4729 Mechanics 2

1	$(20 \sin\theta)^2 = 2 \times 9.8 \times 17$	M1	or B2 for max ht = $v^2\sin^2\theta/2g$
		A1	
	$\sin\theta = \sqrt{(2 \times 9.8 \times 17)} \div 20$	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)	$0.9v^2 = 28\,800/v$	M1	ok if $19200/v$
	solving above	M1 *	**($v^3 = 32\,000$)**
	$v = 31.7$ m s^{-1}	A1 **3**	**10**

5 (i)	$0.8S$	B1	vert comp of *S*
	$0.6T$	B1	vert comp of *T*
	$S\cos\alpha = T\cos\beta + 0.2 \times 9.8$	M1	
	$0.8S = 0.6T + 1.96$ aef	A1 **4**	**AG** $4S = 3T + 9.8$
(ii)	$0.6S$	B1	
	$0.8T$	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)	$v_v^2 = (14\sin 30°)^2 - 2x9.8x(-47.3)$	M1	$14\cos 30°\ t = 47.3$ ft & $v_v = 14\sin 30° - 9.8t$
	(double negative needed) ft their -47.3	A1 ft	$t = 3.90$ (or $dy/dx = 1/\sqrt{3} - x/15$ etc ft)
	$v_v = \pm 31.2$	A1	$v_v = \pm 31.2$ ($\tan\alpha = 1/\sqrt{3} - 47.3/15$)
	$\tan^{-1}(31.2/14\cos 30°)$	M1	$\tan^{-1}(31.2/14\cos 30°)$
	$\alpha = 68.8°$ 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**