

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
	$\theta = 65.9^\circ$	A1 4	4

2	$\bar{x} = 8$	B1	
	$T \sin 30^\circ \times 12 = 8 \times 2 \times 9.8$	M1	ok if g omitted
		A1 ft	ft their $\bar{x}$
	$T = 26.1$	A1 4	4

3 (i)	$140 \times X = 40 \times 70$	M1	
	$X = 20 \text{ N}$	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)	$\bar{d} = (2 \times 40 \sin \Pi / 2) \div 3 \Pi / 2$	M1	must be radians
		A1	
	$\bar{d} = 17.0$	A1	16.98 160/3Π (8/15Π m)
	$70 \bar{y} = 100 \times 60 + 217 \times 10$	M1	
		A1 ft	ft 200 + their $\bar{d}$ or 2 + their $\bar{d}$ (m)
	$\bar{y} = 117$	A1 6	116.7 10

4 (i)	$P/10 - 800 \times 9.8 \sin 12^\circ - 100k = 800 \times 0.25$	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 *	$(v^3 = 32\,000)$
	$v = 31.7 \text{ m s}^{-1}$	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 $m r \omega^2$
	$6S + 8T = 30.72$	A1	aef
	eliminate S or T	M1	
	$S = 3.4 \text{ N}$	A1	3.411
	$T = 1.3 \text{ N}$	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	
	$y = x \tan \theta - 4.9 x^2 / v^2 \cos^2 \theta$	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)	$v_v^2 = (14 \sin 30^\circ)^2 - 2 \times 9.8 \times (-47.3)$	M1	$14 \cos 30^\circ t = 47.3 \text{ ft}$ & $v_v = 14 \sin 30^\circ - 9.8t$
	(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	$v_v = \pm 31.2$ ($\tan \alpha = 1/\sqrt{3} - 47.3/15$)
	$\tan^{-1}(31.2/14 \cos 30^\circ)$	M1	$\tan^{-1}(31.2/14 \cos 30^\circ)$
	$\alpha = 68.8^\circ$ below horiz/21.2° to d'vert.	A1 5	68.8°/.....
(iv)	$\frac{1}{2} m \times 14^2 + m \times 9.8 \times 47.3 = \frac{1}{2} m v^2$	M1	ft ($12.1^2 + 31.2^2$)
	$v = 33.5$	A1 2	33.5 15

7 (i)	$p = 4 \text{ m s}^{-1}$	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	
	$R = 1.08 \text{ N}$	A1 2	17