1 (i)	$[20 + 25\sin\theta = 2.7g]$	M1		For resolving forces vertically
	$\sin\theta = 0.28$	A1	2	**AG**
(ii)	$[25 \times 5 \times \sqrt{(1 - 0.28^2)}]$	M1		For using WD = $Fd\cos\theta$
	Work done is 120 J	A1	2	
2		M1		For resolving components of F in x and y directions
	$F_x = F\cos\theta = 25 \times 0.8 = 20$, $F_y = F\sin\theta = 63 - 25 \times 0.6 = 48$	A1		
		M1		For using $F = \sqrt{(F_x^2 + F_y^2)}$ or for using $\tan\theta = F_y \div F_x$
	$F = 52$ N or $\tan\theta = 2.4$	A1		
	$\tan\theta = 2.4$ or $F = 52$ N	B1	5	
3	$F = 0.25\left(6.1 \times \frac{60}{61}\right)$ [= 1.5]	B1		Allow $F = 0.25(6.1\cos 10.4)$
	$[W\sin\alpha - F = ma]$	M1		For using Newton's 2nd law
	$6.1 \times \left(\frac{11}{61}\right) - 0.25\left(6.1 \times \frac{60}{61}\right) = 0.61a$ or $6.1 \sin 10.4 - 0.25 \times 6.1 \cos 10.4 = 0.61a$	A1		$\left[a = -\frac{40}{61} = -0.656\right]$ The value of a may be seen but is not a required answer.
		M1		For using $0 = v_A^2 + 2as$
	Distance is $4 \div \left(2 \times \frac{40}{61}\right)$ = 3.05 m	A1	5	
	Alternative method			
	$F = 0.25\left(6.1 \times \frac{60}{61}\right)$ [= 1.5]	B1		Allow $F = 0.25(6.1\cos 10.4)$
	KE loss = $\frac{1}{2} \times 0.61 \times 2^2$	B1		Finding loss of KE
	PE loss = $0.61 \times 10 \times x\left(\frac{11}{61}\right)$	B1		Finding loss of PE
	$[1.5x = 1.22 + 1.1x]$	M1		Using WD against F = KE loss + PE loss
	$0.4x = 1.22 \rightarrow$ distance = 3.05 m	A1	5	

4 (i)		M1		For using KE gain = $\frac{1}{2}mv_B^2$ or PE loss = $mg \times AB\sin\theta$
	For KE gain $= 4032 \times 10^3$ or PE loss $= 42 \times 10^6 \sin\theta$	A1		
	PE loss $= 42 \times 10^6 \sin\theta$ or KE gain $= 4032 \times 10^3$	B1	3	
(ii)		M1		For using WD by DF = KE gain – PE loss + WD by resistance
	$5000 = 4032 - 42000\sin\theta + 3360$	A1√		
	$\theta = 3.3^\circ$	A1	3	
5		M1		For using DF = $\frac{P}{v}$ for DF up and down
		M1		For applying Newton's 2nd law up and down
	$\frac{P}{3} - R - 84g \times 0.1 = 84 \times 1.25$	A1		
	$\frac{P}{10} - R + 84g \times 0.1 = 84 \times 1.25$	A1		
	$\left[P\left(\frac{1}{3} - \frac{1}{10}\right) - 168 = 0\right]$	M1		For solving equations for P
	$P = 720$	A1		
	$\left[R = \frac{720}{3} - 84 - 105\right]$	M1		For substitution for P to obtain R
	$R = 51$	A1	8	
6 (i)		M1		For integrating $a(t)$ to find $v(t)$
	$v(t) = 0.05t - 0.0001t^2$ (+ 0)	A1		
	$v(200) = 10 - 4 = 6$ ms^{-1}	A1		
	$v(500) = 25 - 25 = 0$	A1	4	
(ii)		M1		For integrating v(t) between limits 0 to 500 to obtain the distance A travels

	$\int_0^{500}\left(0.05t-0.0001t^2\right)dt$ $\left[\frac{0.05t^2}{2}-\frac{0.0001t^3}{3}\right]_0^{500}$	A1		
	Distance $= 0.025 \times 500^2 - 0.0001 \times 500^3 \div 3$ $= 2083$ m	A1		Accept 2080
		M1		For using area property of graph or $s = \frac{1}{2}(u+v)t$ or $s = ut + \frac{1}{2}at^2$ to find distance travelled by B
	Distance $= \frac{1}{2} \times 6 \times 500 = 1500$ m **or** distance $= \frac{1}{2}(0+6)\times 200 + \frac{1}{2}(6+0)\times 300$ **or** distance $= \left(0+\frac{1}{2}0.03\times 200^2\right)$ $+\left(6\times 300+\frac{1}{2}(-0.02)300^2\right)$	A1		
	Distance between A and B is $2083 - 1500 = 583$ m	B1	6	Can only be scored if distance travelled by A has been found using integration
7 (i)		M1		For using Newton's 2nd law for both particles
	$T - 0.2 \times 3 = 0.3a$ and $7 - T = 0.7a$	A1		
	Acceleration $= 6.4$ ms^{-2}	A1		
	$[v = 0 + 6.4 \times 0.25]$	M1		For using $v = 0 + at$ to find speed when string breaks
	$v = 1.6$ ms^{-1}	A1		
	$\left[\text{Distance} = 0+\frac{1}{2}6.4\times 0.25^2\right]$	M1		For using $s = ut + \frac{1}{2}at^2$ to find distance moved before break
	Distance $= 0.2$ m	A1		
	$[v^2 = 1.6^2 + 2g \times (0.5 - 0.2)]$	M1		For using $v^2 = u^2 + 2gs$ to find speed when B hits floor
	Speed is 2.93 ms^{-1}	A1	9	

(ii)		M1		For finding distance travelled by A after break from $v^2 = u^2 + 2as$
	Distance travelled after break $= (0 – 1.6^2) \div (2 \times –2) = 0.64$	A1		For A, $F = 0.2 \times 3$ and so $– 0.2 \times 3 = 0.3a$ so $a = –2$
	Total distance travelled $= 0.2 + 0.64 = 0.84$	B1	3	Distance = 0.84 m
	Alternative method for 7(ii)			
(ii)	$T = 2.52$, $F = 0.2 \times 3$ WD by $T = 2.52 \times 0.2$ WD by $F = 0.2 \times 3 \times d$	B1		For stating WD by T on A and WD by F
	$[0.6d = 2.52 \times 0.2]$	M1		Using WD by F = WD by T (No change in KE or PE for A)
	WD by T = WD by $F \rightarrow d = 0.84$	A1	3	Distance = 0.84 m