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MS4
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GCE MARKING SCHEME

MATHEMATICS - C1-C4 & FP1-FP3
AS/Advanced

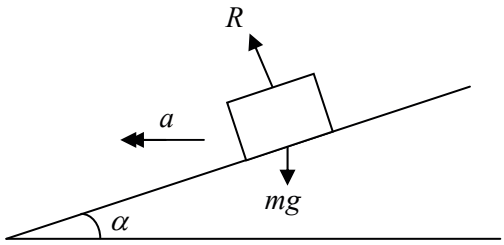
SUMMER 2009

Mathematics M2 (June 2009)
Final Markscheme

1.(a)	$a = \frac{\mathrm{d}}{\mathrm{d}t}(\cos 2t - 3\sin 2t)$	attempted	M1
	$= -2\sin 2t - 3\cos t$		A1 A1
	When $t = \pi$		
	$a = -2\sin 2\pi - 3\cos\pi$		
	$a = 3\ \mathrm{ms}^{-2}$		A1
1.(b)	$x = \int \cos 2t - 3\sin t\ \mathrm{d}t$	attempted	M1
	$x = 0.5\sin 2t + 3\cos t + C$		A1 A1
	When $t = 0$, $x = 4$	used	m1
	$4 = 3 + C$		
	$C = 1$	ft	A1
	$x = 0.5\sin 2t + 3\cos t + 1$		
	$x = \underline{3.62\ \mathrm{m}}$	cao	A1
2.(a)	Using Hooke's Law $80 = \frac{\lambda(0\cdot 25 - 0\cdot 2)}{0\cdot 25}$		M1 A1
	$\lambda = \underline{400\ \mathrm{N}}$	cao	A1
2.(b)	Energy at start $= \frac{1}{2}\times 400\times\frac{0\cdot 05^2}{0\cdot 25}$ $(=2)$	si	M1 A1
	Energy at end $= \frac{1}{2}\times 0\cdot 36\, v^2$ $(=0.18v^2)$		M1
	Conservation of energy	used	M1
	$0.18\, v^2 = 2$		
	$v = 3\frac{1}{3}\ \mathrm{ms}^{-1}$	cao	A1
3.(a)	Resolve perpendicular to plane	attempted	M1
	$R = mg\cos\alpha$		A1
	$R = 3.5 \times 9.8 \times 0.8 = 27.44$		
	$F = \mu R$	used	m1
	$F = 0.25 \times 27.44 = 6.86$		
	Work done against friction $= 6.86 \times 2$		M1
	$= \underline{13.72\ \mathrm{J}}$	ft c's F	A1
3.(b)	K. E. at start $= 0.5mu^2$	used	M1
	$= 1.75\, u^2$		
	P. E. at end $= mgh = 3.5 \times 9.8 \times 2\sin\alpha$		M1
	$= 3.5 \times 9.8 \times 2 \times 0.6$		A1
	$= 41.16$		
	Work-energy Principle $1.75u^2 = 41.16 + 13.72$		M1 A1
	$u^2 = 31.36$		
	$u = \underline{5.6\mathrm{ms}^{-1}}$	cao	A1

4.(a)	N2L applied to particle	3 terms	M1
	$F - 1500 = 5000a$		A1
	$F = 2500$ N		
	$F = \frac{P}{v} = \frac{P}{12}$		M1
	$P =$ <u>30000 W</u>	cao	A1
4.(b)	Since maximum velocity, $a = 0$	si	M1
	$F = 1500$		A1
	$F = \frac{45\times1000}{v}$		M1
	$\frac{45000}{v} = 1500$		
	$v =$ <u>30 ms^{-1}</u>	cao	A1
5.(a)	Initial horizontal velocity = $17.5\cos\alpha = 17.5 \times 0.6$		B1
	$= 10.5$		
	Time to reach wall $= \frac{25\cdot2}{10\cdot5}$		M1
	= <u>2.4 s</u>	ft c's 10.5	A1
5.(b)	Initial vertical velocity = $17.5\sin\alpha = 17.5 \times 0.8$		B1
	$= 14$		
	Using $s = ut + \frac{1}{2}at^2$ with $u = 14$(c), $a = (-)9.8$, $t = 2.4$		M1
	$= 14 \times 2.4 - 4.9 \times 2.4^2$	ft if M1 in (a) awarded	A1
	= <u>5.376 m</u>		A1
5.(c)	Using $v = u + at$ with $u = 14$(c), $a = (-)9.8$, $v = 0$		M1
	$0 = 14 - 9.8t$	ft if M1 in (a) awarded	A1
	$t = \frac{10}{7}$ s		A1
6.(a)	velocity $= \frac{\mathrm{d}\mathbf{r}}{\mathrm{d}t}$	used	M1
	$= -8t\mathbf{i} + (6t - 5)\mathbf{j}$		A1
	Momentum $= m\mathbf{v} = -16t\mathbf{i} + 2(6t - 5)\mathbf{j}$	ft c's **v**	A1
6.(b)	acceleration $= \frac{\mathrm{d}\mathbf{v}}{\mathrm{d}t}$	used	M1
	$= -8\mathbf{i} + 6\mathbf{j}$	constant since independent of t	A1
	Magnitude $= \sqrt{8^2 + 6^2}$		M1
	= <u>10 ms^{-2}</u>	cao	A1
6.(c)	Velocity is perpendicular to acceleration when $\mathbf{v}.\mathbf{a} = 0$		M1
	$\mathbf{v}.\mathbf{a} = (-8t\mathbf{i} + (6t - 5)\mathbf{j}).(-8\mathbf{i} + 6\mathbf{j})$		
	$= 64t + 6(6t - 5)$	ft **v**, **a**	M1 A1
	$100t - 30$		
	$t =$ <u>0.3 s</u>	cao	A1

7.



Resolve vertically M1

$R\cos\alpha = mg$ A1

$= 1000 \times 9.8$

$= 9800$

Using N2L $R\sin\alpha = ma$ M1

$a = \frac{v^2}{r}$ M1

$R\sin\alpha = \frac{1000\times 28^2}{250}$ si A1

$= 3136$

Solving $\tan\alpha = \frac{3136}{9800}$ m1

$= 0.32$

$\alpha = \underline{17.74°}$ cao A1

8.(a) Conservation of energy used M1

$0.5 \times 5 \times 9^2 = 0.5 \times 5 \times v^2 + 5g(2 - 2\cos\theta)$ A1 A1

$v^2 = 81 - 39.2(1 - \cos\theta)$

$v^2 = 41.8 + 39.2$ A1

8.(b) N2L towards centre used M1

$R - mg\cos\theta = \frac{mv^2}{r}$ A1

$R = 5 \times 9.8\cos\theta + \frac{5}{2}(41.8 + 39.2\cos\theta)$ m1

$= 147\cos\theta + 104.5$ A1

8.(c) Particle leaves sphere when $R = 0$ oe M1

$147\cos\theta + 104.5 = 0, \quad \theta = 135.3°$

Therefore particle will leave circle before reaching the top, i.e. particle will not complete circle. A1