

Mark Scheme (Results) January 2010

GCE

Mechanics M2 (6678)

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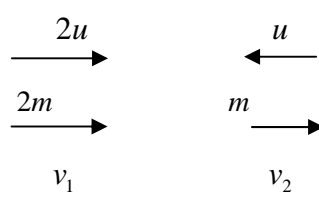
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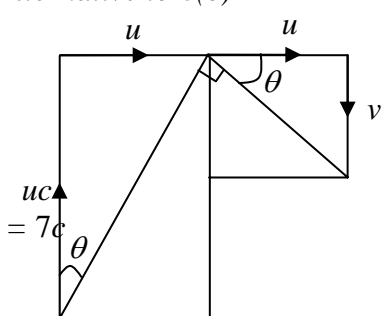
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Question Number	Scheme	Marks
Q1.	$\frac{dv}{dt} = 6t - 4$ $6t - 4 = 0 \Rightarrow t = \frac{2}{3}$ $s = \int 3t^2 - 4t + 3 dt = t^3 - 2t^2 + 3t (+c)$ $t = \frac{2}{3} \Rightarrow s = -\frac{16}{27} + 2 \text{ so distance is } \frac{38}{27} \text{ m}$	<p>M1 A1</p> <p>M1 A1</p> <p>M1 A1</p> <p>M1 A1</p> <p style="text-align: right;">[8]</p>
Q2.	<div style="text-align: center;">  </div> <p>CLM: $4mu - mu = 2mv_1 + mv_2$</p> <p>i.e. $3u = 2v_1 + v_2$</p> <p>NIL: $3eu = -v_1 + v_2$</p> <p>$v_1 = u(1 - e)$</p> <p>$v_2 = u(1 + 2e)$</p>	<p>M1 A1</p> <p>M1 A1</p> <p>DM1 A1</p> <p>A1</p> <p style="text-align: right;">[7]</p>
Q3.	$\frac{1}{2} \times 0.5 \times 20^2 ; \quad 0.5g \times 10$ $10R = \frac{1}{2} \times 0.5 \times 20^2 - 0.5g \times 10$ $\Rightarrow R = 5.1$	<p>B1 B1</p> <p>M1 A1</p> <p>DM1 A1</p> <p style="text-align: right;">[6]</p>

Question Number	Scheme	Marks
Q4.	(i) $I \uparrow = 0.25 \times 40 \sin 60 = 5\sqrt{3}$ (8.66) one component $I \leftarrow = 0.25(-20 + 30) = 2.5$ both $ I = \sqrt{75 + 6.25} = 9.01$ (Ns)	M1 A1 M1 A1 (4)
	(ii) $\frac{\sin \theta}{40} = \frac{\sin 60^\circ}{\sqrt{1300}}$ $\theta = 106^\circ$ (3 s.f.) or $\tan \theta = \pm \frac{5\sqrt{3}}{2.5}$ oee $\theta = 106^\circ$	M1 A1 M1 A1 (4) [8]
	<i>Alternative to 4(i)</i> Use of $I = m(\mathbf{v} - \mathbf{u})$ $30^2 + 40^2 - 2 \times 30 \times 40 \cos 60^\circ$ (= 1300) $I = 0.25\sqrt{1300} = 9.01$ N s (3 s.f.)	M1 M1 A1 A1
	<i>2nd Alternative to 4(i)</i> $\mathbf{u} = 30\mathbf{i}$, $\mathbf{v} = 40 \cos 60\mathbf{i} + 40 \sin 60\mathbf{j} = 20\mathbf{i} + 20\sqrt{3}\mathbf{j}$ $I = \frac{1}{4}(-10\mathbf{i} + 20\sqrt{3}\mathbf{j}) = -2.5\mathbf{i} + 5\sqrt{3}\mathbf{j}$	M1 A1 etc

Question Number	Scheme	Marks
Q5.	<p>(a)</p> $\frac{490}{3.5} - R = 0$ $R = 140 \text{ N}$ <p>(b)</p> $\frac{24}{u} + 70g \cdot \frac{1}{14} - 40u = 0$ $40u^2 - 49u - 24 = 0$ $(5u - 8)(8u + 3) = 0$ $u = 1.6$	<p>B1 M1 A1</p> <p>A1 (4)</p> <p>B1</p> <p>M1 A2, 1, 0</p> <p>DM1</p> <p>DM1 A1 (7)</p> <p>[11]</p>
Q6.	$m(B) : R \times 4 \cos \alpha = F \times 4 \sin \alpha + 20g \times 2 \cos \alpha$ <p>Use of $F = \frac{1}{2}R$</p> <p>Use of correct trig ratios</p> <p>R = 160N or 157N</p>	<p>M1 A2</p> <p>M1</p> <p>B1</p> <p>DM1 A1</p> <p>[7]</p>

Question Number	Scheme			Marks	
Q7.	(a)	<p>Rectangle</p> $24x$ x $24x^2 - 4.5\pi \times \left(\frac{4 \times 3}{3\pi}\right) - 4.5\pi \times \left(\frac{4 \times 3}{3\pi}\right) = (24x + 9\pi)\bar{x}$ $\text{distance} = \bar{x} = \frac{4 2x^2 - 3 }{(8x + 3\pi)} \quad **$	<p>Semicircles</p> $4.5\pi \quad 4.5\pi$ $\frac{4 \times 3}{3\pi} \quad \frac{4 \times 3}{3\pi}$	<p>Template, T</p> $24x + 9\pi$ \bar{x}	<p>B2</p> <p>B2</p> <p>M1 A1</p> <p>A1 (7)</p>
	(b)	<p>When $x = 2$,</p> $ \bar{x} = \frac{20}{16 + 3\pi}$ $\tan \theta = \frac{6}{4 - \bar{x} } = \frac{6}{4 - \frac{20}{16 + 3\pi}}$ $= \frac{48 + 9\pi}{22 + 6\pi} .$		<p>B1</p> <p>M1 A1</p> <p>A1 (4)</p> <p>[11]</p>	

Question Number	Scheme	Marks
Q8.	(a) $x = ut$	B1
	$y = cut - 4.9t^2$	M1 A1
	eliminating t and simplifying to give $y = cx - \frac{4.9x^2}{u^2}$ **	DM1 A1 (5)
	(b)(i) $0 = cx - \frac{4.9x^2}{u^2}$	M1
	$0 = x(c - \frac{4.9x}{u^2}) \Rightarrow R = \frac{u^2c}{4.9} = 10c$	M1 A1
	(ii) When $x = 5c$, $y = H$	M1
	$= 5c^2 - \frac{(5c)^2}{10} = 2.5c^2$	M1 A1 (6)
	(c) $\frac{dy}{dx} = c - \frac{9.8x}{u^2} = c - \frac{x}{5}$	M1 A1
	When $x = 0$, $\frac{dy}{dx} = c$	B1
	So, $c - \frac{x}{5} = \frac{-1}{c}$	DM1 A1
$x = 5(c + \frac{1}{c})$	A1 (6)	
<p>Alternative to 8(c)</p>  <p>$\tan \theta = \frac{u}{cu} = \frac{1}{c} = \frac{v}{u}$</p> <p>$\Rightarrow v = \frac{u}{c} = \frac{7}{c}$</p> <p>$v = u + at ; -\frac{7}{c} = 7c - 9.8t$</p> <p>$t = \frac{7}{9.8}(c + \frac{1}{c})$</p> <p>$x = ut = 7t ; x = 5(c + \frac{1}{c})$</p>	<p>[17]</p> <p>B1</p> <p>M1 A1</p> <p>M1</p> <p>A1</p> <p>A1</p>	

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