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Mark Scheme (Results)
January 2010

GCE

Mechanics M2 (6678)

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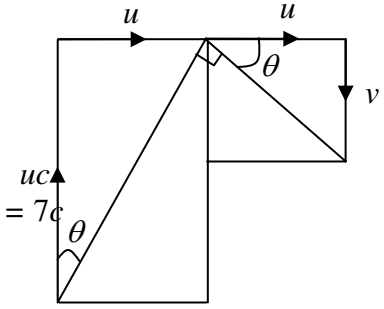
Question Number	Scheme	Marks
Q1.	$\frac{\mathrm{d}v}{\mathrm{d}t} = 6t - 4$	M1 A1
	$6t - 4 = 0 \Rightarrow t = \frac{2}{3}$	M1 A1
	$s = \int 3t^2 - 4t + 3 \,\mathrm{d}t = t^3 - 2t^2 + 3t \ (+c)$	M1 A1
	$t = \frac{2}{3} \Rightarrow s = -\frac{16}{27} + 2$ so distance is $\frac{38}{27}$ m	M1 A1
		[8]
Q2.	$2u \rightarrow$ $\quad$ $\leftarrow u$ $2m \rightarrow$ $\quad$ $m \rightarrow$ v_1 $\quad$ v_2	
	CLM: $4mu - mu = 2mv_1 + mv_2$	M1 A1
	i.e. $3u = 2v_1 + v_2$	
	NIL: $3eu = -v_1 + v_2$	M1 A1
	$v_1 = u(1 - e)$	DM1 A1
	$v_2 = u(1 + 2e)$	A1
		[7]
Q3.	$\frac{1}{2}$ x 0.5 x 20^2 ; $0.5g$ x 10	B1 B1
	$10R = \frac{1}{2}$ x 0.5 x $20^2 - 0.5g$ x 10	M1 A1
	$\Rightarrow R = 5.1$	DM1 A1
		[6]

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 $\lvert I\rvert = \sqrt{75+6.25} = 9.01$ (Ns)	M1 A1 M1 A1 (4)
	(ii) $\dfrac{\sin\theta}{40} = \dfrac{\sin 60^\circ}{\sqrt{1300}}$ $\theta = 106^o$ (3 s.f.)	M1 A1
	or $\tan\theta = \pm\dfrac{5\sqrt{3}}{2.5}$ oee $\theta = 106°$	M1 A1 (4)
		[8]
	Alternative to 4(i) Use of $\mathbf{I} = m(\mathbf{v}-\mathbf{u})$	M1
	$30^2 + 40^2 - 2 \text{ x } 30 \text{ x } 40\cos 60^\circ \quad (= 1300)$	M1 A1
	$I = 0.25\sqrt{1300} = 9.01$ N s (3 s.f.)	A1
	2nd Alternative to 4(i) $\mathbf{u} = 30\mathbf{i}$, $\mathbf{v} = 40\cos 60\mathbf{i} + 40\sin 60\mathbf{j} = 20\mathbf{i} + 20\sqrt{3}\mathbf{j}$ $\mathbf{I} = \dfrac{1}{4}(-10\mathbf{i} + 20\sqrt{3}\mathbf{j}) = -2.5\mathbf{i} + 5\sqrt{3}\mathbf{j}$	M1 A1 etc

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

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

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
	$0 = x(c - \frac{4.9x}{u^2}) \Rightarrow R = \frac{u^2 c}{4.9} = 10c$	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)
		[17]
	Alternative to 8(c)	
		
	$\tan\theta = \frac{u}{cu} = \frac{1}{c} = \frac{v}{u}$	B1
	$\Rightarrow v = \frac{u}{c} = \frac{7}{c}$	M1 A1
	$v = u + at$; $-\frac{7}{c} = 7c - 9.8t$	M1
	$t = \frac{7}{9.8}(c + \frac{1}{c})$	A1
	$x = ut = 7t$; $x = 5(c + \frac{1}{c})$	A1

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