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Mark Scheme (Results)

June 2011

GCE Mechanics M3 (6679) Paper 1

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EDEXCEL GCE MATHEMATICS

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 and can be used if you are using the annotation facility on ePEN.

   - bod – benefit of doubt
   - ft – follow through
   - the symbol $\hat{}$ 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
   - ⌐ The second mark is dependent on gaining the first mark

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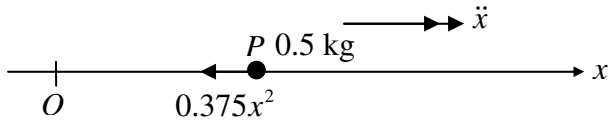
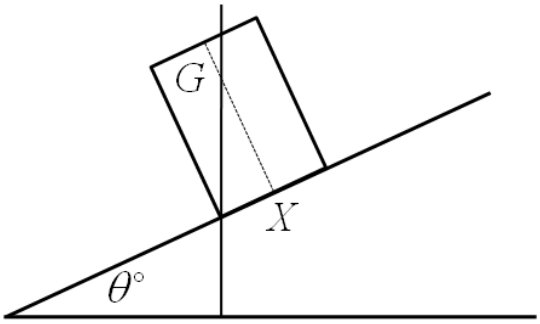
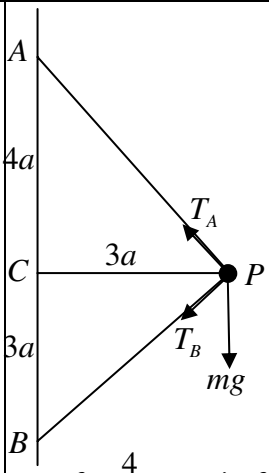
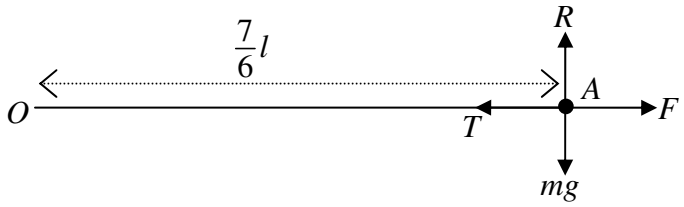
Mechanics M3 6679
Mark Scheme

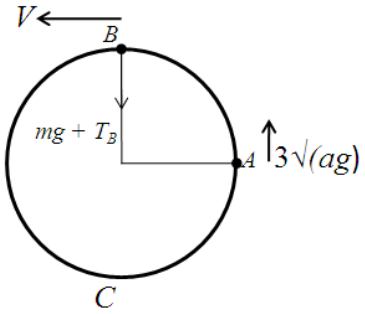
Question Number	Scheme	Marks
1. **(a)**	 $0.5v\dfrac{\mathrm{d}v}{\mathrm{d}x} = -0.375x^2$	M1
	$\dfrac{1}{2}v^2 = -0.25x^3 + c$	M1 A1
	$t = 0, v = 2, x = 8$ $\dfrac{1}{2}\times 2^2 = -0.25\times 8^3 + c$ $c = 130$	
	$\therefore v^2 = -\dfrac{1}{2}x^3 + 260$ *	A1 (4)
(b)	$v = 5 \quad x^3 = 520 - 50$ $x = 7.77$	M1 A1 (2) **6**

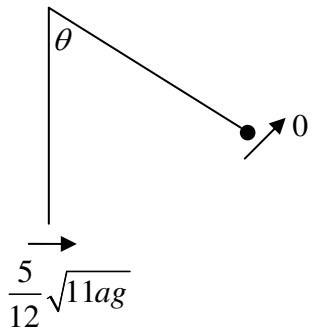
Question Number	Scheme	Marks
2.	$V = \pi\int_0^3 \left(9-x^2\right)^2 \mathrm{d}x = \pi\int_0^3 \left(81-18x^2+x^4\right)\mathrm{d}x$	M1
	$= \pi\left[81x-6x^3+\frac{x^5}{5}\right]_0^3 = \frac{648}{5}\pi$ OR:	M1 A1
	$\int_0^3 \pi\left(9-x^2\right)^2 x\,\mathrm{d}x$ $\quad$ $\pi\int_0^3 \left(81x-18x^3+x^5\right)\mathrm{d}x$	
	$= \frac{\pi}{6}\left[-\left(9-x^2\right)^3\right]_0^3$ $\quad$ $= \pi\left[\frac{81}{2}x^2-\frac{9}{2}x^4+\frac{1}{6}x^6\right]_0^3$	M1 A1
	$= \frac{\pi}{6}\left[0+(9)^3\right]$	M1
	$= \pi\left[\frac{81}{2}\times 3^2-\frac{9}{2}\times 3^4+\frac{1}{6}\times 3^6\right]$	
	$= \frac{243}{2}\pi$ $\quad$ $= \frac{243}{2}\pi$	A1
	$\bar{x} = \frac{\frac{243}{2}}{\frac{648}{5}} = \frac{15}{16}$ $\quad (\text{accept } 0.94)$	M1 A1
		(9) **9**
3.		
(a)	Mass ratio $\quad \pi(3l)^2\times 5l\rho \quad \frac{2}{3}\pi(3l)^3\times 2\rho \quad \|\| \quad 81\pi l^3\rho$	
	$\quad 5 \quad 4 \quad 9$	B1
	Dist. from O $\quad \frac{5}{2}l \quad -\frac{3}{8}\times 3l \quad \|\| \quad \bar{x}$	B1
	Moments equation:	
	$5\times\frac{5}{2}l-4\times\frac{9}{8}l = 9\bar{x}$	M1 A1 ft
	$\bar{x} = \frac{8}{9}l$	A1
		(5)

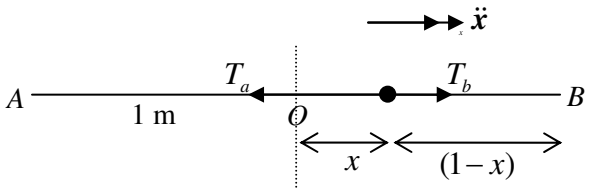
Question Number	Scheme	Marks
(b)		
	$GX = 5l - \frac{8}{9}l = \frac{37}{9}l$	B1ft
	$\tan\theta° = \frac{3l}{\frac{37}{9}l} = \frac{27}{37}$	M1 A1 ft
	$\theta° = 36.1°$ accept $36°$, 0.63 or 0.630 rad or better	A1
		(4)
		9

Question Number	Scheme	Marks
4. **(a)**		
	$\cos\theta = \frac{4}{5}$ or $\sin\theta = \frac{3}{5}$	B1
	R(vert) $T_B\cos 45 + mg = T_A\cos\theta$	M1 A1
	$\frac{1}{\sqrt{2}}T_B + mg = \frac{4}{5}T_A$	
	R(horiz) $T_A\sin\theta + T_B\cos 45 = m\times 3a\omega^2$	M1 A1=A1
	$\frac{3}{5}T_A + \frac{1}{\sqrt{2}}T_B = 3ma\omega^2$	
	$\frac{3}{5}T_A - mg = 3ma\omega^2 - \frac{4}{5}T_a$	M1
	$\frac{7}{5}T_A = 3ma\omega^2 + mg$	
	$T_A = \frac{5}{7}m\left(3a\omega^2 + g\right)$ *	A1 (8)
(b)	$T_b = \sqrt{2}\left(\frac{4}{5}T_a - mg\right)$	M1
	$= \sqrt{2}\left(\frac{4}{7}m\left(3a\omega^2 + g\right) - mg\right)$	
	$= \frac{3\sqrt{2}}{7}m\left(4a\omega^2 - g\right)$ oe	A1
		(2)

Question Number	Scheme	Marks
(c)	$T_b \geqslant 0 \Rightarrow 4a\omega^2 \geqslant g$ $\omega^2 \geqslant \frac{g}{4a}$ $\omega \geqslant \frac{1}{2}\sqrt{\frac{g}{a}}$ * (Allow strict inequalities in (c).)	M1 A1 (2) **12**
5. **(a)**	 $T = \frac{3mg}{l}\left(\frac{1}{6}l\right) = \frac{1}{2}mg$ R$(\uparrow)$ $R = mg$ R$(\rightarrow)$ $F = T = \frac{1}{2}mg$ $F \leqslant \mu R$ $\frac{1}{2}mg \leqslant \mu mg$ $\mu \geqslant \frac{1}{2}$ *	 B1 M1 M1 A1 (4)
(b)	E.P.E. lost $= \frac{1}{2} \times \frac{3mg}{l}\left(\frac{1}{2}l\right)^2 = \frac{3mgl}{8}$ Work done by friction $= \frac{1}{2}mg\left(\frac{l}{2}\right)$ $\frac{3mgl}{8} = \frac{1}{2}mv^2 + \frac{1}{2}mg\left(\frac{l}{2}\right)$ $v^2 = \frac{gl}{4}$ $v = \frac{1}{2}\sqrt{gl}$	 B1 B1 M1 A1ft A1 (5)

Question Number	Scheme	Marks
(c)	$\frac{3mgl}{8} = \frac{1}{2}mgx$ $x = \frac{3l}{4}$	M1 A1 ft A1 (3) **12**
6. **(a)**	 Energy to B: $\frac{1}{2}m\left(3\sqrt{ag}\right)^2 - \frac{1}{2}\times mV^2 = mag$ $9ag - V^2 = 2ag$ $V^2 = 7ag$ NL2 along radius at B: $T_B + mg = m\frac{V^2}{a}$ $T_B + mg = 7mg$ $T_B = 6mg$ $T_B > 0 \Rightarrow$ particle reaches B	M1 A1 M1 A1 M1 A1 (6)

Question Number	Scheme	Marks
(b)	Energy to C: $\frac{1}{2}\times mU^2-\frac{1}{2}m\left(3\sqrt{ag}\right)^2=mag$ $U^2=2ag+9ag$ $U=\sqrt{11ga}$	M1 A1 (2)
(c)	 Energy from C to rest: $\frac{1}{2}\times m\times\left(\frac{5}{12}\sqrt{11ag}\right)^2=mga\left(1-\cos\theta\right)$ $\frac{25}{144}\times 11ag=2ga\left(1-\cos\theta\right)$ $\cos\theta=\frac{1}{2}\left(2-\frac{25\times 11}{144}\right)$ $\theta=87.4...$ $\theta=87°$ (or 1.5 rad) or better	 M1 A1 M1 A1 (4) **12**

Question Number	Scheme	Marks
7.		
(a)	Total extn. = 0.6 $T_b = \dfrac{\lambda \times \text{ext}}{l} = \dfrac{2(0.3-x)}{0.7} = \dfrac{2}{7}(3-10x)$ *	M1 A1 (2)
(b)	$T_a = \dfrac{2(x+0.3)}{0.7} \quad \left(= \dfrac{2}{7}(10x+3)\right)$	B1 (1)
(c)	$T_b - T_a = 0.5\ddot{x}$ $\dfrac{2}{7}(3-10x) - \dfrac{2}{7}(10x+3) = 0.5\ddot{x}$ $2 \times \left(-\dfrac{20x}{7}\right) = 0.5\ddot{x}$ $\ddot{x} = -\dfrac{40}{7 \times 0.5}x$ $(\therefore$ S.H.M.$)$ Period $= \dfrac{2\pi}{\omega} = 2\pi\sqrt{\dfrac{7 \times 0.5}{40}} = 2\pi\sqrt{\dfrac{7}{80}}$ *	M1 A1 ft M1 A1 M1 A1 (6)
(d)	$v_{\max} = a\omega = 0.2\sqrt{\dfrac{80}{7}}$ o.e. or a.w.r.t. 0.68 m s^{-1}	M1 A1 (2)
(e)	$x = a\cos\omega t = 0.2\cos\left(\sqrt{\dfrac{80}{7}}t\right)$ $x = -0.1 \quad -\dfrac{0.1}{0.2} = \cos\left(\sqrt{\dfrac{80}{7}}t\right)$ $t = \sqrt{\dfrac{7}{80}}\cos^{-1}(-0.5)$ $t = \sqrt{\dfrac{7}{80}} \times \dfrac{2\pi}{3} = \dfrac{\pi}{3}\sqrt{\dfrac{7}{20}}$ o.e. (accept a.w.r.t. 0.62) s	M1 A1 M1 A1 (4) **15**

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