

Mark Scheme 4729
June 2005

1	(i)	use of $h/4$	B1			
		com vert above lowest pt of contact	B1		can be implied	
		$r = 5 \times \tan 24^\circ$	M1			
		$r = 2.2$	A1	4	2.226	
	(ii)	No & valid reason (eg $24^\circ \rightarrow 26.6^\circ$)	B1✓	1	✓Yes if their $r \approx 2.5$	5

2		$v^2 = 2 \times 9.8 \times 10$	M1		energy: $\frac{1}{2}mv^2 = \frac{1}{2}mu^2 + mgh$	
		$v = 14$	A1		$\frac{1}{2}v^2 = \frac{1}{2} \cdot 36 + 9.8 \times 10$	
		speed = $\sqrt{(14^2 + 6^2)}$	M1		(must be 6^2) $v^2 = 36 + 196 = 232$	
		speed = 15.2 ms^{-1}	A1			
		$\tan \theta = 14/6$	M1		$\cos^{-1}(6/15.2)$ etc	
		$\theta = 66.8^\circ$ (below) horiz.	A1	6	or 23.2° to the vertical	6

3	(i)	$T \cos \theta = 0.01 \times 9.8$	M1		resolving vertically	
		$8/10T = 0.01 \times 9.8$	A1		with $\cos \theta = 8/10$	
		$T = 0.1225 \text{ N}$	A1	3	AG	
	(ii)	$T + T \sin \theta = ma$	M1		resolving horizontally	
		use of $m r \omega^2$	M1			
		$\omega = 5.72 \text{ rads}^{-1}$	A1	3		
	(iii)	$\text{K.E.} = \frac{1}{2} \times 0.01 \times (r\omega)^2$	M1		$\frac{1}{2}mv^2$ with $v=r\omega$	
		$\text{K.E.} = 0.0588$	A1✓	2	✓ $0.0018 \times \text{their } \omega^2$	8

4	(i)	$5m = mu + 4m$	M1		cons. of mom.	
		$u = 1$	A1			
		$e = (2-1)/5$	M1			
		$e = \frac{1}{5}$	A1	4		
	(ii)	$I = 4m$	B1			
		\rightarrow	B1	2	to the right	
	(iii)	$4m = 5mv$	M1			
		$v = \frac{4}{5}$	A1			
		$\frac{4}{5} < 1$	B1	3		9

5	(i)	$60T = 15 \times 30 \cos \theta$	M1		moments about A	
		“	A1			
		$60T = 15 \times 30 \times 0.6$	A1		$\cos \theta = 0.6$	
		$T = 4.5 \text{ N}$	A1	4	AG	
	(ii)	$X = T \sin \theta$	M1		res. horiz. (or moments)	
		$X = 3.6 \text{ N}$	A1			
		$Y + T \cos \theta = 15$	M1		res. vert.(3 terms) (or moments)	
		$Y = 12.3 \text{ N}$	A1			
		$R = 12.8 \text{ N}$	A1✓		✓(their $X^2 + Y^2$)	
		73.7° to horizontal	A1✓	6	or 16.3° to vert. ✓ \tan^{-1} their (Y/X)	10
		or triangle of forces: Triangle (M1) $R^2 = 15^2 + 4.5^2 - 2 \times 4.5 \times 15 \times 0.6$ (M1A1)				
		$R = 12.8$ (A1) $\sin \theta / 4.5 = \sin \alpha / 12.8$ (M1) $\theta = 16.3^\circ$ to vert. (A1)				

6	(i)	$\frac{1}{2} \cdot 700 \cdot 20^2$ or $\frac{1}{2} \cdot 700 \cdot 15^2$	B1		either K.E.	
		$700 \times 9.8 \times 400 \sin 5^\circ$	B1		correct P.E.	
		$\frac{1}{2} \cdot 700 \cdot 15^2 + 700 \cdot 9.8 \cdot 400 \sin 5^\circ =$ $\frac{1}{2} \cdot 700 \cdot 20^2 + \text{W.D.}$	M1		for 4 terms with W.D.	
		W.D. = 178,000 J	A1	4	or 178 kJ	
	(ii)	$D = 200 + 700 \cdot 9.8 \sin 5^\circ$	M1			
		$D = 798 \text{ N}$	A1		may be implied	
		$P = D \times 15 = 12,000 = 12 \text{ kW}$	A1	3	AG (11,968W)	
	(iii)	$D' = 11,968 \div 20 = 598$	M1			
		$D' - 700 \cdot 9.8 \sin 5^\circ - 200 = 700a$	M1			
		$a = 0.285 \text{ ms}^{-2}$ (\pm)	A1	3	allow 0.283 (from 12kW)	10
Alternative for false assumption					of constant acceleration	
(i)	$D - 700 \times 9.8 \sin 5^\circ = 700a$ and $15^2 = 20^2 + 2a \cdot 400$	M1		(D = 445, a = -0.21875)		
	W.D. = $400 \times D = 178,000$	A1		2 marks (out of 4) maximum		

7	(i)	$50 \times 9.8 \times 2 = R \times 3.75 + 80 \times 9.8 \times 0.25$	M1		moments about D.	
		“	A1		SR/no g/ R = 21.3 (M1A1A0)	
		R = 209 N	A1	3		
	(ii)	$130 \bar{x} = 50 \times 2 + 80 \times 4.25$	M1 A1		moments about BC or FE..... $130 \bar{x} = 80 \times 0.25 + 50 \times 2.5$	
		$\bar{x} = 3.385$	A1		$\bar{x} = 1.115$	
		$130 \bar{y} = 50 \times 0.125 + 80 \times 0.25$	M1 A1		moments about EC	
		$\bar{y} = 0.202$	A1			
		$\tan \theta = 0.615 / 0.202$	M1			
		$\theta = 71.8^\circ$ to the horizontal	A1	8	71.6° to 72.0°	11

8	(i)	$x = 49 \cos \theta \cdot t$	B1			
		$y = 49 \sin \theta \cdot t - \frac{1}{2} \cdot 9.8 \cdot t^2$	B1			
		$y = x \tan \theta - 4.9x^2 / 49^2 \cdot \cos^2 \theta$	M 1		aef (eliminating t)	
		$y = x \tan \theta - x^2(1 + \tan^2 \theta) / 490$	A1	4	AG	
	(ii)	$30 = 70 \tan \theta - 10(1 + \tan^2 \theta)$	M 1			
		$\tan \theta = (70 \pm \sqrt{3300}) \div 20$	M 1		(6.37/0.628)	
		81.1°	A1		θ_1 or θ_2	
		32.1°	A1	4	“	
	(iii)	$x^2(1 + \tan^2 \theta) / 490 = x \tan \theta$	M 1		set y = 0	
		$x = 490 \tan \theta / (1 + \tan^2 \theta)$	A1			
$x = 75.0$		A1				

	$x = 221$ (220.6)	A1			
	$d = 146$ m	A1 ✓	5	✓	13
(iii)	Alternatively (1 st 2 marks)				
	$t = 49 \sin \theta / 4.9$ and (9.88/5.31) $x = 49 \cos \theta \cdot t$	M 1		$s = ut + \frac{1}{2}at^2$ and $x = 49 \cos \theta \cdot t$ or $R = \frac{u^2 \sin 2\theta}{g}$ (precise)	
	$x = 490 \sin \theta \cos \theta$	A1		$245 \sin 2\theta$	