

# Mark Scheme (Results) Summer 2010

GCE

## GCE Mechanics M3 (6679/01)

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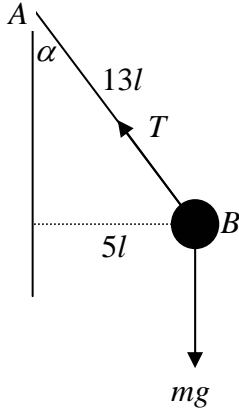
Summer 2010

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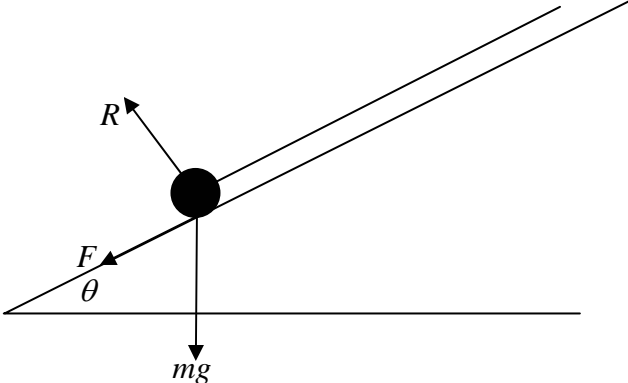
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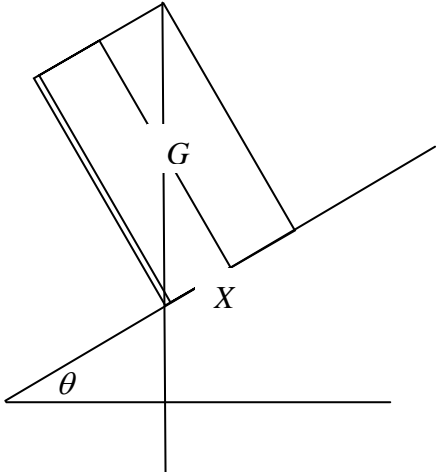
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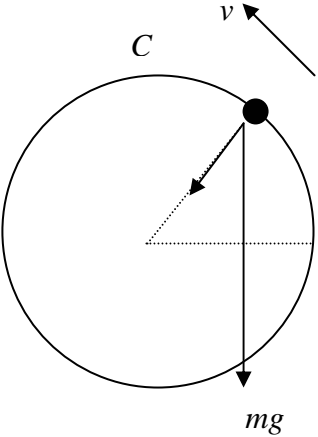
Summer 2010  
 Mechanics M3 6679  
 Mark Scheme

Question Number	Scheme	Marks
Q1	<div style="text-align: center;">  </div> <p>(a)</p> $\cos \alpha = \frac{12}{13}$ $R(\uparrow) \quad T \cos \alpha = mg$ $T \times \frac{12}{13} = mg$ $T = \frac{13}{12} mg \quad \text{oe}$	<p>B1</p> <p>M1</p> <p>A1 (3)</p>
(b)	<p>Eqn of motion <math>T \sin \alpha = m \frac{v^2}{5l}</math></p> $\frac{13mg}{12} \times \frac{5}{13} = m \frac{v^2}{5l}$ $v^2 = \frac{25gl}{12}$ $v = \frac{5}{2} \sqrt{\frac{gl}{3}} \quad \left( \text{accept } 5\sqrt{\frac{gl}{12}} \text{ or } \sqrt{\frac{25gl}{12}} \text{ or any other equiv} \right)$	<p>M1 A1</p> <p>M1 dep</p> <p>A1 (4)</p> <p>[7]</p>

Question Number	Scheme	Marks
Q2 (a)	$F = (-) \frac{k}{x^2}$ $mg = (-) \frac{k}{R^2}$ $F = \frac{mgR^2}{x^2} *$	M1 M1 A1 (3)
(b)	$m\ddot{x} = -\frac{mgR^2}{x^2}$ $v \frac{dv}{dx} = -\frac{gR^2}{x^2}$ $\frac{1}{2}v^2 = \int \left( -\frac{gR^2}{x^2} \right) dx$ $\frac{1}{2}v^2 = \frac{gR^2}{x} (+c)$ $x = R, v = 3U \quad \frac{9U^2}{2} = gR + c$ $\frac{1}{2}v^2 = \frac{gR^2}{x} + \frac{9U^2}{2} - gR$ $x = 2R, v = U \quad \frac{1}{2}U^2 = \frac{gR^2}{2R} + \frac{9U^2}{2} - gR$ $U^2 = \frac{gR}{8}$ $U = \sqrt{\frac{gR}{8}}$	M1 M1 M1 dep on 1st M mark A1 M1 dep on 3rd M mark M1 dep on 3rd M mark A1 (7) [10]

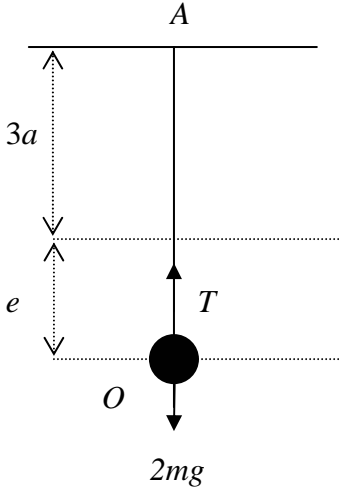
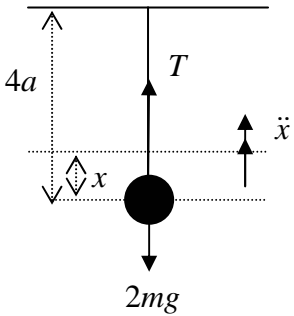
Question Number	Scheme	Marks
Q3	 <p> <math display="block">\text{EPE lost} = \frac{\lambda \times 0.6^2}{2 \times 0.9} - \frac{\lambda \times 0.1^2}{2 \times 0.9} \left( = \frac{7}{36} \lambda \right)</math> <math display="block">R(\uparrow) \quad R = mg \cos \theta</math> <math display="block">= 0.5g \times \frac{4}{5} = 0.4g</math> <math display="block">F = \mu R = 0.15 \times 0.4g</math> <p>P.E. gained = E.P.E. lost - work done against friction</p> <math display="block">0.5g \times 0.7 \sin \theta = \frac{\lambda \times 0.6^2}{2 \times 0.9} - \frac{\lambda \times 0.1^2}{2 \times 0.9} - 0.15 \times 0.4g \times 0.7</math> <math display="block">0.1944\lambda = 0.5 \times 9.8 \times 0.7 \times \frac{3}{5} + 0.15 \times 0.4 \times 9.8 \times 0.7</math> <math display="block">\lambda = 12.70 \dots</math> <math display="block">\lambda = 13 \text{ N} \quad \text{or } 12.7</math> </p>	<p>M1 A1</p> <p>M1</p> <p>M1 A1</p> <p>M1 A1 A1</p> <p>A1</p> <p>[9]</p>

Question Number	Scheme	Marks																
Q4 (a)	<table border="1" data-bbox="263 315 871 555"> <thead> <tr> <th></th> <th>cone</th> <th>container</th> <th>cylinder</th> </tr> </thead> <tbody> <tr> <td>mass ratio</td> <td><math>\frac{4\pi l^3}{3}</math></td> <td><math>\frac{68\pi l^3}{3}</math></td> <td><math>24\pi l^3</math></td> </tr> <tr> <td></td> <td>4</td> <td>68</td> <td>72</td> </tr> <tr> <td>dist from <math>O</math></td> <td><math>l</math></td> <td><math>\bar{x}</math></td> <td><math>3l</math></td> </tr> </tbody> </table> <p data-bbox="263 595 989 712">                     Moments: <math>4l + 68\bar{x} = 72 \times 3l</math>  <math>\bar{x} = \frac{212l}{68} = \frac{53}{17}l</math> accept <math>3.12l</math> </p>		cone	container	cylinder	mass ratio	$\frac{4\pi l^3}{3}$	$\frac{68\pi l^3}{3}$	$24\pi l^3$		4	68	72	dist from $O$	$l$	$\bar{x}$	$3l$	<p data-bbox="1273 383 1353 412">M1 A1</p> <p data-bbox="1273 506 1305 535">B1</p> <p data-bbox="1273 595 1378 624">M1 A1ft</p> <p data-bbox="1273 658 1474 687">A1 (6)</p>
	cone	container	cylinder															
mass ratio	$\frac{4\pi l^3}{3}$	$\frac{68\pi l^3}{3}$	$24\pi l^3$															
	4	68	72															
dist from $O$	$l$	$\bar{x}$	$3l$															
(b)	 <p data-bbox="411 1279 933 1518"> <math>GX = 6l - \bar{x}</math> seen  <math>\tan \theta = \frac{2l}{6l - \bar{x}}</math>  <math>= \frac{2 \times 17}{49}</math>  <math>\theta = 34.75\dots = 34.8</math> or 35                 </p>	<p data-bbox="1273 1279 1310 1308">M1</p> <p data-bbox="1273 1341 1353 1370">M1 A1</p> <p data-bbox="1273 1487 1474 1552">A1 (4) [10]</p>																

Question Number	Scheme	Marks
Q5		
(a)	Energy: $mga \sin \theta = \frac{1}{2}m \times 5ag - \frac{1}{2}mv^2$ $v^2 = 5ag - 2ag \sin \theta$	M1 A1 A1 (3)
(b)	Eqn of motion along radius: $T + mg \sin \theta = \frac{mv^2}{a}$ $T = \frac{m}{a}(5ag - 2ag \sin \theta) - mg \sin \theta$ $T = mg(5 - 3 \sin \theta)$	M1 A1 M1 A1 (4)
(c)	At C, $\theta = 90^\circ$ $T = mg(5 - 3) = 2mg$ $T > 0 \therefore P$ reaches C	M1 A1 A1 (3)
(d)	Max speed at lowest point ( $\theta = 270^\circ$ ; $v^2 = 5ag - 2ag \sin 270^\circ$ $v^2 = 5ag + 2ag$ $v = \sqrt{7ag}$ )	M1 A1 (2) [12]

Question Number	Scheme	Marks
Q6 (a)	$\frac{d^2x}{dt^2} = -\frac{3}{(t+1)^2}$ $\frac{dx}{dt} = \int -3(t+1)^{-2} dt$ $= 3(t+1)^{-1} (+c)$ <p><math>t=0, v=2 \quad 2=3+c \quad c=-1</math></p> $\frac{dx}{dt} = \frac{3}{t+1} - 1 \quad *$	<p>M1</p> <p>M1 A1</p> <p>M1</p> <p>A1 (5)</p>
(b)	$x = \int \left( \frac{3}{t+1} - 1 \right) dt$ $= 3\ln(t+1) - t \quad (+c')$ <p><math>t=0, x=0 \Rightarrow c' = 0</math></p> $x = 3\ln(t+1) - t$ $v = 0 \Rightarrow \frac{3}{t+1} = 1$ $t = 2$ $x = 3\ln 3 - 2$ $= 1.295\dots$ $= 1.30 \text{ m (Allow 1.3)}$	<p>M1</p> <p>A1</p> <p>B1</p> <p>M1</p> <p>A1</p> <p>M1</p> <p>A1 (7)</p> <p>[12]</p>



Question Number	Scheme	Marks
Q7	<div style="text-align: center;">  </div> <p>(a)</p> $R(\uparrow) \quad T = 2mg$ <p>Hooke's law: <math>T = \frac{6mge}{3a}</math></p> $2mg = \frac{6mge}{3a}$ $e = a$ $AO = 4a$	<p>B1</p> <p>M!</p> <p>A1 (3)</p>
(b)	<div style="text-align: center;">  </div> <p>H.L.</p> <p>Eqn. of motion</p> $T = \frac{6mg(a-x)}{3a} = \frac{2mg(a-x)}{a}$ $-2mg + T = 2m\ddot{x}$ $-2mg + \frac{2mg(a-x)}{a} = 2m\ddot{x}$ $-\frac{2mgx}{a} = 2m\ddot{x}$ $\ddot{x} = -\frac{g}{a}x$ <p>period <math>2\pi\sqrt{\frac{a}{g}}</math> *</p>	<p>B1ft</p> <p>M1</p> <p>M1</p> <p>A1</p> <p>A1 (5)</p>

Question Number	Scheme	Marks
(c)	$v^2 = \omega^2 (a^2 - x^2)$ $v_{\max}^2 = \frac{g}{a} \left( \left( \frac{a}{4} \right)^2 - 0 \right)$ $v_{\max} = \frac{1}{4} \sqrt{ga}$	<p>M1 A1</p> <p>A1 (3)</p>
(d)	$x = -\frac{a}{8}$ $v^2 = \frac{g}{a} \left( \frac{a^2}{16} - \frac{a^2}{64} \right)$ $= \frac{3ag}{64}$ $v^2 = u^2 + 2as$ $0 = \frac{3ag}{64} - 2gh$ $h = \frac{3a}{128}$ <p>Total height above <math>O = \frac{a}{8} + \frac{3a}{128} = \frac{19a}{128}</math></p>	<p>M1</p> <p>M1</p> <p>A1</p> <p>A1 (4)</p> <p>[15]</p>



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