4729 Mechanics 2

1	$(20 \sin \theta)^2 = 2 \times 9.8 \times 17$	M1	or B2 for
		A1	max ht = $v^2\sin^2\theta/2g$
	$\sin \theta = \sqrt{(2 \times 9.8 \times 17)} \div 20$	M1	subst. values in above
	$\theta = 65.9°$	A1 **4**	**4**

2	$\bar{x} = 8$	B1	
	T sin30° x 12 = 8 x 2 x 9.8	M1	ok if g omitted
		A1 ft	ft their $\bar{x}$
	T = 26.1	A1 **4**	**4**

3	(i)	140 x X = 40 x 70	M1	
		X = 20 N	A1	
		at *F* 20 N to the right	B1	inspect diagram
		at *G* 20 N to the left	B1 **4**	**SR** B1 for correct directions only
	(ii)	đ = (2x40sinΠ/2)÷3Π/2	M1	must be radians
			A1	
		đ = 17.0	A1	16.98 160/3Π (8/15Π m)
		$70 \bar{y} = 100 \times 60 + 217 \times 10$	M1	
			A1 ft	ft 200 + their đ or 2 + their đ (m)
		$\bar{y} = 117$	A1 **6**	116.7 **10**

4	(i)	$P/10 - 800 \times 9.8 \sin 12° - 100k = 800 \times 0.25$	M1	$P/10 = D_1$ ok
			A1	D_1 ok
		$P/20 - 400k = 800 \times 0.75$	M1	$P/20 = D_2$ ok
			A1	$D_1 = 2D_2$ needed for this A1
		solving above	M1	
		$k = 0.900$	A1	**AG** 0.9000395
		$P = 19\ 200$	A1 **7**	or 19.2 kW (maybe in part (ii))
	(ii)	$0.9 v^2 = 28\ 800/v$	M1	ok if 19200/v
		solving above	M1 *	($v^3 = 32\ 000$)
		$v = 31.7$ m s^{-1}	A1 **3**	**10**

5	(i)	0.8 *S*	B1	vert comp of *S*
		0.6 *T*	B1	vert comp of *T*
		$S \cos\alpha = T \cos\beta + 0.2 \times 9.8$	M1	
		$0.8 S = 0.6 T + 1.96$ aef	A1 **4**	**AG** $4S = 3T + 9.8$
	(ii)	0.6 *S*	B1	
		0.8 *T*	B1	
		$0.2 \times 0.24 \times 8^2$	B1	3.072 384/125
		$S \sin\alpha + T \sin\beta = 0.2 \times 0.24 \times 8^2$	M1	must be $mr\omega^2$
		$6S + 8T = 30.72$	A1	aef
		eliminate *S* or *T*	M1	
		$S = 3.4$ N	A1	3.411
		$T = 1.3$ N	A1 **8**	1.282 **12**

6	(i)	$x = v\cos\theta\, t$	B1	
		$y = v\sin\theta\, t - \frac{1}{2} \times 9.8\, t^2$	B1	or g
		substitute $t = x/v\cos\theta$	M1	
		$y = x\tan\theta - 4.9x^2/v^2\cos^2\theta$	A1 **4**	**AG**
	(ii)	Sub $y = -h$, $x = h$, $v = 14$, $\theta = 30$	M1	signs must be correct
		$-h = h/\sqrt{3} - h^2/30$	A1	aef
		solving above	M1	
		$h = 47.3$	A1 **4**	
	(iii)	$v_v^2 = (14\sin30°)^2 - 2\times9.8\times(-47.3)$	M1	$14\cos30°\, t=47.3$ ft & $v_v =14\sin30°-9.8t$
		(double negative needed) ft their -47.3	A1 ft	$t = 3.90$ (or $dy/dx=1/\sqrt{3} - x/15$ etc ft)
		$v_v = \pm31.2$	A1	$v_v = \pm31.2$ ($\tan\alpha = 1/\sqrt{3} - 47.3/15$)
		$\tan^{-1}(31.2/14\cos30°)$	M1	$\tan^{-1}(31.2/14\cos30°)$
		$\alpha= 68.8°$ below horiz/21.2° to d'vert.	A1 **5**	68.8°/…..
	(iv)	$\frac{1}{2}mx14^2 + mx9.8x47.3 = \frac{1}{2}mv^2$	M1	ft ($12.1^2 + 31.2^2$)
		$v = 33.5$	A1 **2**	33.5 **15**

7	(i)	$p = 4$ m s^{-1}	B1	P's first speed
		$0.8 = 0.2p_1 + 0.3q_1$	M1	
			A1	
		$0.5 = (q_1 - p_1)/4$	M1	
			A1	
		solving above	M1	
		$q_1 = 2.4$ 12/5	A1	Q's first speed
		$p_1 = 0.4$ 2/5	A1 **8**	may be in (ii). **SR** 1 for both negative
	(ii)	$0.8 = 0.2p_2 + 0.3q_2$	M1	
			A1	
		$0.5 = (p_2 - q_2)/2$	M1	
			A1	
		solving above	M1	
		$p_2 = 2.2$ 11/5	A1	
		$q_2 = 1.2$ 6/5	A1 **7**	
	(iii)	$R = 0.3 \times 1.2^2 /0.4$	M1	
		$R = 1.08$ N	A1 **2**	**17**