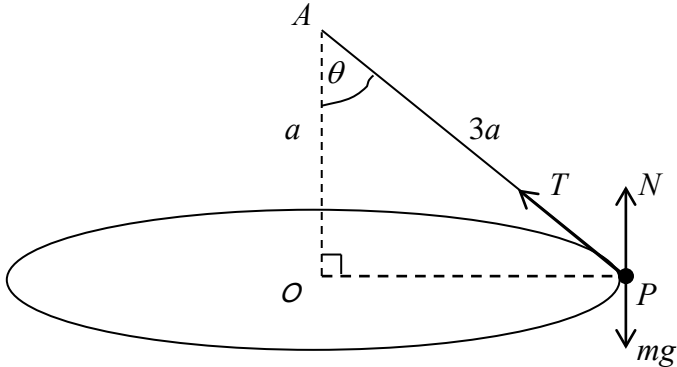
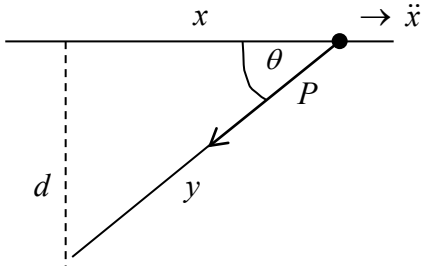


Mock Paper Mark Scheme

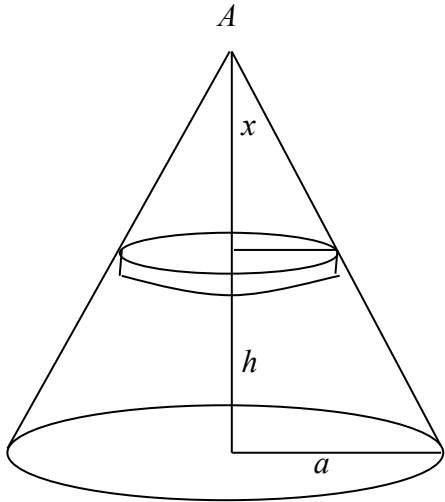
Advanced Subsidiary/Advanced GCE General Certificate of Education

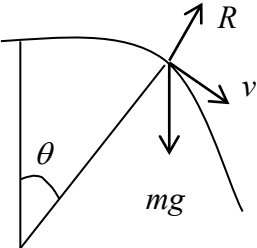
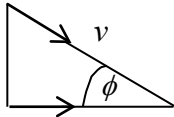
Subject **MECHANICS**Paper No. **Mock M3**

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

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

Question number	Scheme	Marks
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 ⁻¹	M1 A1 A1 M1 A1 (5) (11 marks)

Question number	Scheme	Marks										
6. (a)	 <p style="text-align: center;">Radius of element = $\frac{x}{h}a$</p> <p>Hence $\int_0^h \pi \frac{x^2 a^2}{h^2} x \, dx = \frac{1}{3} \pi a^2 h \times \bar{x}$</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 = $\frac{1}{3} \pi a^2 h = V$</p> <p>Volume of small cone = $\frac{1}{3} \pi \times \frac{4a^2}{9} \times \frac{h}{2} = \frac{2}{9}V$</p> <p>Volume of S = $\frac{7}{9}V$</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20%;">Volume</td> <td style="width: 20%; text-align: center;">V</td> <td style="width: 20%; text-align: center;">$\frac{2}{9}V$</td> <td style="width: 20%; text-align: center;">$\frac{7}{9}V$</td> <td style="width: 10%;"></td> </tr> <tr> <td>CM from A</td> <td style="text-align: center;">$\frac{3}{4}h$</td> <td style="text-align: center;">$\frac{h}{2} + \frac{3}{4} \left(\frac{h}{2} \right)$</td> <td style="text-align: center;">\bar{x}</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;">(13 marks)</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 $\frac{1}{2}mv^2 = \frac{1}{2}mu^2 + mga(1 - \cos \theta)$</p> $v^2 = \frac{1}{2}ga + 2ga(1 - \cos \theta)$ $= \frac{1}{2}ga(5 - 4 \cos \theta)$	M1 A1 A1 (3)
(b)	$R(\nearrow): mg \cos \theta - R = \frac{mv^2}{a}$ <p>so $R = mg(3 \cos \theta - \frac{5}{2})$</p> $\cos \theta = 0.9 \Rightarrow R = mg(2.7 - 2.5)$ $= 0.2mg > 0 \Rightarrow P \text{ still on hemisphere}$	M1 A1 A1 M1 A1 (5)
(c)	$P \text{ leaves hemisphere when } R = 0 \Rightarrow 3 \cos \theta - \frac{5}{2} = 0 \Rightarrow \cos \theta = \frac{5}{6}$	M1 A1 (2)
(d)	$\cos \theta = \frac{5}{6} \Rightarrow v^2 = \frac{1}{2}ga(5 - 4 \times \frac{5}{6})$ $= \frac{5ga}{6}, \quad v = \sqrt{\frac{5ga}{6}}$	M1 A1 (2)
(e)	<p>At B, speed v is given by $v^2 = u^2 + 2ga = \frac{5}{2}ga$, $v = \sqrt{\frac{5ga}{2}}$</p>	M1 A1 (2)
(f)	<p>After leaving hemisphere, horizontal component of velocity remains constant = $\sqrt{\frac{5ga}{6}} \frac{5}{6}$</p> $\cos \phi = \frac{\frac{5}{6}\sqrt{\frac{5ga}{6}}}{\sqrt{\frac{5ga}{2}}} = \frac{5}{6\sqrt{3}}$  <p>$\Rightarrow \phi = 61.2^\circ$ or 61° to horizontal</p>	B1 M1 A1 (3) (17 marks)

