

Mark Scheme (Results) January 2010

GCE

Mechanics M3 (6679)

Edexcel is one of the leading examining and awarding bodies in the UK and throughout the world. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. Through a network of UK and overseas offices, Edexcel's centres receive the support they need to help them deliver their education and training programmes to learners.

For further information, please call our GCE line on 0844 576 0025, our GCSE team on 0844 576 0027, or visit our website at www.edexcel.com.

If you have any subject specific questions about the content of this Mark Scheme that require the help of a subject specialist, you may find our **Ask The Expert** email service helpful.

Ask The Expert can be accessed online at the following link:

<http://www.edexcel.com/Aboutus/contact-us/>

January 2010

Publications Code UA022968

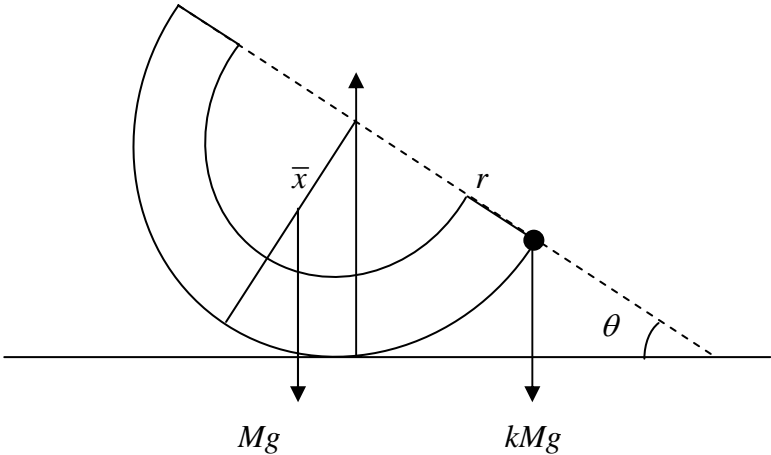
All the material in this publication is copyright

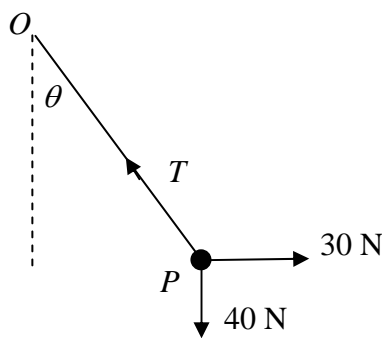
© Edexcel Ltd 2010

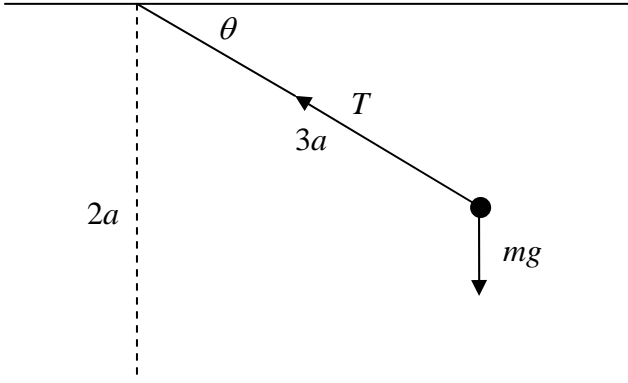
January 2010
6679 Mechanics M3
Mark Scheme

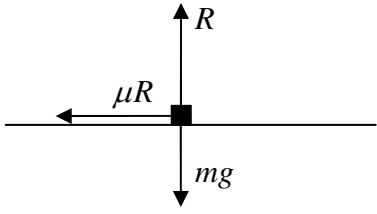
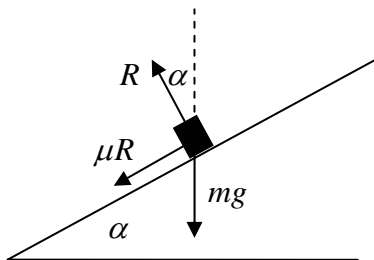
Question Number	Scheme	Marks
Q1.	$0.5a = 4 + \cos(\pi t)$	B1
	Integrating $0.5v = 4t + \frac{\sin(\pi t)}{\pi} (+ C)$	M1 A1
	Using boundary values $3 = 4 + C \Rightarrow C = -1$	M1 A1
	When $t = 1.5$ $0.5v = 6 - \frac{1}{\pi} - 1$	M1
	$v \approx 9.36 \text{ (m s}^{-1}\text{)}$	cao A1
		(7) [7]

Question Number	Scheme	Marks
Q2.	<p>(a)</p> $\frac{2\pi}{\omega} = 2.4 \Rightarrow \omega = \frac{5\pi}{6} (\approx 2.62)$ $x = 0, t = 0 \Rightarrow x = a \sin \omega t$ <p>when $t = 0.4$, $x = a \sin\left(\frac{5\pi}{6} \times 0.4\right) \quad \left(= \frac{\sqrt{3}}{2} a \right)$</p> $v^2 = \omega^2 (a^2 - x^2) \Rightarrow 16 = \frac{25\pi^2}{36} \left(a^2 - \frac{3a^2}{4} \right) \Rightarrow a = \frac{48}{5\pi} (\approx 3.06)$ $v_{\max} = a\omega = 8 \quad (\text{or awrt } 8.0 \text{ if decimals used earlier}) \quad \text{cao}$ <p>(b)</p> $\ddot{x}_{\max} = a\omega^2 = \frac{20\pi}{3} \quad \text{awrt } 21$	<p>M1 A1</p> <p>M1</p> <p>M1 A1</p> <p>M1 A1 (7)</p> <p>M1 A1 (2)</p> <p>[9]</p>
	<p>Alternative in (a)</p> <p>(a)</p> $\frac{2\pi}{\omega} = 2.4 \Rightarrow \omega = \frac{5\pi}{6}$ $x = 0, t = 0 \Rightarrow x = a \sin \omega t$ $\dot{x} = a\omega \cos \omega t$ $4 = a\omega \cos\left(\frac{5\pi}{6} \times 0.4\right)$ $a = \frac{48}{5\pi} (\approx 3.06) \quad \text{or } a\omega = 8$ $v_{\max} = a\omega = 8$	<p>M1 A1</p> <p>M1</p> <p>M1</p> <p>A1</p> <p>M1 A1 (7)</p>

Question Number	Scheme	Marks															
Q3.	<p>(a)</p> <table style="margin-left: 40px;"> <tr> <td></td> <td style="text-align: center;">s</td> <td style="text-align: center;">B</td> <td style="text-align: center;">S</td> <td></td> </tr> <tr> <td>Mass ratios</td> <td style="text-align: center;">8</td> <td style="text-align: center;">19</td> <td style="text-align: center;">27</td> <td>anything in correct ratio</td> </tr> <tr> <td>\bar{x}</td> <td style="text-align: center;">$\frac{3}{8} \times \frac{2}{3} r$</td> <td style="text-align: center;">\bar{x}</td> <td style="text-align: center;">$\frac{3}{8} r$</td> <td></td> </tr> </table> $8 \times \frac{1}{4} r + 19 \bar{x} = 27 \times \frac{3}{8} r$ $\bar{x} = \frac{65}{152} r \quad *$ <p>(b)</p>  <p style="margin-left: 40px;">$Mg \times \bar{x} \sin \theta = kMg \times r \cos \theta$</p> <p style="margin-left: 40px;">leading to $k = \frac{13}{38}$</p>		s	B	S		Mass ratios	8	19	27	anything in correct ratio	\bar{x}	$\frac{3}{8} \times \frac{2}{3} r$	\bar{x}	$\frac{3}{8} r$		<p>B1</p> <p>B1</p> <p>M1 A1ft</p> <p>A1 (5)</p> <p>M1 A1=A1</p> <p>M1 A1 (5)</p> <p>[10]</p>
	s	B	S														
Mass ratios	8	19	27	anything in correct ratio													
\bar{x}	$\frac{3}{8} \times \frac{2}{3} r$	\bar{x}	$\frac{3}{8} r$														

Question Number	Scheme	Marks
Q4.	<div style="text-align: center;">  </div> <p> $\uparrow \quad T \cos \theta = 40$ M1 attempt at both equations $\rightarrow \quad T \sin \theta = 30$ leading to $T = 50$ </p> <p style="text-align: center;"> $E = \frac{\lambda x^2}{2a} = 10$ </p> <p> HL $T = \frac{\lambda x}{a} = 50$ </p> <p>leading to $x = 0.4$</p> <p>$OP = 0.5 + 0.4 = 0.9 \text{ (m)}$</p>	<p>M1 A1 A1 M1 A1</p> <p>B1</p> <p>M1</p> <p>M1 A1</p> <p>A1ft (10) [10]</p>

Question Number	Scheme	Marks
Q5.	<p>(a) </p> $\frac{1}{2}m \times 2ag - \frac{1}{2}mv^2 = mg(2a - 3a \sin \theta)$ <p>leading to $v^2 = 2ga(3 \sin \theta - 1)$ *</p> <p>(b) minimum value of T is when $v = 0 \Rightarrow \sin \theta = \frac{1}{3}$</p> $T = mg \sin \theta = \frac{mg}{3}$ <p>maximum value of T is when $\theta = \frac{\pi}{2} \quad (v^2 = 4ag)$</p> $\uparrow \quad T = \frac{mv^2}{3a} + mg = \frac{7mg}{3}$ $\left(\frac{mg}{3} \leq T \leq \frac{7mg}{3} \right)$	<p>cs0</p> <p>M1 A1=A1 M1 A1 (5)</p> <p>B1 M1 A1</p> <p>M1 A1 A1 (6)</p> <p>[11]</p>

Question Number	Scheme	Marks
Q6.	<p>(a)</p>  <p style="text-align: center;"> $\uparrow \quad R = mg$ Use of limiting friction, $F_r = \mu R$ $\leftarrow \quad \mu R = \frac{m28^2}{120}$ $\mu = \frac{28^2}{120 \times 9.8} = \frac{2}{3} \quad *$ </p> <p>(b)</p>  <p style="text-align: center;"> $\uparrow \quad R \cos \alpha - \mu R \sin \alpha = mg$ $\leftarrow \quad \mu R \cos \alpha + R \sin \alpha = \frac{mv^2}{r}$ $\frac{\mu \cos \alpha + \sin \alpha}{\cos \alpha - \mu \sin \alpha} = \frac{v^2}{rg}$ $\frac{2 \cos \alpha + 3 \sin \alpha}{3 \cos \alpha - 2 \sin \alpha} = \frac{25}{24}$ leading to $\tan \alpha = \frac{27}{122}$ </p>	<p>B1 B1 M1 A1 M1 A1 (6) cao</p> <p>M1 A1 M1 A1 M1 M1 M1 A1 (8) [14]</p> <p>Eliminating R Substituting values awrt 0.22</p>

Question Number	Scheme	Marks
Q7.	<p>(a)</p> $\frac{1}{2}mv^2 + \frac{3mgx^2}{4a} = mg(a+x)$ <p>leading to $v^2 = 2g(a+x) - \frac{3gx^2}{2a}$ *</p> <p>(b) Greatest speed is when the acceleration is zero</p> $T = \frac{\lambda x}{a} = \frac{3mgx}{2a} = mg \Rightarrow x = \frac{2a}{3}$ $v^2 = 2g\left(a + \frac{2a}{3}\right) - \frac{3g}{2a} \times \left(\frac{2a}{3}\right)^2 \left(= \frac{8ag}{3} \right)$ $v = \frac{2}{3}\sqrt{(6ag)} \quad \text{accept exact equivalents}$ <p>(c) $v=0 \Rightarrow 2g(a+x) - \frac{3gx^2}{2a} = 0$</p> $3x^2 - 4ax - 4a^2 = (x-2a)(3x+2a) = 0$ $x = 2a$ <p>At D, $m\ddot{x} = mg - \frac{\lambda \times 2a}{a}$</p> $ \ddot{x} = 2g$	<p>M1 A2 (1, 0)</p> <p>cs0 A1 (4)</p> <p>M1 A1</p> <p>M1</p> <p>A1 (4)</p> <p>M1</p> <p>M1 A1</p> <p>M1 A1ft</p> <p>A1 (6)</p> <p>[14]</p>
	<p><i>Alternative to (b)</i></p> $v^2 = 2g(a+x) - \frac{3gx^2}{2a}$ <p>Differentiating with respect to x</p> $2v \frac{dv}{dx} = 2g - \frac{3gx}{a}$ $\frac{dv}{dx} = 0 \Rightarrow x = \frac{2a}{3}$ $v^2 = 2g\left(a + \frac{2a}{3}\right) - \frac{3g}{2a} \times \left(\frac{2a}{3}\right)^2 \left(= \frac{8ag}{3} \right)$ $v = \frac{2}{3}\sqrt{(6ag)} \quad \text{accept exact equivalents}$	<p>M1 A1</p> <p>M1</p> <p>A1 (4)</p>

Question Number	Scheme	Marks
Q7.	<p><i>Alternative approach using SHM for (b) and (c)</i> If SHM is used mark (b) and (c) together placing the marks in the grid as shown.</p> <p>Establishment of equilibrium position</p> $T = \frac{\lambda x}{a} = \frac{3mge}{2a} = mg \Rightarrow e = \frac{2a}{3}$ <p>N2L , using y for displacement from equilibrium position</p> $m\ddot{y} = mg - \frac{\frac{3}{2}mg(y+e)}{a} = -\frac{3g}{2a}y$ $\omega^2 = \frac{3g}{2a}$ <p>Speed at end of free fall $u^2 = 2ga$</p> <p>Using A for amplitude and $v^2 = \omega^2(a^2 - x^2)$</p> $u^2 = 2ga \text{ when } y = -\frac{2}{3}a \Rightarrow 2ga = \frac{3g}{2a} \left(A^2 - \frac{4a^2}{9} \right)$ $A = \frac{4a}{3}$ <p>Maximum speed $A\omega = \frac{4a}{3} \times \sqrt{\left(\frac{3g}{2a}\right)} = \frac{2}{3}\sqrt{6ag}$</p> <p>Maximum acceleration $A\omega^2 = \frac{4a}{3} \times \frac{3g}{2a} = 2g$</p>	<p>bM1 bA1</p> <p>bM1 bA1</p> <p>cM1</p> <p>cM1</p> <p>cA1</p> <p>cM1 cA1</p> <p>cA1</p>

Further copies of this publication are available from
Edexcel Publications, Adamsway, Mansfield, Notts, NG18 4FN

Telephone 01623 467467
Fax 01623 450481

Email publications@linneydirect.com

Order Code UA022968 January 2010

For more information on Edexcel qualifications, please visit www.edexcel.com/quals

Edexcel Limited. Registered in England and Wales no.4496750
Registered Office: One90 High Holborn, London, WC1V 7BH