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Mark Scheme (Results)
January 2011

GCE

GCE Mechanics M3 (6679) Paper 1

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General Instructions for Marking

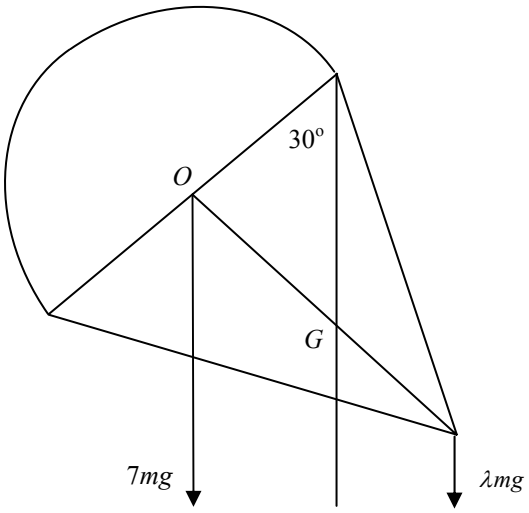
1. The total number of marks for the paper is 75.
2. The Edexcel Mathematics mark schemes use the following types of marks:
   - **M** marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
   - **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
   - **B** marks are unconditional accuracy marks (independent of M marks)
   - Marks should not be subdivided.
3. Abbreviations

   These are some of the traditional marking abbreviations that will appear in the mark schemes.

   - bod – benefit of doubt
   - ft – follow through
   - the symbol $\surd$ will be used for correct ft
   - cao – correct answer only
   - cso - correct solution only. There must be no errors in this part of the question to obtain this mark
   - isw – ignore subsequent working
   - awrt – answers which round to
   - SC: special case
   - oe – or equivalent (and appropriate)
   - dep – dependent
   - indep – independent
   - dp decimal places
   - sf significant figures
   - $*$ The answer is printed on the paper
   - $\lfloor$ The second mark is dependent on gaining the first mark

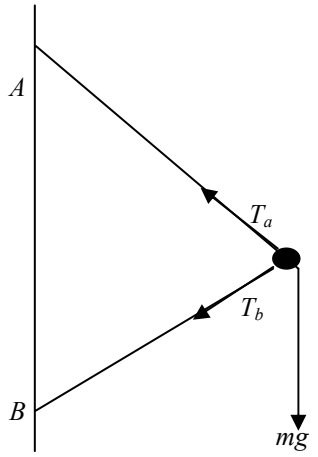
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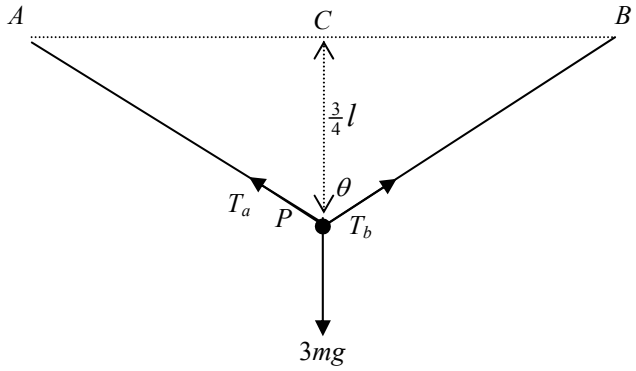
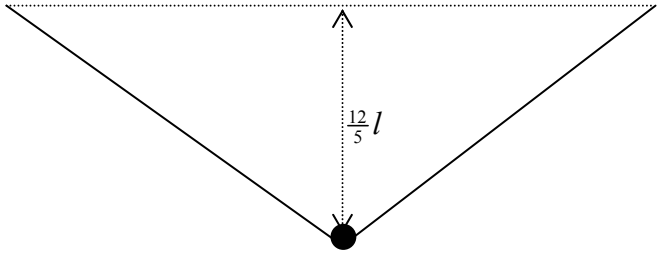
Question Number	Scheme	Marks
1.	$v\dfrac{\mathrm{d}v}{\mathrm{d}x} = 7-2x$	M1
	$\frac{1}{2}v^2 = 7x - x^2 \ \ (+c)$	M1A1
	$x=0 \quad v=6 \ \Rightarrow \ c=18$	A1
	$v=0 \quad x^2-7x-18=0$	
	$(x+2)(x-9)=0$	M1
	$\therefore x=9$	A1
		[6]

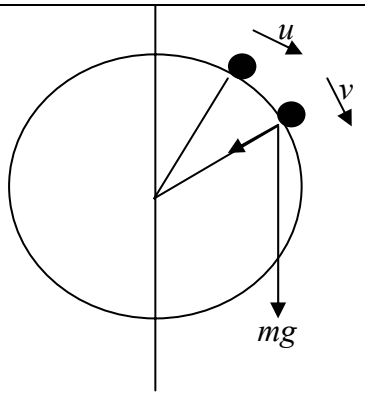
Question Number	Scheme	Marks
2. **(a)**	Mass ratio $4m$ km $\mid (4+k)m$ Dist from O $\frac{3}{8}r$ $-\frac{1}{2}r$ $\mid 0$	B1 B1
	Moments about O: $\frac{3}{8}r \times 4m = \frac{1}{2}r \times km$	M1
	$k = 3$	A1
		(4)
(b)		
	$\tan 30 = \frac{OG}{r}$	B1
	$OG = \frac{\lambda}{(7+\lambda)} \times 2r$	M1
	$\frac{1}{\sqrt{3}} = \frac{\lambda}{(7+\lambda)} \times 2r \times \frac{1}{r}$	A1
	$7 + \lambda = 2\sqrt{3}\lambda$	
	$\lambda = \frac{7}{(2\sqrt{3}-1)}$ (o.e.) or 2.84	A1
		(4) **[8]**

Question Number	Scheme	Marks
3. **(a)**	$\text{Vol} = \pi\int_1^2 y^2\,\mathrm{d}x = \pi\int_1^2 \mathrm{e}^{2x}\,\mathrm{d}x$ $= \frac{1}{2}\pi\left[\mathrm{e}^{2x}\right]_1^2$ $= \frac{1}{2}\pi\left[\mathrm{e}^4 - \mathrm{e}^2\right]$	M1 M1 A1 A1 (4)
(b)	$\text{C of M} = \frac{\int_1^2 \pi y^2 x\,\mathrm{d}x}{\text{vol}}$ $\int_1^2 \mathrm{e}^{2x}x\,\mathrm{d}x = \left[\frac{1}{2}x\mathrm{e}^{2x}\right]_1^2 - \int_1^2 \frac{1}{2}\mathrm{e}^{2x}\,\mathrm{d}x$ $= \left[\frac{1}{2}x\mathrm{e}^{2x}\right]_1^2 - \left[\frac{1}{4}\mathrm{e}^{2x}\right]_1^2$ $= \frac{1}{2}\times 2\mathrm{e}^4 - \frac{1}{2}\times 1\mathrm{e}^2 - \left(\frac{1}{4}\mathrm{e}^4 - \frac{1}{4}\mathrm{e}^2\right)$ $= \left(\frac{3}{4}\mathrm{e}^4 - \frac{1}{4}\mathrm{e}^2\right)$ $\text{C of M} = \frac{\pi\left(\frac{3}{4}\mathrm{e}^4 - \frac{1}{4}\mathrm{e}^2\right)}{\frac{1}{2}\pi\left(\mathrm{e}^4 - \mathrm{e}^2\right)} = 1.656...$ $= 1.66$ (3 sf)	M1 A1 M1 A1 M1 A1 (6) **[10]**

Question Number	Scheme	Marks
4. **(a)**	$x = 5\sin\left(\frac{\pi t}{3}\right)$ $\dot{x} = 5\times\frac{\pi}{3}\cos\left(\frac{\pi t}{3}\right)$ $\ddot{x} = -5\times\left(\frac{\pi}{3}\right)^2\sin\left(\frac{\pi t}{3}\right)$ $\ddot{x} = -\frac{\pi^2}{9}x \qquad (\therefore \text{S.H.M.})$	M1A1 A1 (3)
(b)	$\text{period} = \frac{2\pi}{\frac{\pi}{3}} = 6$ $\text{amplitude} = 5$	B1 B1 (2)
(c)	$\ldots = 5\times\frac{\pi}{3}\cos\left(\frac{\pi t}{3}\right)$ or $\lvert v_{\max}\rvert = a\omega$ $\max.\, v = \frac{5\pi}{3}$	M1 A1 (2)
(d)	At A $x = 2$ $\quad 2 = 5\sin\left(\frac{\pi t}{3}\right)$ $\sin\frac{\pi}{3}t = 0.4$ $t_A = \frac{3}{\pi}\times\sin^{-1}0.4$ At B $\quad x = 3 \quad t_B = \frac{3}{\pi}\times\sin^{-1}0.6$ $\text{time } A\to B \;= \frac{3}{\pi}\times\sin^{-1}0.6 - \frac{3}{\pi}\times\sin^{-1}0.4$ $= 0.2215\ldots = 0.22$ s accept awrt 0.22	M1 A1 A1 A1 (4) **[11]**

Question Number	Scheme	Marks
5.		
(a)	$r = \dfrac{l}{\sqrt{2}}$	B1
	$\mathrm{R}(\uparrow) \quad T_a \cos 45 = T_b \cos 45 + mg$	M1A1
	$T_a - T_b = mg\sqrt{2}$ (1)	
	$\mathrm{R}(\rightarrow) \quad T_a \cos 45 + T_b \cos 45 = mr\omega^2$	M1A1
	$T_a \times \dfrac{1}{\sqrt{2}} + T_b \times \dfrac{1}{\sqrt{2}} = m\dfrac{l}{\sqrt{2}}\omega^2$	
	$T_a + T_b = ml\omega^2$ (2)	
	$T_a - T_b = mg\sqrt{2}$ (1)	
	$2T_a = m\left(l\omega^2 + g\sqrt{2}\right)$	M1
	$T_a = \dfrac{1}{2}m\left(l\omega^2 + g\sqrt{2}\right)$	
	$T_b = ml\omega^2 - T_a$	A1
	$= \dfrac{1}{2}m\left(l\omega^2 - g\sqrt{2}\right)$	A1
		(8)
(b)	$T_b > 0 \qquad \dfrac{1}{2}m\left(l\omega^2 - g\sqrt{2}\right) > 0$	M1
	$\omega^2 > \dfrac{g\sqrt{2}}{l}$ *	A1
		(2) **[10]**

Question Number	Scheme	Marks
6. **(a)**		
	length AP = length $BP = \frac{5}{4}l$	B1
	$T_a = T_b = \frac{kmg\left(\frac{1}{4}l\right)}{l} = \frac{1}{4}kmg$ $\left(\text{or } T = ...\right)$	M1A1
	$\text{R}\left(\uparrow\right)$ $T_a\cos\theta + T_b\cos\theta = 3mg$ $\left(\text{or } 2T\cos\theta = 3mg\right)$	M1A1
	$\frac{1}{4}kmg\times\frac{3}{5}+\frac{1}{4}kmg\times\frac{3}{5}=3mg$ $\left(\text{or } \frac{1}{2}kmg\times\frac{3}{5}=3mg\right)$	A1
	$\frac{3}{10}kmg = 3mg$	
	$k = 10$ *	A1
		(7)
(b)		
	initial extn $= \frac{13}{5}l - l = \frac{8}{5}l$	B1
	E.P.E. lost $= 2\times\frac{\lambda x^2}{2l} = 2\times\frac{10mg}{2l}\left(\frac{8l}{5}\right)^2 = \frac{128mgl}{5}$	M1A1
	P.E. gained $= 3mg\times\frac{12l}{5} = \frac{36mgl}{5}$	
	$\frac{1}{2}\times 3mv^2 + \frac{36mgl}{5} = \frac{128mgl}{5}$	M1A1
	$v^2 = \frac{256gl}{15} - \frac{72gl}{15}$	
	$v = \sqrt{\left(\frac{184}{15}gl\right)}$	A1
		(6) **[13]**

Question Number	Scheme	Marks
7.		
(a)	$mgl\left(\cos\alpha-\cos\theta\right)=\frac{1}{2}mv^2-\frac{1}{2}mu^2$ $v^2=u^2+2gl\left(\cos\alpha-\cos\theta\right)$ *	M1A1=A1 A1 (4)
(b)	$\cos\alpha=\frac{3}{5}\quad v^2=2gl\left(\frac{3}{5}-\cos\theta\right)+u^2$ At top $\theta=360°\quad v^2=2gl\left(\frac{3}{5}-1\right)+u^2$ $v^2>0\quad -2gl\times\frac{2}{5}+u^2>0$ $u^2>\frac{4gl}{5}$ $u>2\sqrt{\frac{gl}{5}}$ *	M1A1 M1 A1 (4)

Question Number	Scheme	Marks
(c)	Equation of motion along radius at lowest point:	
	$T_1 - mg = \frac{mv^2}{l}$	M1A1
	$\theta = 180 \qquad v^2 = 2gl\left(\frac{3}{5}+1\right)+u^2$	M1
	$v^2 = \frac{16gl}{5}+u^2$	
	$T_1 = \frac{m}{l}\left(\frac{16gl}{5}+u^2\right)+mg$	
	$= \frac{21mg}{5}+\frac{mu^2}{l}$	A1
	At highest point:	
	$T_2 + mg = \frac{mv^2}{l}$	M1
	$\theta = 360 \qquad T_2 = 2mg\left(-\frac{2}{5}\right)+\frac{mu^2}{l}-mg$	M1
	$T_2 = \frac{mu^2}{l}-\frac{9mg}{5}$	A1
	$T_1 = 5T_2$	
	$\frac{21mg}{5}+\frac{mu^2}{l} = 5\left(\frac{mu^2}{l}-\frac{9mg}{5}\right)$	M1
	$\frac{66mg}{5} = \frac{4mu^2}{l}$	
	$u^2 = \frac{33gl}{10}$ *	A1
		(9)
		[17]

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