

# EDEXCEL

190 High Holborn London WC1V 7BH

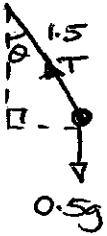
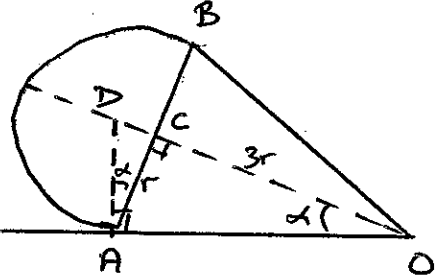
January 2005

Advanced Subsidiary/Advanced Level

General Certificate of Education

Subject: **Mechanics**

Paper: **M3**

Question Number	Scheme	Marks
1.(a)	 $r = 1.5 \sin \theta$ $T \sin \theta = m r \omega^2$ $T \sin \theta = 0.5 \times 1.5 \sin \theta \times 2.7^2$ $T = \underline{5.4675 \text{ N}}$	B1 M1 A1 A1 (4)
(b)	$T \cos \theta = 0.5g$ $\cos \theta = \frac{0.5g}{5.4675}$ $\theta = \underline{26^\circ} \text{ (nearest degree)}$	M1 A1 A1 (3) (7)
2.(a)	$\frac{3r}{4} ; \frac{3r}{8}$ $-m \cdot \frac{3r}{4} + M \cdot \frac{3r}{8} = (m+M) \bar{x}$ $\frac{3r(M-2m)}{8(M+m)} = \bar{x} \quad *$	B1 ; B1 M1 A1 A1 (5)
(b)	 $CD = r \tan \alpha$ $= r \times \left( \frac{r}{3r} \right)$ $= \frac{1}{3} r$ <p>No equil<sup>m</sup> <math>\Rightarrow \bar{x} &gt; CD</math></p> $\frac{3r(M-2m)}{8(M+m)} > \frac{r}{3}$ $9(M-2m) > 8(M+m)$ $M > 26m \quad *$	M1 A1 M1 A1 (4) (9)

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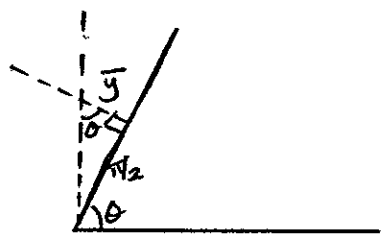
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3.(c)	$\int_0^{\pi} \frac{1}{2} y^2 dx = \int_0^{\pi} \frac{1}{2} \sin^2 x dx$ $= \frac{1}{4} \int_0^{\pi} (1 - \cos 2x) dx$ $= \frac{1}{4} \left[ x - \frac{1}{2} \sin 2x \right]_0^{\pi}$ $= \frac{\pi}{4}$ $\bar{y} = \frac{\frac{\pi}{4}}{\int_0^{\pi} \sin x dx} = \frac{\frac{\pi}{4}}{2} = \frac{\pi}{8}$	<p>M1</p> <p>M1</p> <p>A1</p> <p>A1</p> <p>M1</p> <p>A1</p> <p>(6)</p>
(b)	 $\tan \theta = \frac{\pi/2}{y}$ $= 4$ $\theta = 75.96^\circ$	<p>M1</p> <p>A1 ✓</p> <p>A1</p> <p>(3)</p> <p>(9)</p>

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4. (a)	$6 = 2\pi/w \Rightarrow w = \pi/3$ $a = 2L$ $x = 2L \cos wt$ $2L - b = 2L \cos\left(\frac{\pi}{3} \cdot \frac{3}{4}\right)$ $\underline{b = L(2 - \sqrt{2})} \quad *$	M1 B1  M1 A1 ✓  A1 eso. (5)
(b)	$\ddot{x} = -2Lw \sin wt$ $= -2L \frac{\pi}{3} \sin \frac{\pi}{4}$ $\text{Speed} = \frac{\sqrt{2}L\pi}{3}$	M1  A1 (2)
(c)	$\frac{1}{2}(2 - \sqrt{2})L = 2L \sin wt$ $t = 0.1469\dots$ $\therefore \text{Total time} = 2 \times 0.14$ $= \underline{0.28 \text{ (2dp)}}$	M1 A1  A1 (3) (10)
5. (a)	$\frac{dv}{dt} = -\frac{3}{\sqrt{t+4}}$ $v = -3 \int (t+4)^{-\frac{1}{2}} dt$ $v = -6(t+4)^{\frac{1}{2}} + C$ $t=0, v=18: 18 = -6 \times 2 + C \Rightarrow C = 30$ $\underline{v = 30 - 6\sqrt{t+4}} \quad *$	M1  M1 A1 M1 A1 eso. (5)
(b)	$x = \int 30 - 6(t+4)^{\frac{1}{2}} dt$ $= 30t - 4(t+4)^{\frac{3}{2}} + D$ $t=0, x=0: 0 = 0 - 4 \times 8 + D \Rightarrow D = 32$ $v=0 \Rightarrow 30 - 6\sqrt{t+4} = 0 \Rightarrow t = 21$ $\text{When } t=21, x = 30 \times 21 - 4 \times 5^2 + 32$ $= \underline{\underline{162 \text{ (2)}}}$	M1 A1 M1 M1 A1 M1  A1 (7) (12)

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6.(a)	$KE_{\text{Loss}} + PE_{\text{Loss}} = EPE_{\text{Gain}}$ $\frac{1}{2} \cdot m 2g L + m g 3L = \frac{\lambda (3L)^2}{2L}$ $\times \frac{8m g}{9} = \lambda$	M1 A2 (1.e.e.) A1 (4)
(b)	$m g - T = m \ddot{x}$ $m g - \frac{8m g}{9L} (x + e) = m \ddot{x}$ $-\frac{8g}{9L} x = \ddot{x}$ <p>Hence SHM about D</p>	M1 A1 M1 A1 A1 c.s.o. (5)
(c)	<p>(i) Period = <math>\frac{2\pi}{\omega} = 2\pi \sqrt{\frac{9L}{8g}} = 3\pi \sqrt{\frac{L}{2g}}</math></p> <p>(ii) <math>m g = \frac{8m g}{9L} e \Rightarrow e = \frac{9L}{8} g</math></p> $a = 3L - \frac{9L}{8} = \frac{15L}{8}$ $v_{\text{max}} = a \omega = \frac{15L}{8} \sqrt{\frac{8g}{9L}}$ $= \frac{5}{4} \sqrt{2g L}$	M1 A1 B1 M1 A1 (5) (14)

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7.(a)	<del><math>\frac{1}{2}mv^2 - 15 = mgS(1 - \cos 60^\circ)</math></del> <del><math>v = 8 \text{ms}^{-1}</math></del>	M1 A1 A1 A1 (4)
(b)	$\frac{1}{2}mv^2 = mgS(1 - \cos 60^\circ)$ $v = 7 \text{ms}^{-1}$ <u>CM:</u> $60 \times 8 - 3m = (60+m)7$ $480 - 3m = 420 + 7m$ $60 = 10m$ $6 = m$	M1 A1 A1 M1 A1✓ A1✓ A1 (7)
(c)	$T - 66g = \frac{66 \times 7^2}{5}$ $T = 132g$ $= \underline{1290 (1294) \text{ N}}$	M1 A1✓ A1 (3)
		(4)