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Mark Scheme (Final)
Summer 2009

GCE

GCE Mechanics M3 (6679/01)

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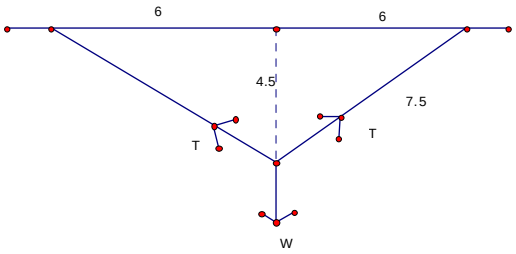
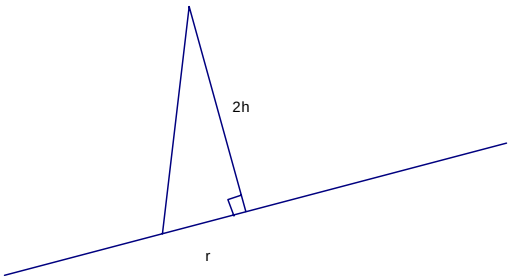
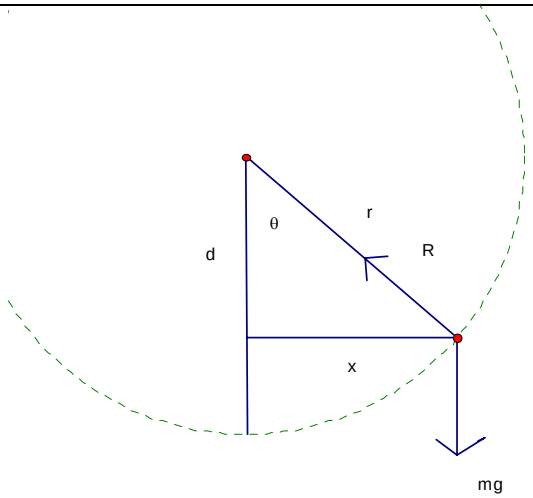
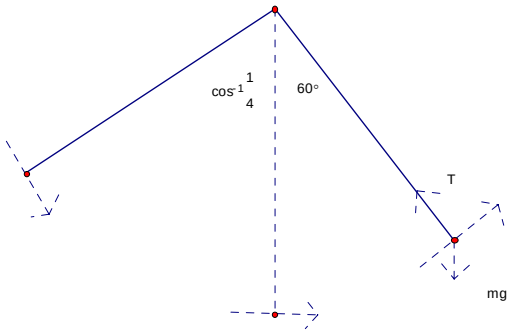
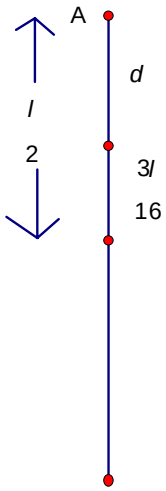
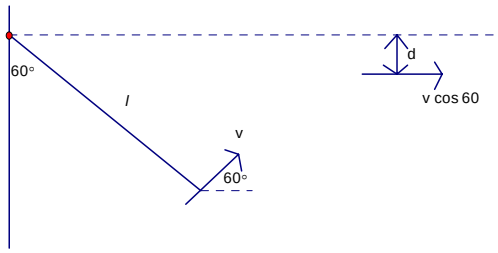
General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

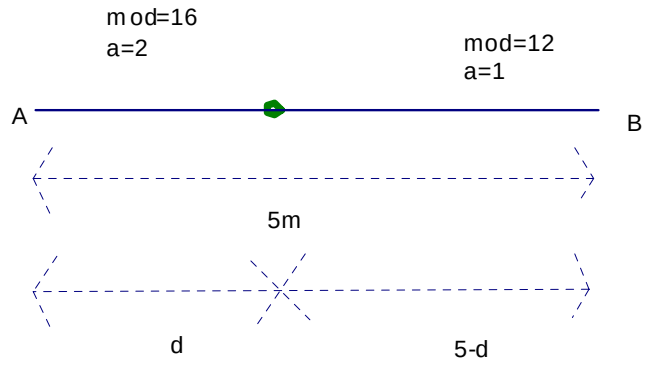
June 2009
6679 Mechanics M3
Mark Scheme

Question Number		Scheme	Marks
1	a	 Resolving vertically: $2T\cos\theta = W$ Hooke's Law: $T = \frac{80\times 3.5}{4}$ $W = 84\text{N}$	M1A2,1,0 M1A1 A1
	b	EPE $= 2\times\frac{80\times 3.5^2}{2\times 4}, = 245$ (or awrt 245) (alternative $\frac{80\times 7^2}{16} = 245$)	M1A1ft,A1
			(9)
2	a	Object Mass c of m above base Cone m $2h+3h$ Base $3m$ h Marker $4m$ d m x $5h$ +$3m$ x h = $4m$ x d $d = 2h$	B1(ratio masses) B1(distances) M1A1ft A1
	b	 $\frac{r}{d} = \frac{1}{12}$ $6r = h$	M1A1ft A1
			(8)

Question Number		Scheme	Marks
3	a	 $\leftrightarrow \quad R\sin\theta = mx\omega^2$ $R \times \frac{x}{r} = mx \times \frac{3g}{2r}$ $R = \frac{3mg}{2}$	M1 A1 M1 A1
	b	$\updownarrow \quad R\cos\theta = mg$ $\frac{3mg}{2} \times \frac{d}{r} = mg$ $d = \frac{2}{3}r$	M1 A1 M1 A1 **(8)**
4	a	Volume $= \int_{\frac{1}{4}}^{1} \pi y^2 dx = \int_{\frac{1}{4}}^{1} \pi \frac{1}{x^4} dx$ $= \left[\pi \times \frac{-1}{3x^3}\right]_{\frac{1}{4}}^{1}$ $= \pi(\frac{-1}{3} + \frac{64}{3}) = 21\pi$ *	M1A1 A1ft A1
	b	$21\pi\rho\bar{x} = \rho\int \pi y^2 x dx = \rho\int \pi \frac{1}{x^4} x dx$ $21\pi\bar{x} = \pi\left[\frac{-1}{2x^2}\right]_{\frac{1}{4}}^{1}$ $\bar{x} = \frac{1}{21}(\frac{-1}{2} + \frac{16}{2}) = \frac{5}{14}$ or awrt 0.36 $\bar{y} = 0$ by symmetry	M1A1 A1ft A1 B1 **(9)**

Question Number		Scheme	Marks
5	a		
		Energy: $(\frac{1}{2}mu^2+)mgl(\cos\theta-\frac{1}{4})=\frac{1}{2}mv^2$	M1A1
		Resolving: $T-mg\cos\theta=\frac{mv^2}{l}$	M1A1
		Eliminate v^2: $T=mg\cos\theta+\frac{1}{l}(2mgl(\cos\theta-\frac{1}{4}))$	M1
		$T=3mg\cos\theta-\frac{mg}{2}$ *	A1
	b		
		$\theta=60°\Rightarrow mv^2=2mgl(\frac{1}{2}-\frac{1}{4})$ $\Rightarrow v^2=\frac{gl}{2}$	M1
		vertical motion under gravity: $\updownarrow\ 0=(v\cos 30°)^2-2gs$	M1
		$0=\frac{gl}{2}\times\frac{3}{4}-2gs\Rightarrow s=\frac{3l}{16}$	A1
		Distance below A $=\frac{l}{2}-\frac{3l}{16}=\frac{5l}{16}$	M1A1
			(11)
	Alter-native for end of (b) using energy		
		$\frac{1}{2}mv^2-mgl\cos 60=\frac{1}{2}m(v\cos 60)^2-mgd$	M1A1
		$\frac{gl}{4}-\frac{gl}{2}=\frac{gl}{4}\times\frac{1}{4}-gd$	M1
		$d=\frac{1-4+8}{16}l=\frac{5l}{16}$	A1

Question Number		Scheme	Marks
6	a	At max v, driving force = resistance Driving force $= \frac{80}{v}$	B1
		$\Rightarrow \frac{80}{20} = k \times 20^2 \Rightarrow k = \frac{1}{100}$	M1A1
		$F = ma \Rightarrow 100a = \frac{80}{v} - kv^2 \quad (= \frac{8000 - v^3}{100v})$	M1
		$* \quad \Rightarrow v\frac{dv}{dx} = \frac{8000 - v^3}{10000v} \quad *$	A1
	b	$\int_4^8 \frac{10000v^2}{8000 - v^3} dv = \int_0^D 1 dx$	M1A1
		$D = \left[-\frac{10000}{3} \ln\left\|8000 - v^3\right\| \right]_4^8$	A1
		$= (-\frac{10000}{3} \ln \frac{7488}{7936}) = 193.7..... \approx 194\,\text{m} \quad$ (accept 190)	M1 A1
	c	$\frac{dv}{dt} = \frac{8000 - v^3}{10000v} \Rightarrow \int_0^T 1 dt = \int_4^8 \frac{10000v}{8000 - v^3} dv$	M1A1
		$\Rightarrow T \approx \frac{1}{2} \times 2 \times 10000 \times \left\{ \frac{4}{7935} + \frac{2 \times 6}{7784} + \frac{8}{7488} \right\}$	M1
		$\Rightarrow T (= 31.1409....) \approx 31$	A1
			(14)

Question Number	Scheme	Marks
7 a		
	Hooke's law: Equilibrium $\Rightarrow \dfrac{16(d-2)}{2} = \dfrac{12(4-d)}{1}$	M1A1A1
	$\Rightarrow d = 3.2$	A1
	so extensions are 1.2m and 0.8m.	A1
b	If the particle is displaced distance x towards **B** then	
	$-m\ddot{x} = \dfrac{16(1.2+x)}{2} - \dfrac{12(0.8-x)}{1} (= 20x)$	M1A1ft A1
	$\Rightarrow \ddot{x} = -40x$ or $\ddot{x} = -\dfrac{20}{m} (\Rightarrow \text{SHM})$	A1
c	$T = \dfrac{2\pi}{\sqrt{40}}$	B1ft
	$a = \dfrac{\sqrt{10}}{\text{their } \omega}$	B1ft
	$x = a\sin\omega t$ their a, their ω	M1
	$\dfrac{1}{4} = \dfrac{1}{2}\sin\sqrt{40}t$	A1
	$\sqrt{40}t = \dfrac{\pi}{6} (\Rightarrow t = \dfrac{\pi}{6\sqrt{40}})$	M1
	Proportion $\dfrac{4t}{T} = \dfrac{4\pi}{6\sqrt{40}} \times \dfrac{\sqrt{40}}{2\pi} = \dfrac{1}{3}$	M1A1
		(16)