advancing learning, changing lives

# Mark Scheme (Results)

# January 2008

GCE

## GCE Mathematics (6679/01)

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

A PEARSON COMPANY

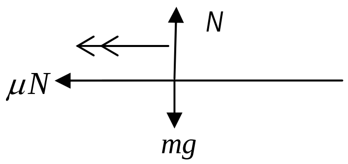
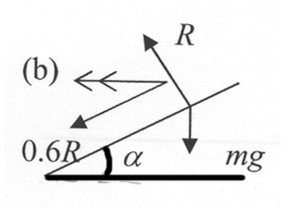
edexcel

# January 2008
# 6679 Mechanics M3
# Mark Scheme

| Question Number | Scheme | Marks |
|---|---|---|
| 1.(a) | $T$ or $\frac{\lambda \times e}{l} = mg$ (even $T$=$m$ is M1, A0, A0 sp case) | M1 |
| | $\frac{\lambda \times 0.16}{0.4} = 2g$ | A1 |
| | $\Rightarrow \lambda = \underline{49\text{ N}}$ or 5g | A1 (3) |
| (b) | Special case $T\sin\theta = mg$ giving $\theta$ = 30 is M1 A0 A0 unless there is evidence that they think $\theta$ is with horizontal – then M1 A1 A0 | |
| | R(↑) $T\cos\theta = mg$ or $\cos\theta = \frac{mg}{T}$ | M1 |
| | $49.\frac{0.32}{0.4}.\cos\theta = 19.6$ or $4g.\cos\theta = 2g$ or $2mg.\cos\theta = mg$ (ft on their $\lambda$) | A1ft |
| | $\Rightarrow \cos\theta = \frac{1}{2} \Rightarrow \theta = 60°$ ( or $\frac{\pi}{3}$ radians) | A1 (3) |
| | | **6** |
| 2. | $m$ '$a$' = $\pm\frac{16}{5x^2}$, with acceleration in any form (e.g. $\frac{d^2x}{dt^2}$, $v\frac{dv}{dx}$, $\frac{dv}{dt}$ or $a$) | B1 |
| | Uses $a = v\frac{dv}{dx}$ to obtain $kv\frac{dv}{dx} = \pm k'\frac{32}{x^2}$ | M1 |
| | Separates variables, $k\int v\,dv = k'\int \frac{32}{x^2}dx$ | dM1 |
| | Obtains $\frac{1}{2}v^2 = \mp\frac{32}{x}$ $(+C)$ or equivalent e.g. $\frac{0.1}{2}v^2 = -\frac{16}{5x}$ $(+C)$ | A1 |
| | Substituting x = 2 if + used earlier or – 2 if – used in d.e.<br>$x = 2$, $v = \pm 8 \Rightarrow 32 = -16 + C \Rightarrow C = 48$ (or value appropriate to their correct equation) | M1 A1 |
| | $v = 0 \Rightarrow \frac{32}{x} = 48 \Rightarrow x = \frac{2}{3}$ m (N.B. $-\frac{2}{3}$ is not acceptable for final answer ) | M1 A1 cao |
| | | **8** |
| | N.B $\frac{d}{dx}(\frac{1}{2}mv^2) = \frac{16}{5x^2}$, is also a valid approach.<br>Last two method marks are independent of earlier marks and of each other | |

| Question Number | Scheme | Marks |
|---|---|---|
| 3.(a) | | |
| | Large cone small cone $S$ | |
| | Vol. $\frac{1}{3}\pi(2r)^2(2h)$ $\frac{1}{3}\pi r^2 h$ $\frac{7}{3}\pi r^2 h$ (accept ratios 8 : 1 : 7) | B1 |
| | C of M $\frac{1}{2}h$, $\frac{5}{4}h$ $\bar{x}$ (or equivalent) | B1, B1 |
| | $\frac{8}{3}\pi r^2 h.\frac{1}{2}h - \frac{1}{3}\pi r^2 h.\frac{5}{4}h = \frac{7}{3}\pi r^2 h.\bar{x}$ or equivalent | M1 |
| | $\rightarrow \bar{x} = \frac{11}{28}h$ * | A1 (5) |
| (b) | $\tan\theta = \frac{2r}{\bar{x}} = \frac{2r}{\frac{11}{28}h}, = \frac{2r}{\frac{11}{14}r} = \frac{28}{11}$ | M1, A1 |
| | $\theta \approx 68.6°$ or 1.20 radians | A1 (3) **8** |
| | (Special case – obtains complement by using $\tan\theta = \frac{2r}{\bar{x}}$ giving 21.4° or .374 radians M1A0A0) | |
| | Centres of mass may be measured from another point ( e.g. centre of small circle, or vertex) The Method mark will then require a complete method (Moments and subtraction) to give required value for $\bar{x}$). However B marks can be awarded for correct values if the candidate makes the working clear. | |

| | | |
|---|---|---|
| 4. (a) | Energy equation with at least three terms, including K.E term<br>$\frac{1}{2}mV^2 + ..$<br>$+ ..\ \frac{1}{2}.\frac{2mg}{a}.\frac{a^2}{16}, + mg.\frac{1}{2}a.\sin 30, = \frac{1}{2}.\frac{2mg}{a}.\frac{9a^2}{16}$<br>$\Rightarrow V = \sqrt{\frac{ga}{2}}$ | M1<br>A1, A1, A1<br>dM1 A1 (6) |
| (b) | Using point where velocity is zero and point where string becomes slack:<br>$\frac{1}{2}mw^2 =$<br>$\frac{1}{2}.\frac{2mg}{a}.\frac{9a^2}{16}, -mg.\frac{3a}{4}.\sin 30$<br>$\Rightarrow w = \sqrt{\frac{3ag}{8}}$<br>Alternative (using point of projection and point where string becomes slack):<br>$\frac{1}{2}mw^2 - \frac{1}{2}mV_1^2, = \frac{mga}{16} - \frac{mga}{8}$<br>So $w = \sqrt{\frac{3ag}{8}}$ | M1<br>A1, A1<br>A1 (4)<br>M1,A1 A1<br>A1<br>**10** |
| | In part (a)<br>DM1 requires EE, PE and KE to have been included in the energy equation.<br>If sign errors lead to $V^2 = -\frac{ga}{2}$, the last two marks are M0 A0<br>In parts (a) and (b) A marks need to have the correct signs<br>In part (b) for M1 need **one** KE term in energy equation of at least **3 terms** with distance $\frac{3a}{4}$ to indicate first method, and **two** KE terms in energy equation of at least **4 terms** with distance $\frac{a}{4}$ to indicate second method.<br>SHM approach in part (b). (**Condone this method only if SHM is proved**)<br>Using $v^2 = \omega^2(a^2 - x^2)$ with $\omega^2 = \frac{2g}{a}$ and $x = \pm\frac{a}{4}$.<br>Using '$a$' = $\frac{a}{2}$ to give $w = \sqrt{\frac{3ag}{8}}$. | M1 A1 A1<br>A1 |

| | | |
|---|---|---|
| 5.(a) | <br>$\frac{mv^2}{r} = \mu N, = \mu mg$<br>$\mu = \frac{v^2}{rg} = \frac{21^2}{75\times 9.8} = 0.6$ * | M1, A1<br>A1 (3) |
| (b) | <br>R(↑) $R\cos\alpha, \mp 0.6R\sin\alpha = mg$<br>$\Rightarrow R\left(\frac{4}{5} - \frac{3}{5}.\frac{3}{5}\right) = mg \Rightarrow R = \frac{25mg}{11}$ | M1, A1, A1<br>A1 (4) |
| (c) | R(←) $R\sin\alpha, \pm 0.6R\cos\alpha = \frac{mv^2}{r}$<br>$v \approx$ 32.5 m s$^{-1}$ | M1, A1, A1<br>dM1 A1cao<br>(5)<br>**12** |
| | In part (b) M1 needs three terms of which one is mg<br>If cos $\alpha$ and sin $\alpha$ are interchanged in equation this is awarded M1 A0 A1<br>In part (c) M1 needs three terms of which one is $\frac{mv^2}{r}$ or $mr\omega^2$<br>If cos $\alpha$ and sin $\alpha$ are interchanged in equation this is also awarded M1 A0 A1<br><br>If they resolve along the plane and perpendicular to the plane in part (b), then attempt at<br>$R - mg\cos\alpha = \frac{mv^2}{r}\sin\alpha$, and $0.6R + mg\sin\alpha = \frac{mv^2}{r}\cos\alpha$ and attempt to eliminate $v$<br>Two correct equations<br>Correct work to solve simultaneous equations<br>Answer<br><br>In part (c) Substitute R into one of the equations<br>Substitutes into a correct equation (earning accuracy marks in part (b))<br>Uses $R = \frac{25mg}{11}$ (or $\frac{25mg}{29}$)<br>Obtain $v$ = 32.5 | M1<br>A1<br>A1<br>A1 (4)<br><br>M1<br>A1<br><br>A1<br><br>M1A1 (5) |

| | | |
|---|---|---|
| 6.(a) | Energy equation with two terms on RHS, $\frac{1}{2}mv^2 = \frac{1}{2}m.\frac{5ga}{2} + mga\sin\theta$ | M1, A1 |
| | $\Rightarrow v^2 = \frac{ga}{2}(5 + 4\sin\theta)$ * | A1 cso (3) |
| (b) | R(\\ string) $T - mg\sin\theta = \frac{mv^2}{a}$ (3 terms) | M1 A1 |
| | $\Rightarrow T = \frac{mg}{2}(5 + 6\sin\theta)$ o.e. | A1 (3) |
| (c) | $T = 0 \Rightarrow \sin\theta, = -\frac{5}{6}$ | M1, A1 |
| | Has a solution, so string slack when $\alpha \approx 236(.4)°$ or 4.13 radians | A1 (3) |
| (d) | At top of small circle, $\frac{1}{2}mv^2 = \frac{1}{2}m.\frac{5ga}{2} - \frac{mga}{2}$ (M1 for energy equation with 3 terms) | M1 A1 |
| | $\Rightarrow v^2 = \frac{3}{2}ga = 14.7a$ | A1 |
| | Resolving and using Force = $\frac{mv^2}{r}$, $T + mg = m.\frac{\frac{3}{2}ga}{\frac{1}{2}a}$ (M1 needs three terms, but any $v$) | M1 A1 |
| | $\Rightarrow T = 2mg$ | A1 (6) |
| | | **15** |
| | Use of $v^2 = u^2 + 2gh$ is M0 in part (a) | |

| | | |
|---|---|---|
| 7.(a) | (Measuring $x$ from $E$) $2\ddot{x} = 2g - 98(x+0.2)$, and so $\ddot{x} = -49x$ | M1 A1, A1 |
| | SHM period with $\omega^2 = 49$ so $T = \frac{2\pi}{7}$ | d M1 A1cso (5) |
| (b) | Max. acceleration = 49 $\times$ max. $x$ = 49 x 0.4 = 19.6 m s$^{-2}$ | B1 (1) |
| (c) | String slack when $x$ = –0.2: $v^2 = 49(0.4^2 - 0.2^2)$ | M1 A1 |
| | $\Rightarrow v \approx 2.42$ m s$^{-1}$ $= \frac{7\sqrt{3}}{5}$ | A1 (3) |
| (d) | Uses $x = a\cos\omega t$ or use $x = a\sin\omega t$ but not with $x$ = 0 or $\pm a$ | M1 |
| | Attempt complete method for finding time when string goes slack –0.2 = 0.4 cos 7$t$ $\Rightarrow$ cos 7$t$ $= -\frac{1}{2}$ | dM1 A1 |
| | $t = \frac{2\pi}{21} \approx 0.299$ s | A1 |
| | Time when string is slack $= \frac{(2)\times 2.42}{g} = \frac{2\sqrt{3}}{7} \approx 0.495\,\text{s}$ (2 needed for A ) | M1 A1ft<br>A1 (7) |
| | Total time = 2 x 0.299 + 0.495 $\approx$ 1.09 s | **16** |
| (a)<br><br><br><br>(b)<br>(c)<br><br><br><br>(d) | DM1 requires the minus sign.<br>Special case<br>$2\ddot{x} = 2g - 98x$ is M1A1A0M0A0 $2\ddot{x} = -98x$ is M0A0A0M0A0<br>No use of $\ddot{x}$, just $a$ is M1 A0,A0 then M1 A0 if otherwise correct.<br>Quoted results are not acceptable.<br><br>Answer must be positive and evaluated for B1<br><br>M1 – Use correct formula with their $\omega$, $a$ and $x$ but **not** $x$ = 0.<br>A1 Correct values but allow $x$ = +0.2<br>**Alternative**<br>It is possible to use energy instead to do this part<br>$\frac{1}{2}mv^2 + mg \times 0.6 = \frac{\lambda \times 0.6^2}{2l}$ M1 A1<br><br>If they use $x = a\sin\omega t$ with $x$ = $\pm 0.2$ and add $\frac{\pi}{7}$ or $\frac{\pi}{14}$ this is dM1, A1 if done correctly<br>If they use $x = a\cos\omega t$ with x = -0.2 this is dM1, then A1 (as in scheme)<br>If they use $x = a\cos\omega t$ with x = +0.2 this needs *their* $\frac{\pi}{7}$ minus answer to reach dM1, then A1 | |