GCE MARKING SCHEME

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

SUMMER 2014

M2

Q	Solution	Mark	Notes
1(a)	EE = $\frac{1}{2} \times \frac{\lambda x^2}{l}$, λ=625, x=(+/-)0.1, l=0.2	M1	
	EE = $\frac{1}{2} \times \frac{625 \times 0 \cdot 1^2}{0 \cdot 2}$		
	EE = <u>15.625 (J)</u>	A1	
1(b)	KE = $\frac{1}{2} \times 0 \cdot 8v^2$ $(= 0.4v^2)$	B1	
	WD by resistance = 46 × 0.1 (= 4.6)	B1	
	Work-energy Principle	M1	3 terms, no PE.
	$\frac{1}{2} 0.8v^2 + 46 \times 0.1 = 15.625$	A1	FT their EE
	$0.4v^2 = 15.625 - 4.6$		
	$0.4v^2 = 11.025$		
	$v = \sqrt{\frac{11 \cdot 025}{0 \cdot 4}}$		
	v = <u>5.25 (ms^{-1})</u>	A1	cao

Q	Solution	Mark	Notes
2(a)	$F - R = ma$ $30t^{-2} - 150 = 5a$ $6t^{-2} - 30 = a$ $\frac{dv}{dt} = 6t^{-2} - 30$	M1 A1 	used, F and R opposing. Answer given
(b)	$24 = \frac{6}{t^2} - 30$ $\frac{6}{t^2} = 54$ $t = \frac{1}{3}$	M1 A1	Ft (a) if same form cao, accept 0.3.
2(c)	Integrate w.r.t. t $v = -6t^{-1} - 30t\ (+ C)$ $t = \frac{1}{3}$, $v = 18$ $18 = -18 - 10 + C$ $C = 46$ $v = -6t^{-1} - 30t + 46$	M1 A1 m1	Increase in powers
	When $v = 10$ $10 = -\frac{6}{t} - 30t + 46$ $5t^2 - 6t + 1 = 0$ $(5t - 1)(t - 1) = 0$ $t = \frac{1}{5}, 1$	m1 m1 A1	 recognition of quadratic Some attempt to solve. cao

Q	Solution	Mark	Notes
3(a)	$T = \frac{P}{v}$, $P = 90\times1000$, $v = 4.8$	M1	si
	$T = \frac{90\times1000}{4\cdot8}$	A1	si
	$T = 18750$		
	N2L	M1	dim correct, all forces T, R opposing.
	$T - mg\sin\alpha - R = ma$	A1	
	$18750 - 4000\times9.8\times\frac{2}{49} - R = 4000\times1.2$	A1	
	$R = 18750 - 1600 - 4800$		
	$R = \underline{12350\text{ (N)}}$	A1	cao
3(b)	N2L with $a = 0$	M1	all forces.
	$T = \frac{90\times1000}{v}$	B1	si
	$T - 1600 - 12800 = 0$	A1	
	$v = \underline{6.25\text{ ms}^{-1}}$	A1	

Q	Solution	Mark	Notes
4(a)	$\mathbf{r} = \mathbf{p} + t\mathbf{v}$	M1	used
	$\mathbf{r}_A = (3 - t)\mathbf{i} + (5 + 2t)\mathbf{j} + (20 + t)\mathbf{k}$	A1	
	$\mathbf{r}_B = (-2 + 3t)\mathbf{i} + (x - 4t)\mathbf{j} + (15 + 2t)\mathbf{k}$	A1	
4(b)	$\mathbf{r}_B - \mathbf{r}_A =$	M1	
	$(-5 + 4t)\mathbf{i} + (x - 5 - 6t)\mathbf{j} + (-5 + t)\mathbf{k}$	A1	ft (a) similar expressions.
	$AB^2 = x^2 + y^2 + z^2$	M1	
	$AB^2 = (-5 + 4t)^2 + (x - 5 - 6t)^2 + (-5 + t)^2$	A1	cao
4(c)	Differentiate	M1	powers reduced
	$\frac{dAB^2}{dt} = 2(-5 + 4t)(4) + 2(x - 5 - 6t)(-6) + 2(-5 + t)(1)$		
	$-40 + 32t - 12x + 60 + 72t - 10 + 2t = 0$	m1	equating to 0.
	$106t + 10 = 12x$		
	When $t = 5$		
	$x = \underline{45}$	A1	cao

Q	Solution	Mark	Notes
5(a)	$u_H = \dfrac{42}{2 \cdot 5} = \underline{16.8\ (\text{ms}^{-1})}$	B1	
	$s = u_V t + 0.5at^2$, $s = 3$, $t = 2.5$, $a = (\pm)9.8$	M1	
	$3 = 2.5u_V - 4.9 \times 2.5^2$	A1	
	$u_V = \underline{13.45\ (\text{ms}^{-1})}$	A1	cao, accept 13.4, 13.5.
5(b)	$v_V = u_V + at$, $u_V = 13.45$, $a = (\pm)9.8$, $t = 2.5$	M1	
	$v_V = 13.45 - 9.8 \times 2.5$	A1	ft from (a)
	$v_V = -11.05$		
	magnitude of vel $= \sqrt{u_H^{\,2} + v_V^{\,2}}$	m1	
	$= \underline{20.11\ (\text{ms}^{-1})}$	A1	cao
	$\theta = \tan^{-1}\left(\dfrac{11 \cdot 05}{16 \cdot 8}\right)$	m1	
	$\theta = \underline{33.33°}$ (below horizontal)	A1	cao
5(c)	$s = ut + 0.5at^2$, $s = 0$, $u = 13.45$, $a = (\pm)9.8$	M1	
	$0 = 13.45t - 4.9t^2$		
	$t = 2.7449$		
	Distance $= 2.7449 \times 16.8$	m1	
	Distance $= 46.11$		
	Required distance $= 46.11 - 42 = \underline{4.11\ (\text{m})}$	A1	cao

Q	Solution	Mark	Notes
6(a)	$\mathbf{a} = \frac{dv}{dt}$	M1	differentiation attempted. Vectors required.
	$\mathbf{a} = 8\cos 2t\,\mathbf{i} - 75\sin 5t\,\mathbf{j}$	A1	
	At $t = \frac{3\pi}{2}$, $(\mathbf{a} = -8\mathbf{i} + 75\mathbf{j})$	m1	substitution of t.
	Magnitude of force $= 3\times\sqrt{8^2 + 75^2}$	M1	or $\mathbf{F} = 3(-8\mathbf{i} + 75\mathbf{j})$
	$= \underline{226.28\ (\text{N})}$	A1	cao
6(b)	$\mathbf{r} = \int 4\sin 2t\ \mathbf{i} + 15\cos 5t\,\mathbf{j}\ \mathrm{d}t$	M1	integration attempted
	$\mathbf{r} = -2\cos 2t\,\mathbf{i} + 3\sin 5t\,\mathbf{j}\ (+\mathbf{c})$	A1	
	At $t = 0$,		
	$-2\mathbf{i} + 3\mathbf{j} = -2\mathbf{i} + \mathbf{c}$	m1	
	$\mathbf{c} = 3\mathbf{j}$	A1	
	$\mathbf{r} = -2\cos 2t\,\mathbf{i} + 3\sin 5t\,\mathbf{j} + 3\mathbf{j}$		
6(c)	Particle crosses the y-axis when		
	$-2\cos 2t = 0$	M1	
	$2t = \frac{\pi}{2}$		
	$t = \frac{\pi}{4}$	A1	cao
	Distance from origin $= 3\sin(5\times\frac{\pi}{4}) + 3$	m1	substitute t into $\mathbf{r}$
	$= \underline{0.88\ (\text{m})}$	A1	cao

Q	Solution	Mark	Notes
7(a)	Conservation of energy	M1	
	$0.5m(4u)^2 = mg(2l) + 0.5mu^2$	A1	
	$16u^2 = 4gl + u^2$		
	$u^2 = \frac{4}{15}gl$	A1	convincing
7(b)(i)	Conservation of energy	M1	
	$0.5m(4u)^2 = 0.5mv^2 + mgl(1 - \cos\theta)$	A1	
	$v^2 = 16u^2 - 2gl + 2gl\cos\theta$		
	$v^2 = \frac{34}{15}gl + 2gl\cos\theta$	A1	
	N2L towards centre of circle	M1	
	$T - mg\cos\theta = \frac{mv^2}{l}$	A1	
	$T = \frac{34}{15}mg + 3mg\cos\theta$	m1	If M1s gained, substitute for v^2.
	$T = \frac{mg}{15}(34 + 45\cos\theta)$	A1	any correct form
7(b)(ii)	when $T = 0$, $\cos\theta = -\frac{34}{45}$	M1	putting $T = 0$ in $a\cos \pm b$
	$\theta = 139.1°$	A1	Ft cos = a, a<0.