GCE MARKING SCHEME

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

SUMMER 2013

Q	Solution	Mark	Notes
1(a)	Loss in KE $= 0.5mv^2$		
	$= 0.5 \times 8 \times 7^2$	M1	Corr use of KE formula
	$=$ <u>196J</u>	A1	
1(b)	Work energy principle	M1	correct use
	$196 = F \times 15$	A1	ft loss in KE
	$F = \mu R$		
	$= 8g\mu = (78.4\mu)$	B1	
	Therefore $196 = 78.4\mu \times 15$		
	$\mu = \frac{1}{6}$	A1	ft loss in KE. Isw
	OR		
	Use of $v^2=u^2+2as$		
	$0=7^2 + 2a\times15$	(M1)	
	$a = -1.633$		
	Use $F = ma$		
	$-F = 8\times -1.633$	(M1)	
	$F = 8\mu g$	(B1)	
	$\mu = \frac{13\cdot067}{8g} = \frac{1}{6}$	(A1)p	

Q	Solution	Mark	Notes
2(a)	$\mathbf{r} = \int v\,\mathrm{d}t$	M1	use of integration
	$\mathbf{r} = \int (13t-3)\mathbf{i} + (2+3t^2)\mathrm{j}\,\mathrm{d}t$		
	$\mathbf{r} = \left(\frac{13}{2}t^2 - 3t\right)\mathrm{i} + (2t+t^3)\mathrm{j} + (\underline{c})$	A1 A1	one for each coefficient
	When t = 0,	m1	use of initial conditions
	$\mathbf{c} = 2\mathbf{i} + 7\mathbf{j}$	A1	ft **r**
	$\mathbf{r} = (6.5t^2 - 3t + 2)\mathbf{i} + (2t + t^3 + 7)\mathbf{j}$		
2(b)	$\mathbf{a} = \frac{\mathrm{d}v}{\mathrm{d}t}$	M1	use of differentiation
	$= 13\mathbf{i} + 6t\mathbf{j}$	A1	
2(c)	We require $\mathbf{v}.(\mathbf{i} - 2\mathbf{j}) = 0$	M1	used
	$\mathbf{v}.(\mathbf{i} - 2\mathbf{j}) = (13t - 3) - 2(2 + 3t^2)$	M1	allow sign errors
	$= -6t^2 + 13t - 7$	A1	any form
	$6t^2 - 13t + 7 = 0$		
	$(6t - 7)(t - 1) = 0$	m1	method for quad equation Depends on both M's
	$t = \underline{1, 7/6}$	A1	

Q	Solution	Mark	Notes
3(a)(i)	Initial horizontal speed = $15\cos\alpha$ $= 15 \times 0.8$ $= 12\ ms^{-1}$	B1	
	Time of flight $= 9/12$	M1	
	$= \underline{0.75s}$	A1	any correct form
3(a)(ii)	Initial vertical speed $= 15\sin\alpha$ $= 15 \times 0.6$ $= 9\ ms^{-1}$	B1	
	Use of $s = ut + 0.5at^2$, u=9(c), a=(±)9.8, t=0.75(c)	M1	
	$s = 9 \times 0.75 - 0.5 \times 9.8 \times 0.75^2$		
	$s = 3.99375$ m	A1	si
	Height of B above ground = $\underline{4.99375\ m}$	A1	ft s
3(b)	use of $v^2 = u^2 + 2as$, u=9, a=(±)9.8, s=-1	M1	allow sign errors
	$v^2 = 9^2 + 2(-9.8)(-1)$	A1	
	$v^2 = 100.6$		
	$u_H = 12$	B1	ft candidate's value
	Speed $= \sqrt{12^2 + 100.6}$	m1	
	Speed $= \underline{15.64\ ms^{-1}}$	A1	cao

Q	Solution	Mark	Notes
4(a)	Resolve vertically	M1	dim correct
	$R\sin\theta = Mg$	A1	
	$\sin\theta = \frac{3}{5}$	B1	
	$R = Mg \times \frac{5}{3}$		
	$R = 5Mg/3$	A1	answer given, convincing.
4(b)	N2L towards centre	M1	dim correct
	$R\cos\theta = Ma$	A1	
	$\frac{5Mg}{3} \times \frac{4}{5} = M \times \frac{8g}{3r}$		
	$CP = r = 2$	A1	
	$\frac{\text{Height}}{r} = \frac{4}{3}$	M1	use of similar triangles
	Height $= \frac{8}{3}$ m	A1	ft candidate's r if first M1 given.

Q	Solution	Mark	Notes
5(a)	$0 < t < 6$	B1 B1	
5(b)	Distance t = 6 to t = 9 = $\int_6^9 2t^2 - 12t \, dt$	M1	use of integration Limits not required
	Distance = $[\ 2t^3/3 - 6t^2]^9_6$ = 72	A1	correct integration
	Distance t = 0 to t = 6 = $-\int_0^6 2t^2 - 12t \, dt$ Distance = $-[\ 2t^3/3 - 6t^2]^6_0$ = -[-72] = 72	A1	or for the other integral
	Required distance = 72 + 72 = <u>144</u>	m1 A1	cao

Q	Solution	Mark	Notes
6(a)	$T = P/v$	M1	used
	$T = \frac{60\times1000}{20}$		
	$T = \underline{3000\ N}$	A1	
6(b)	Apply N2L to car and trailer	M1	dim correct equation All forces present
	$T - (1500+500)g\sin\alpha - (170+30) = 2000a$	A2	-1 each error
	$3000 - 2000 \times 9.8 \times \frac{1}{14} - 200 = 2000a$		
	$a = \underline{0.7\ ms^{-2}}$	A1	convincing
6(c)	N2L applied to trailer	M1	dim correct, all forces
	$T - 500g\sin\alpha - 30 = 500a$	A2	-1 each error
	$T = 500 \times 9.8 \times \frac{1}{14} + 30 + 500 \times 0.7$		
	$T = \underline{730\ N}$	A1	
	OR		
	N2L applied to car	(M1)	dim correct, all forces
	$3000 - 1500g\sin\alpha - 170 - T = 1500 \times 0.7$	(A2)	-1 each error
	$T = 3000 - 1500 \times 9.8 \times \frac{1}{14} - 170 - 1500 \times 0.7$		
	$T = \underline{730\ N}$	(A1)	

Q	Solution	Mark	Notes
7(a)	PE at start = $- 2 \times 9.8 \times 0.7$	M1	mgh used
		A1	allow 0.7, (1.2+x), (0.5+x), 1.2, 0.5, x.
	$= -13.72$ J		
	PE at end = $-2 \times 9.8 \times (1.2 + x)$		
	$= -23.52 - 19.6x$		
	EE at end = $\frac{1}{2} \times \frac{360}{1 \cdot 2} x^2$	M1	use of formula
		A1	
	EE at end = $150x^2$		
	Conservation of energy	M1	equation, all energies
	$150x^2 - 19.6x - 23.52 = -13.72$	A1	correct equation any form
	$150x^2 - 19.6x - 9.8 = 0$		
	$x = \underline{0.33}$	A1	cao
7(b)	KE at end = $0.5 \times 2v^2$	B1	
	$= v^2$		
	PE at end = $-2 \times 9.8 \times 1.2$		
	$= -23.52$		
	Conservation of energy	M1	equation, no EE
	$v^2 - 23.52 = -13.72$	A1	correct equation, any form
	$v^2 = 9.8$		
	$v = \underline{3.13 \text{ ms}^{-1}}$	A1	

Q	Solution	Mark	Notes
8(a)	Conservation of energy	M1	equation required
	$0.5mu^2 + mgr\cos\alpha = 0.5mv^2 + mgr\cos\theta$	A1	KE
		A1	PE
	$0.5 \times 3 \times 5^2 + 3 \times 9.8 \times 4 \times 0.8 =$ $0.5 \times 3 \times v^2 + 3 \times 9.8 \times 4 \times \cos\theta$		
	$75 + 188.16 = 3v^2 + 235.2\cos\theta$		
	$v^2 = 87.72 - 78.4\cos\theta$		
	$v = \sqrt{(87.72 - 78.4\cos\theta)}$	A1	cao
8(b)	N2L towards centre	M1	dim correct, all forces
	$mg\cos\theta - R = ma$	A1	
	$R = 3 \times 9.8\cos\theta - \frac{3}{4}(87.72 - 78.4\cos\theta)$	m1	substitute, v^2/r
	$R = 29.4\cos\theta - 65.79 + 58.8\cos\theta$		
	$R = \underline{88.2\cos\theta - 65.79}$		