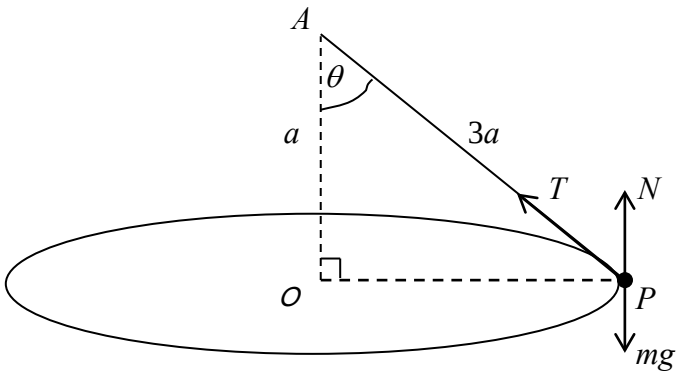
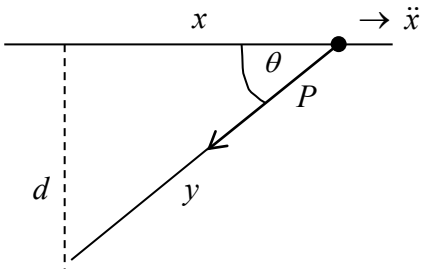
Edexcel
Success through qualifications

Mock Paper Mark Scheme

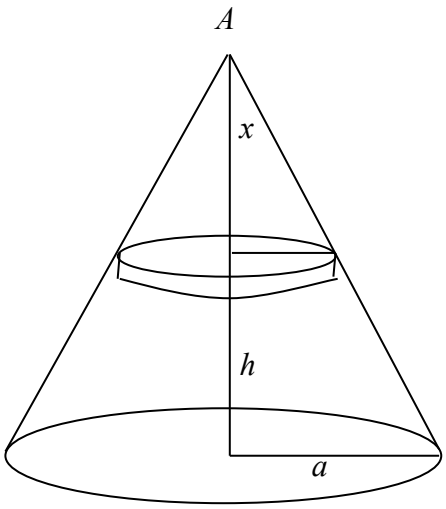
Advanced Subsidiary/Advanced GCE
General Certificate of Education

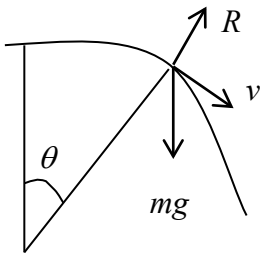
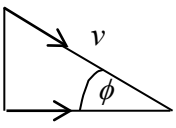
Subject **MECHANICS** Paper No. **Mock M3**

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

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

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

Question number	Scheme	Marks
6. (*a*)		
	Radius of element = $\frac{x}{h}a$	B1
	Hence $\int_0^h \pi \frac{x^2a^2}{h^2}x\ \mathrm{d}x = \frac{1}{3}\pi a^2 h \times \bar{x}$	M1 A1
	$\frac{1}{3}\pi a^2 h \times \bar{x} = \frac{\pi a^2}{h^2}\left[\frac{x^4}{4}\right]_0^h$	M1
	$= \frac{\pi a^2 h^2}{4}$	M1
	$\Rightarrow \bar{x} = \frac{3}{4}h$	A1 (6)
(*b*)	Volume of large cone = $\frac{1}{3}\pi a^2 h = V$	
	Volume of small cone = $\frac{1}{3}\pi \times \frac{4a^2}{9} \times \frac{h}{2} = \frac{2}{9}V$	
	Volume of S $= \frac{7}{9}V$	
	Volume V $\frac{2}{9}V$ $\frac{7}{9}V$	M1 A1
	CM from A $\frac{3}{4}h$ $\frac{h}{2}+\frac{3}{4}\left(\frac{h}{2}\right)$ $\bar{x}$	B1 B1
	$V \times \frac{3}{4}h - \frac{2}{9}V\left(\frac{7h}{8}\right) = \frac{7}{9}V\ \bar{x}$	M1 A1
	$\Rightarrow \bar{x} = \frac{5h}{7}$	A1 (7)
		(13 marks)

Question number	Scheme	Marks
7. (*a*)	 Energy $\frac{1}{2}mv^2 = \frac{1}{2}mu^2 + mga(1-\cos\theta)$	M1 A1
	$v^2 = \frac{1}{2}ga + 2ga(1-\cos\theta)$	
	$= \frac{1}{2}ga(5-4\cos\theta)$	A1 (3)
(*b*)	$R(\nearrow)$: $mg\cos\theta - R = \frac{mv^2}{a}$	M1 A1
	so $R = mg(3\cos\theta - \frac{5}{2})$	A1
	$\cos\theta = 0.9 \Rightarrow R = mg(2.7-2.5)$	M1
	$= 0.2\,mg > 0 \Rightarrow P$ still on hemisphere	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*)	$\cos\theta = \frac{5}{6} \Rightarrow v^2 = \frac{1}{2}ga(5-4\times\frac{5}{6})$	M1
	$= \frac{5ga}{6}$, $v = \sqrt{\frac{5ga}{6}}$	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 $= \sqrt{\frac{5ga}{6}}\frac{5}{6}$	B1
	$\cos\phi = \frac{\frac{5}{6}\sqrt{\frac{5ga}{6}}}{\sqrt{\frac{5ga}{2}}} = \frac{5}{6\sqrt{3}}$ 	M1
	$\Rightarrow \phi = 61.2°$ or $61°$ to horizontal	A1 (3)
		(17 marks)