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 x tan24°	M1			
		r = 2.2	A1	4	2.226	
	(ii)	No & valid reason (eg 24°⍁26.6°)	B1√	1	√Yes if their r ⍁ 2.5	**5**

2		$v^2 = 2x9.8x10$	M1		energy:$\frac{1}{2}mv^2=\frac{1}{2}mu^2 + mgh$	
		v = 14	A1		$\frac{1}{2}v^2 = \frac{1}{2}.36 + 9.8x10$	
		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	
		θ=66.8°(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 N	A1	3	AG	
	(ii)	$T + T\sin\theta = ma$	M1		resolving horizontally	
		use of $mr\omega^2$	M1			
		ω = 5.72 $rads^{-1}$	A1	3		
	(iii)	K.E.=$\frac{1}{2}x0.01x(r\omega)^2$	M1		$\frac{1}{2}mv^2$ with v=rw	
		K.E.= 0.0588	A1√	2	√0.0018 x their ω^2	**8**

4	(i)	5m = mu + 4m	M1		cons. of mom.	
		u = 1	A1			
		e = (2-1)/5	M1			
		e = 🗐	A1	4		
	(ii)	I = 4m	B1			
		→	B1	2	to the right	
	(iii)	4m = 5mv	M1			
		v = 😐	A1			
		😐 < 1	B1	3		**9**

5	(i)	$60T = 15x30\cos\theta$	M1		moments about A	
		"	A1			
		$60T = 15x30 \times 0.6$	A1		$\cos\theta = 0.6$	
		T = 4.5 N	A1	4	**AG**	
	(ii)	$X = T\sin\theta$	M1		res. horiz. (or moments)	
		X = 3.6 N	A1			
		$Y + T\cos\theta = 15$	M1		res. vert.(3 terms) (or moments)	
		Y = 12.3 N	A1			
		R = 12.8 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) $R^2 = 15^2+4.5^2-2x4.5x15x0.6$(M1A1)				
		R= 12.8 (A1) $\sin\theta/4.5=\sin\alpha/12.8$ (M1) θ = 16.3° to vert. (A1)				

6	(i)	½.700.20^2 or ½.700.15^2	B1		either K.E.	
		700x9.8x400sin5°	B1		correct P.E.	
		½.700.15^2+700.9.8.400sin5°= ½.700.20^2 + W.D.	M1		for 4 terms with W.D.	
		W.D. = 178,000 J	A1	4	or 178 kJ	
	(ii)	D=200 + 700.9.8sin5°	M1			
		D = 798 N	A1		may be implied	
		P = Dx15 = 12,000 = 12kW	A1	3	AG **(11,968W)**	
	(iii)	D' = 11,968÷20 = 598	M1			
		D'-700.9.8sin5°-200 = 700a	M1			
		a = 0.285 ms^{-2} (±)	A1	3	allow 0.283 (from 12kW)	**10**
		Alternative for false assumption			**of constant acceleration**	
	(i)	D-700 x 9.8sin5° = 700a and $15^2 = 20^2 + 2a.400$	M1		(D = 445, a = -0.21875)	
		W.D. = 400xD = 178,000	A1		2 marks (out of 4) maximum	

7	(i)	50x9.8x2 = Rx3.75 +80x9.8x0.25	M1		moments about D.	
		"	A1		SR/no g/ R = 21.3 (M1A1A0)	
		R = 209 N	A1	3		
	(ii)	$130\bar{x}$ = 50 x 2 + 80 x 4.25	M1 A1		moments about BC or FE….. $130\bar{x}$ =80x0.25 + 50x2.5	
		$\bar{x}$ = 3.385	A1		$\bar{x}$ = 1.115	
		$130\bar{y}$ = 50 x 0.125 + 80 x 0.25	M1 A1		moments about EC	
		$\bar{y}$ = 0.202	A1			
		tanθ = 0.615/0.202	M1			
		θ = 71.8° to the horizontal	A1	8	71.6° to 72.0°	**11**

8	(i)	x = 49cosθ . t	B1			
		y=49sinθ.t - ½.9.8.t^2	B1			
		y=xtanθ - 4.9x^2/49^2.$\cos^2\theta$	M1		aef (eliminating t)	
		y=xtanθ – $x^2(1+\tan^2\theta)/490$	A1	4	AG	
	(ii)	30 = 70tanθ – 10(1+$\tan^2\theta$)	M1			
		tanθ=(70±√3300)÷20	M1		(6.37/0.628)	
		81.1°	A1		θ_1 or θ_2	
		32.1°	A1	4	"	
	(iii)	$x^2(1+\tan^2\theta)/490$ = xtanθ	M1		set y = 0	
		x = 490tanθ/(1+$\tan^2\theta$)	A1			
		x = 75.0	A1			

		x = 221 (220.6)	A1			
		d = 146 m	A1 √	5	√	**13**
	(iii)	Alternatively (1st 2 marks)				
		t=49sinθ/4.9 and (9.88/5.31) x=49cosθ.t	M 1		s=ut+½at^2 and x=49cosθ.t or R = u^{2}sin2θ/g (precise)	
		x = 490sinθcosθ	A1		245sin2θ	