

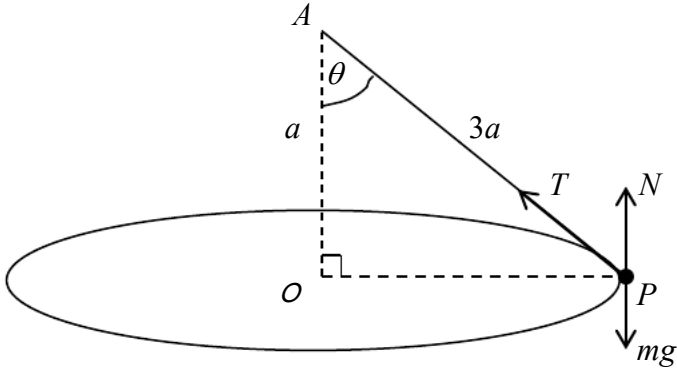
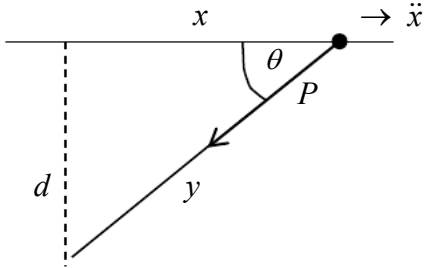
### Mock Paper Mark Scheme

#### Advanced Subsidiary/Advanced GCE General Certificate of Education

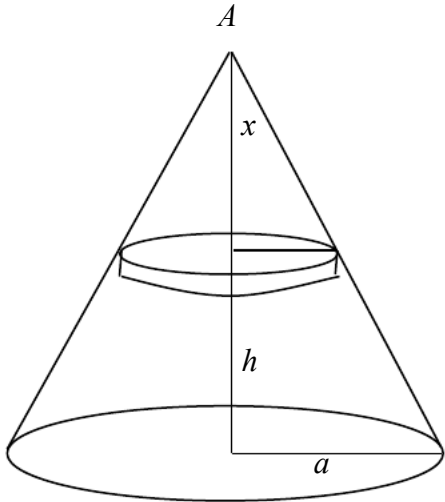
Subject **MECHANICS**

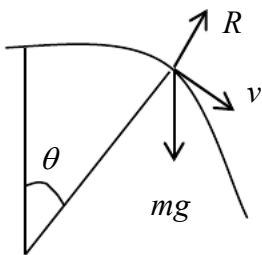
Paper No. **Mock M3**

Question number	Scheme	Marks
<b>1.</b>	$v \frac{dv}{dx} = 6 - 4x$ $\int v \, dv = \int 6 - 4x \Rightarrow \frac{1}{2} v^2 = 6x - 2x^2 + c$ $x = 0, v = 4 \Rightarrow c = 8$ $v = 0 \Rightarrow 8 + 6x - 2x^2 = 0$ $4 + 3x - x^2 = 0$ $(4 - x)(1 + x) = 0$ $(x > 0 \Rightarrow) \quad x = 4$	<p>M1</p> <p>M1 A1</p> <p>A1</p> <p>M1</p> <p>A1 (6)</p> <p style="text-align: right;"><b>(6 marks)</b></p>
<b>2.</b>	$\frac{\lambda(100 - l)}{l} = 0.3g$ $\frac{\lambda(110 - l)}{l} = 0.5g$ $\Rightarrow 5(100 - l) = 3(110 - l)$ $l = 85 \text{ cm}$ $\lambda = \frac{0.3g \times 85}{15} = 16.66 \text{ N}$	<p>M1 A1</p> <p>A1</p> <p>M1</p> <p>A1 (5)</p> <p>M1 A1 (2)</p> <p style="text-align: right;"><b>(7 marks)</b></p>

Question number	Scheme	Marks
3.	 <p> <math>OP = a\sqrt{8}</math>  <math>R(\leftarrow): T \sin \theta = \frac{mv^2}{a\sqrt{8}}</math>  <math>T \frac{\sqrt{8}a}{3a} = \frac{m \times 4ga}{a\sqrt{8}} \quad (\sin \theta)</math>  <math>\Rightarrow T = \frac{3mg}{2}</math>  <math>R(\uparrow): T \cos \theta + N = mg</math>  <math>\Rightarrow N = mg - \frac{3}{2}mg \times \frac{1}{3} = \frac{1}{2}mg</math> </p>	<p>B1</p> <p>M1 A1</p> <p>B1 ft.</p> <p>M1 A1 (6)</p> <p>M1 A1</p> <p>M1 A1 (4)</p> <p><b>(10 marks)</b></p>
4. (a)	 <p> <math>R(\rightarrow): 0.2\ddot{x} = -5y \cos \theta</math>  <math>\cos \theta = \frac{x}{y}</math>  <math>\Rightarrow \ddot{x} = -25x</math>  <math>\Rightarrow \text{SHM period} = \frac{2\pi}{5}</math> </p>	<p>M1 A1</p> <p>M1</p> <p>A1</p> <p>A1 (5)</p>
(b)	<p><math>d = 2</math>; max speed = '<math>d\omega</math>' = <math>2 \times 5 = 10 \text{ m s}^{-1}</math></p>	<p>M1 A1 (2)</p>
(c)	<p><math>x = 2 \cos 5t</math></p> <p>Distance 3 m from start <math>\Rightarrow x = -1</math></p> <p><math>\cos 5t = -\frac{1}{2}</math></p> <p><math>\Rightarrow 5t = \frac{2\pi}{3}, t = \frac{2\pi}{15} \text{ s}</math></p>	<p>M1</p> <p>B1</p> <p>M1 A1 (4)</p> <p><b>(11 marks)</b></p>

Question number	Scheme	Mark
5. (a)	Energy: $\frac{1}{2} \times 2 \times 10^2 = 2 \times 9.8 \times h + \frac{1}{2} \times \frac{120 \times h^2}{3}$ $20h^2 + 19.6h - 100 = 0$ $h = \frac{-19.6 \pm \sqrt{(19.6^2 + 4 \times 20 \times 100)}}{40}$ $= 1.7991 \dots \approx 1.8$ (or 1.80) m	M1 A1 A1 M1 M1 A1 (6)
(b)	$\frac{1}{2} \times 2 \times V^2 = 2 \times 9.8 \times 1.8 + \frac{1}{2} \times \frac{120 \times 2.3^2}{3} - \frac{1}{2} \times \frac{120 \times 0.5^2}{3}$ $V = 11.7$ (3 s.f.) or 12 (2 s.f.) m s <sup>-1</sup>	M1 A1 A1 M1 A1 (5) <b>(11 marks)</b>

Question number	Scheme	Marks										
6. (a)	 <p style="text-align: center;">Radius of element = <math>\frac{x}{h}a</math></p> <p>Hence <math>\int_0^h \pi \frac{x^2 a^2}{h^2} x \, dx = \frac{1}{3} \pi a^2 h \times \bar{x}</math></p> $\frac{1}{3} \pi a^2 h \times \bar{x} = \frac{\pi a^2}{h^2} \left[ \frac{x^4}{4} \right]_0^h$ $= \frac{\pi a^2 h^2}{4}$ $\Rightarrow \bar{x} = \frac{3}{4}h$	<p>B1</p> <p>M1 A1</p> <p>M1</p> <p>M1</p> <p>A1 (6)</p>										
(b)	<p>Volume of large cone = <math>\frac{1}{3} \pi a^2 h = V</math></p> <p>Volume of small cone = <math>\frac{1}{3} \pi \times \frac{4a^2}{9} \times \frac{h}{2} = \frac{2}{9}V</math></p> <p>Volume of S = <math>\frac{7}{9}V</math></p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20%;">Volume</td> <td style="width: 20%; text-align: center;"><math>V</math></td> <td style="width: 20%; text-align: center;"><math>\frac{2}{9}V</math></td> <td style="width: 20%; text-align: center;"><math>\frac{7}{9}V</math></td> <td style="width: 10%;"></td> </tr> <tr> <td>CM from A</td> <td style="text-align: center;"><math>\frac{3}{4}h</math></td> <td style="text-align: center;"><math>\frac{h}{2} + \frac{3}{4}\left(\frac{h}{2}\right)</math></td> <td style="text-align: center;"><math>\bar{x}</math></td> <td></td> </tr> </table> $V \times \frac{3}{4}h - \frac{2}{9}V \left( \frac{7h}{8} \right) = \frac{7}{9}V \bar{x}$ $\Rightarrow \bar{x} = \frac{5h}{7}$	Volume	$V$	$\frac{2}{9}V$	$\frac{7}{9}V$		CM from A	$\frac{3}{4}h$	$\frac{h}{2} + \frac{3}{4}\left(\frac{h}{2}\right)$	$\bar{x}$		<p>M1 A1</p> <p>B1 B1</p> <p>M1 A1</p> <p>A1 (7)</p> <p style="text-align: right;"><b>(13 marks)</b></p>
Volume	$V$	$\frac{2}{9}V$	$\frac{7}{9}V$									
CM from A	$\frac{3}{4}h$	$\frac{h}{2} + \frac{3}{4}\left(\frac{h}{2}\right)$	$\bar{x}$									

Question number	Scheme	Marks
7. (a)	 <p>Energy <math>\frac{1}{2}mv^2 = \frac{1}{2}mu^2 + mga(1 - \cos \theta)</math>  <math>v^2 = \frac{1}{2}ga + 2ga(1 - \cos \theta)</math>  <math>= \frac{1}{2}ga(5 - 4 \cos \theta)</math></p>	M1 A1  A1 (3)
(b)	$R(\nearrow): mg \cos \theta - R = \frac{mv^2}{a}$ so $R = mg(3 \cos \theta - \frac{5}{2})$ $\cos \theta = 0.9 \Rightarrow R = mg(2.7 - 2.5)$ $= 0.2 mg > 0 \Rightarrow P$ still on hemisphere	M1 A1  A1 M1 A1 (5)
(c)	$P$ leaves hemisphere when $R = 0 \Rightarrow 3 \cos \theta - \frac{5}{2} = 0 \Rightarrow \cos \theta = \frac{5}{6}$	M1 A1 (2)
(d)	$\cos \theta = \frac{5}{6} \Rightarrow v^2 = \frac{1}{2}ga(5 - 4 \times \frac{5}{6})$ $= \frac{5ga}{6}, v = \sqrt{\frac{5ga}{6}}$	M1  A1 (2)
(e)	At $B$ , speed $v$ is given by $v^2 = u^2 + 2ga = \frac{5}{2}ga, v = \sqrt{\frac{5ga}{2}}$	M1 A1 (2)
(f)	After leaving hemisphere, horizontal component of velocity remains constant = $\sqrt{\frac{5ga}{6}} \frac{5}{6}$ $\cos \phi = \frac{\frac{5}{6}\sqrt{\frac{5ga}{6}}}{\sqrt{\frac{5ga}{2}}} = \frac{5}{6\sqrt{3}}$ $\Rightarrow \phi = 61.2^\circ$ or $61^\circ$ to horizontal	B1  M1  A1 (3)  <b>(17 marks)</b>

