MECHANICS 3 (A) TEST PAPER 2 : ANSWERS AND MARK SCHEM

		Marks	Total
1.	$m\frac{dv}{dt} = -mkv$ $\quad \int \frac{1}{v}\,dv = \int -k\,dt$ $\quad \ln v = -kt + c$	M1 A1 M1 A1	
	$\ln u = c$, so $\ln\frac{v}{u} = -kt$ $\quad v = ue^{-kt}$	M1 A1 A1	7
2.	$T\cos\theta = mg$, $\; T\sin\theta = m(0{\cdot}4\sin\theta)\omega^2$ $\quad g = 0{\cdot}4\omega^2\cos\theta$	M1 A1 M1 A1	
	$\theta \le 60°$, so $\cos\theta \ge 0{\cdot}5$ $\quad g \ge 0{\cdot}2\omega^2$ $\quad \omega^2 \le 49$ $\quad \omega \le 7$	B1 M1 A1	7
3.	(a) $mg = \frac{mge}{2(0{\cdot}5)}$ $\quad e = 0{\cdot}5 \times 2 = 1$ m $\quad OP = 1{\cdot}5$ m	M1 A1 A1	
	(b) P.E. $= \frac{mg(1^2)}{2(2)(0{\cdot}5)} = \frac{mg}{2}$ J $\quad$ (c) Work done $= mg \times 1{\cdot}5 = \frac{3mg}{2}$ J	M1 A1 M1 A1	
	(d) Grav. P.E. lost > elastic P.E. gained, because the weight does work in moving the supportive force in (c)	B1	8
4.	Symmetric, so tensions in strings are equal $\quad 2T\cos\theta = mg$	B1 M1 A1	
	$AP\sin\theta = l$, so $AP = \frac{l}{\sin\theta}$ $\quad T = \frac{3mg}{l}\left(\frac{l}{\sin\theta} - l\right)$	M1 A1	
	Hence $2 \times 3mg\left(\frac{1}{\sin\theta} - 1\right)\cos\theta = mg$ $\quad 6(\cot\theta - \cos\theta) = 1$, etc	M1 A1 A1	8
5.	(a) P.E. gained = K.E. lost : $mgr(1 - \cos\theta) = \frac{1}{2}m(3gr) - \frac{1}{2}mv^2$	M1 M1 A1	
	$v^2 = 3gr - 2gr + 2gr\cos\theta = gr(1 + 2\cos\theta)$	M1 A1	
	(b) $R - mg\cos\theta = \frac{mv^2}{r}$	M1 A1	
	$R = \frac{m}{r}gr(1 + 2\cos\theta) + mg\cos\theta$ $\quad R = mg(1 + 3\cos\theta)$	M1 A1	
	(c) (i) When $v = 0$, $\cos\theta = -\frac{1}{2}$ $\quad$ (ii) When $R = 0$, $\cos\theta = -\frac{1}{3}$	B1 B1	
	(d) $h_1 = r + \frac{1}{2}r = \frac{3r}{2}$ $\quad h_2 = r + \frac{1}{3}r = \frac{4r}{3}$ $\quad$ Ratio $= \frac{3r}{2} \div \frac{4r}{3} = \frac{9}{8}$	M1 A1 A1	14
6.	(a) $mg = \frac{\lambda}{0{\cdot}8} \times 0{\cdot}7 = 0{\cdot}5 \times 9{\cdot}8$ $\quad \lambda = 4{\cdot}9 \times \frac{0{\cdot}8}{0{\cdot}7} = 5{\cdot}6$ N	M1 A1 A1	
	(b) $(0{\cdot}5 \times 9{\cdot}8) - \frac{5{\cdot}6}{0{\cdot}8}(0{\cdot}7 + x) = 0{\cdot}5\ddot{x}$ $\quad 4{\cdot}9 - 4{\cdot}9 - 7x = 0{\cdot}5\ddot{x}$	M1 A1	
	$\ddot{x} = -14x$, of form $\ddot{x} = n^2x$ with $n^2 = 14$, so simple harmonic	A1 A1	
	Period $= 2\pi/\sqrt{14} = 1{\cdot}68$ s	A1	
	(c) Maximum speed $= an = 0{\cdot}5\sqrt{14} = 1{\cdot}87$ ms^{-1}	B1 M1 A1	
	(d) $x = 0{\cdot}5\cos nt$ $\quad 0{\cdot}25 = 0{\cdot}5\cos nt$ $\quad \cos nt = 0{\cdot}5$	B1 M1	
	$nt = \frac{\pi}{3}$ $\quad t = 0{\cdot}28$ s	A1 A1	15
7.	(a) $x^2 + y^2 = r^2$ $\quad \bar{x}\int_0^r \pi y^2\,dx = \int_0^r \pi x y^2\,dx$	B1 M1 A1	
	$\pi\bar{x}\int_0^r r^2 - x^2\,dx = \pi\int_0^r r^2x - x^3\,dx$ $\quad \frac{2r^3}{3}\bar{x} = \frac{r^4}{4}$ $\quad \bar{x} = \frac{3r}{8}$	M1 A1 A1 A1	
	(b) Forces shown: weight, normal reaction (thro' O), friction at plane	B1 B1 B1	
	(c) Resolve // plane : $F = W\sin\alpha$ $\quad M(O)$: $Fr = W\frac{3r}{8}\cos\alpha$	B1 M1 A1	
	$Wr\sin\theta = \frac{3r}{8}W\cos\alpha$ $\quad \cos\alpha = \frac{8}{3} \times \frac{3}{10} = \frac{4}{5}$	M1 A1 A1	16