

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.

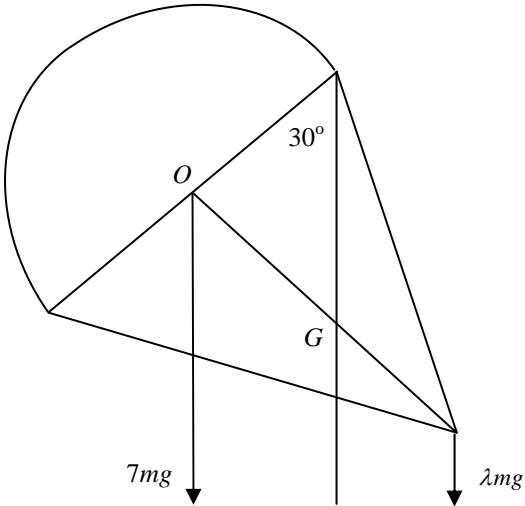
3. Abbreviations

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
- \square The second mark is dependent on gaining the first mark

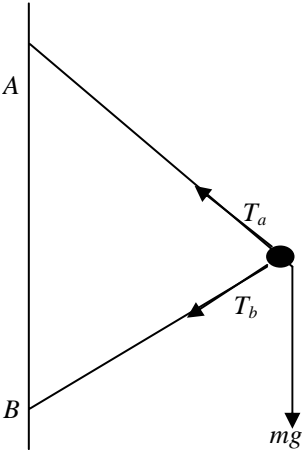
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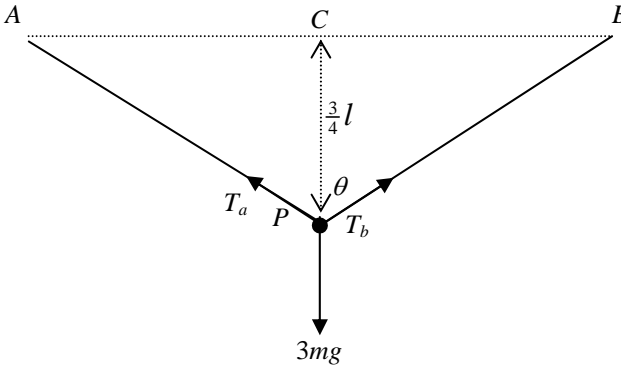
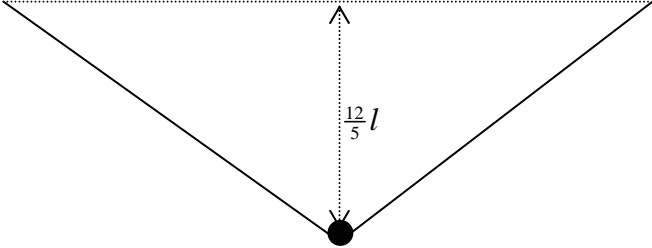
Question Number	Scheme	Marks
1.	$v \frac{dv}{dx} = 7 - 2x$ $\frac{1}{2}v^2 = 7x - x^2 (+c)$ $x = 0 \quad v = 6 \Rightarrow c = 18$ $v = 0 \quad x^2 - 7x - 18 = 0$ $(x + 2)(x - 9) = 0$ $\therefore x = 9$	M1 M1A1 A1 M1 A1 [6]

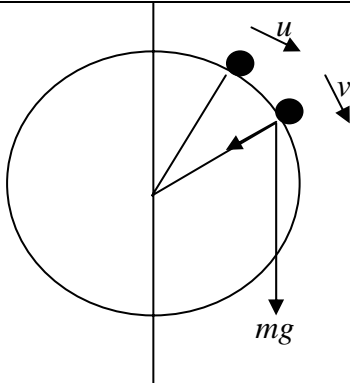
Question Number	Scheme	Marks
2. (a)	<p>Mass ratio $4m$ km $(4+k)m$</p> <p>Dist from O $\frac{3}{8}r$ $-\frac{1}{2}r$ 0</p> <p>Moments about O:</p> $\frac{3}{8}r \times 4m = \frac{1}{2}r \times km$ <p>$k = 3$</p>	B1 B1 M1 A1 (4)
(b)	 <p>$\tan 30 = \frac{OG}{r}$</p> $OG = \frac{\lambda}{(7+\lambda)} \times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

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

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

Question Number	Scheme	Marks
5.	<div style="text-align: center;">  </div> <p>(a)</p> $r = \frac{l}{\sqrt{2}}$ $R(\uparrow) \quad T_a \cos 45 = T_b \cos 45 + mg$ $T_a - T_b = mg \sqrt{2} \quad (1)$ $R(\rightarrow) \quad T_a \cos 45 + T_b \cos 45 = mr\omega^2$ $T_a \times \frac{1}{\sqrt{2}} + T_b \times \frac{1}{\sqrt{2}} = m \frac{l}{\sqrt{2}} \omega^2$ $T_a + T_b = ml\omega^2 \quad (2)$ $T_a - T_b = mg \sqrt{2} \quad (1)$ $2T_a = m(l\omega^2 + g\sqrt{2})$ $T_a = \frac{1}{2}m(l\omega^2 + g\sqrt{2})$ $T_b = ml\omega^2 - T_a$ $= \frac{1}{2}m(l\omega^2 - g\sqrt{2})$	<p>B1</p> <p>M1A1</p> <p>M1A1</p> <p>M1</p> <p>A1</p> <p>A1</p> <p>(8)</p>
(b)	$T_b > 0 \quad \frac{1}{2}m(l\omega^2 - g\sqrt{2}) > 0$ $\omega^2 > \frac{g\sqrt{2}}{l} \quad *$	<p>M1</p> <p>A1</p> <p>(2)</p> <p>[10]</p>

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

Question Number	Scheme	Marks
7.	<div style="text-align: center;">  </div> <p>(a)</p> $mgl(\cos \alpha - \cos \theta) = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$ $v^2 = u^2 + 2gl(\cos \alpha - \cos \theta) \quad *$	<p>M1A1=A1</p> <p>A1</p> <p>(4)</p>
(b)	$\cos \alpha = \frac{3}{5} \quad v^2 = 2gl\left(\frac{3}{5} - \cos \theta\right) + u^2$ <p>At top $\theta = 360^\circ \quad v^2 = 2gl\left(\frac{3}{5} - 1\right) + u^2$</p> $v^2 > 0 \quad -2gl \times \frac{2}{5} + u^2 > 0$ $u^2 > \frac{4gl}{5}$ $u > 2\sqrt{\frac{gl}{5}} \quad *$	<p>M1A1</p> <p>M1</p> <p>A1</p> <p>(4)</p>

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

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