases $ $ = -GMm / 2r becomes larger so r decreases $ $ = -GMm / 2r becomes larger so r decreases $ $ = -GMm / 2r and r decreases $ $ = -Cm / 2r and r decreases$			(ii)	$E_{\rm P}$ = - GMm / r		B1	[1]
M1 so r GMm / 2r becomes larger so r decreasesM1 A1[2](ii) $E_{K} = GMm / 2r$ and r decreases so $(E_{K} \text{ and })$ v increasesM1 A1[2](a) e.g. fixed mass/ amount of gas ideal gas (any two, 1 each)B2[2](b) (i) $n = pV / RT$ $= (2.5 × 10^{7} × 4.00 × 10^{4} × 10^{6}) / (8.31 × 290)$ $= 415 \text{ mol}$ C1 C1 $= 5.41 × 10^{6} \text{ cm}^{3}$ C1 C1 $= 5.41 × 10^{6} \text{ cm}^{3}$ (ii) volume of gas at $1.85 \times 10^{5} \text{ Pa} = (2.5 × 10^{7} × 4.00 × 10^{4}) / (1.85 × 10^{5})$ $= 5.41 × 10^{6} \text{ cm}^{3}$ C1 C1 $= 5.41 × 10^{6} \text{ cm}^{3}$ 3(a) gradient of graph is (a measure of) the sensitivity the gradient varies with temperatureM1 A1 A1(b) $2040 \pm 20 \Omega$ corresponds to $15.0 \pm 0.2 \text{ °C}$ $T / K = T / °C + 273.15$ (allow 273.2)C1 A1 C14(a) (i) $1.0$ $= 2\pi \times 40 \times 42 \times 10^{3}$ $= 10.6 \text{ m s}^{-1}$ C1 A1 A1(ii) acceleration $= 4\pi f^{2} f a$ $= (80\pi)^{2} \times 42 \times 10^{-3}$ $= 2650 \text{ m s}^{-2}$ C1 A1 A1(c) (i) S marked correctly (on 'horizontal line through centre of wheel)B1			(iii)				[2]
1       so ( $E_k$ and) $v$ increases       A1       [2]         2       (a) e.g. fixed mass/ amount of gas ideal gas (any two, 1 each)       B2       [2]         (b) (i) $n = pV/RT$ C1       C1 $= (2.5 \times 10^7 \times 4.00 \times 10^4 \times 10^6) / (8.31 \times 290)$ C1       A1 $= 415 \text{ mol}$ A1       [3]         (ii) volume of gas at $1.85 \times 10^5 \text{ Pa} = (2.5 \times 10^7 \times 4.00 \times 10^4) / (1.85 \times 10^5)$ C1 $= 5.41 \times 10^6 \text{ cm}^3$ C1 $x_0, 5.41 \times 10^6 = 4.00 \times 10^4 + 7.24 \times 10^3 N$ C1 $N = 741$ (answer 740 or fails to allow for gas in cylinder, max 2/3)       A1         3       (a) gradient of graph is (a measure of) the sensitivity the gradient varies with temperature       M1         (b) $2040 \pm 20 \Omega$ corresponds to $15.0 \pm 0.2 \text{ °C}$ C1 $T/K = T/ \text{ °C} + 273.15$ (allow 273.2)       C1         temperature is $288.2 \text{ K}$ A1         4       (a) (i) $1.0$ B1         (ii) A0 Hz       C1         (iii) acceleration $= 4\pi^2 f$ a       C1 $= (80\pi)^2 \times 42 \times 10^3$ C1 $= (80\pi)^2 \times 42 $		(c)	(i)	or <i>GMm</i> / 2 <i>r</i> becomes larger			[2]
ideal gas (any two, 1 each)       B2       [2]         (b) (i) $n = pV/RT$ = (2.5 × 10 <sup>7</sup> × 4.00 × 10 <sup>4</sup> × 10 <sup>6</sup> ) / (8.31 × 290) = 415 mol       C1       C1         (ii) volume of gas at 1.85 × 10 <sup>5</sup> Pa = (2.5 × 10 <sup>7</sup> × 4.00 × 10 <sup>4</sup> ) / (1.85 × 10 <sup>5</sup> ) = 5.41 × 10 <sup>6</sup> cm <sup>3</sup> C1         (ii) volume of gas at 1.85 × 10 <sup>5</sup> Pa = (2.5 × 10 <sup>7</sup> × 4.00 × 10 <sup>4</sup> ) / (1.85 × 10 <sup>5</sup> ) = 5.41 × 10 <sup>6</sup> cm <sup>3</sup> C1         (ii) volume of gas at 1.85 × 10 <sup>5</sup> Pa = (2.5 × 10 <sup>7</sup> × 4.00 × 10 <sup>4</sup> ) / (1.85 × 10 <sup>5</sup> ) = 5.41 × 10 <sup>6</sup> cm <sup>3</sup> C1         (ii) volume of gas at 1.85 × 10 <sup>5</sup> Pa = (2.5 × 10 <sup>7</sup> × 4.00 × 10 <sup>4</sup> ) / (1.85 × 10 <sup>5</sup> ) = 5.41 × 10 <sup>6</sup> cm <sup>3</sup> C1         (ii) newer 740 or fails to allow for gas in cylinder, max 2/3)       A1       [3]         3 (a) gradient of graph is (a measure of) the sensitivity the gradient varies with temperature       A1       [2]         (b) 2040 ± 20 Ω corresponds to 15.0 ± 0.2 °C T / K = T / °C + 273.15 (allow 273.2) temperature is 288.2 K       A1       [3]         4 (a) (i) 1.0       B1       [1]         (ii) 40 Hz       B1       [1]         (b) (i) speed = $2\pi fa$ = $2\pi \times 40 \times 42 \times 10^{-3}$ = $10.6 m s^{-1}$ C1         (ii) acceleration = $4\pi^2 f^2 a$ = $(80\pi)^2 \times 42 \times 10^{-3}$ = $2650 m s^{-2}$ C1         (c) (i) S marked correctly (on 'horizontal line through centre of wheel)       B1			(ii)				[2]
$= (2.5 \times 10^7 \times 4.00 \times 10^4 \times 10^6) / (8.31 \times 290)$ $= 415 \text{ mol}$ (ii) volume of gas at $1.85 \times 10^5 \text{ Pa} = (2.5 \times 10^7 \times 4.00 \times 10^4) / (1.85 \times 10^5)$ $= 5.41 \times 10^6 \text{ cm}^3$ So, $5.41 \times 10^6 = 4.00 \times 10^4 + 7.24 \times 10^3 N$ N = 741 (answer 740 or fails to allow for gas in cylinder, max 2/3) 3 (a) gradient of graph is (a measure of) the sensitivity the gradient varies with temperature (b) $2040 \pm 20 \Omega$ corresponds to $15.0 \pm 0.2 \text{ °C}$ $T / K = T / \text{ °C} + 273.15$ (allow $273.2$ ) temperature is $288.2 \text{ K}$ 4 (a) (i) 1.0 (ii) $40 \text{ Hz}$ (b) (i) speed $= 2\pi fa$ $= 2\pi \times 40 \times 42 \times 10^3$ $= 10.6 \text{ m s}^{-1}$ (ii) acceleration $= 4\pi^2 f^2 a$ $= (80\pi)^2 \times 42 \times 10^3$ $= 2650 \text{ m s}^{-2}$ (c) (i) S marked correctly (on 'horizontal line through centre of wheel) B1	2	(a)	idea	al gas		B2	[2]
$= 5.41 \times 10^{6} \text{ cm}^{3}$ $So, 5.41 \times 10^{6} = 4.00 \times 10^{4} + 7.24 \times 10^{3} N$ $N = 741$ $(answer 740 \text{ or fails to allow for gas in cylinder, max 2/3)$ $(a) \text{ gradient of graph is (a measure of) the sensitivity the gradient varies with temperature (b) 2040 \pm 20 \Omega \text{ corresponds to } 15.0 \pm 0.2 \text{ °C}$ $T/K = T/ \text{ °C} + 273.15 \text{ (allow 273.2)}$ $T/K = T/ \text{ °C} + 273.15 \text{ (allow 273.2)}$ $T/K = 7/ \text{ °C} + 273.15$		(b)	(i)	= $(2.5 \times 10^7 \times 4.00 \times 10^4 \text{ x } 10^{-6}) / (8.31 \times 290)$		C1	[3]
the gradient varies with temperatureA1[2](b) $2040 \pm 20 \Omega$ corresponds to $15.0 \pm 0.2 \circ C$ $T/K = T/\circ C + 273.15$ (allow $273.2$ ) temperature is $288.2  K$ C14(a) (i) 1.0B1(ii) 40 HzB1(b) (i) speed $= 2\pi fa$ $= 2\pi \times 40 \times 42 \times 10^{-3}$ $= 10.6  \mathrm{m  s^{-1}}$ C1(ii) acceleration $= 4\pi^2 f^2 a$ $= 2650  \mathrm{m  s^{-2}}$ C1(c) (i) S marked correctly (on 'horizontal line through centre of wheel)B1			(ii)	= $5.41 \times 10^{6}$ cm <sup>3</sup> so, $5.41 \times 10^{6}$ = $4.00 \times 10^{4}$ + $7.24 \times 10^{3}$ N N = 741	35 × 10 <sup>5</sup> )	C1	[3]
$T/K = T/°C + 273.15$ (allow 273.2)       C1         temperature is 288.2 K       A1         4       (a) (i) 1.0         (ii) 40 Hz       B1         (b) (i) speed = $2\pi fa$ C1 $= 2\pi \times 40 \times 42 \times 10^{-3}$ A1 $= 10.6 \text{ m s}^{-1}$ A1         (ii) acceleration = $4\pi^2 f^2 a$ C1 $= (80\pi)^2 \times 42 \times 10^{-3}$ C1 $= 2650 \text{ m s}^{-2}$ A1         (c) (i) S marked correctly (on 'horizontal line through centre of wheel)       B1	3	(a)					[2]
(ii) 40 Hz       B1 [1]         (b) (i) speed = $2\pi fa$ C1 $= 2\pi \times 40 \times 42 \times 10^{-3}$ A1 [2]         (ii) acceleration = $4\pi^2 f^2 a$ C1 $= (80\pi)^2 \times 42 \times 10^{-3}$ C1 $= 2650 \text{ m s}^{-2}$ A1 [2]         (c) (i) S marked correctly (on 'horizontal line through centre of wheel)       B1		(b)	Τ/	K = <i>T</i> / °C + 273.15 (allow 273.2)		C1	[3]
(b) (i) speed = $2\pi fa$ C1 $= 2\pi \times 40 \times 42 \times 10^{-3}$ A1 $= 10.6 \text{ m s}^{-1}$ A1         (ii) acceleration = $4\pi^2 f^2 a$ C1 $= (80\pi)^2 \times 42 \times 10^{-3}$ C1 $= 2650 \text{ m s}^{-2}$ A1         (c) (i) S marked correctly (on 'horizontal line through centre of wheel)       B1	4	(a)	(i)	1.0		B1	[1]
$= 2\pi \times 40 \times 42 \times 10^{-3}$ $= 10.6 \text{ m s}^{-1}$ (ii) acceleration = $4\pi^2 f^2 a$ $= (80\pi)^2 \times 42 \times 10^{-3}$ $= 2650 \text{ m s}^{-2}$ (c) (i) S marked correctly (on 'horizontal line through centre of wheel) B1			(ii)	40 Hz		B1	[1]
= 10.6 m s <sup>-1</sup> A1 [2](ii) acceleration = $4\pi^2 t^2 a$ C1= $(80\pi)^2 \times 42 \times 10^{-3}$ A1 [2]= 2650 m s <sup>-2</sup> A1 [2](c) (i) S marked correctly (on 'horizontal line through centre of wheel)B1		(b)	(i)	•		C1	
$= (80\pi)^2 \times 42 \times 10^{-3}$ = 2650 m s <sup>-2</sup> A1 [2] (c) (i) S marked correctly (on 'horizontal line through centre of wheel) B1				$= 10.6 \text{ m s}^{-1}$		A1	[2]
(c) (i) S marked correctly (on 'horizontal line through centre of wheel) B1			(ii)	$=(80\pi)^2 \times 42 \times 10^{-3}$			[2]
		(c)	(i)		)		()
		. /					[2]

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Γ	Page	e 2	Mark Scheme	Syllabus	Paper	1	
			GCE A/AS Level – May/June 2006	9702	04		
5	(a)	(i)	force per unit positive charge (ratio idea essential)		B1	[1]	
		(ii)	$E = Q / 4\pi\epsilon_0 r^2$ $\epsilon_0$ being the permittivity of free space		M1 A1	[2]	
	(b)	(i)	$2.0 \times 10^{6} = Q / (4\pi \times 8.85 \times 10^{-12} \times 0.35^{2})$ $Q = 2.7 \times 10^{-5} \text{ C}$		C1 A1	[2]	
		(ii)	$V = (2.7 \times 10^{-5}) / (4\pi \times 8.85 \times 10^{-12} \times 0.35)$ = 7.0 × 10 <sup>5</sup> V		C1 A1	[2]	
	(c)		ctrons are stripped off the atoms ctrons and positive ions move in opposite directions,		B1		
			ing rise to a current)		B1	[2]	
6	(a)	(i)	arrow B in correct direction (down the page)		B1		
		(ii)	arrow F in correct direction (towards Y)		B1	[2]	
	(b)	(i)	When two bodies interact, force on one body is equal but opposidirection to force on the other body.	site in	B1	[1]	
		(ii)	direction opposite to that in (a)(ii)		B1	[1]	
	(c)	mei forc	gested reasonable values of <i>I</i> and <i>d</i> ntion of expression <i>F</i> = <i>BIL</i> se between wires is small npared to weight of wire		B1 B1 M1 A1	[4]	
7	(a)	ʻuni	form' distribution		B1	[1]	
	(b)	con	centric rings		B1	[1]	
	(c)	(c) higher speed, more momentum $\lambda = h / p$ so $\lambda$ decreases and ring diameter decreases			M1 M1 A1	[3]	
8	(a)	arro	ow labelled E pointing down the page		B1	[1]	
	(b)	(i)	Bqv = qE forces are independent of mass and charge 'cancels' so no deviation		M1 M1 A1	[3]	
		(ii)	magnetic force > electric force so deflects 'downwards'		M1 M1 A1	[3]	