1	**(i)**	[WD = 65 × 76cos5°]	M1		For using WD = Tdcos α
		Work done is 4920 J	A1	**[2]**	
	(ii)	[P = 65 cos5° × 1.5]	M1		For using P = Tvcos α
		Rate of working is 97.1 W	A1ft	**[2]**	ft for the value of ans**(i)** × 1.5÷76 SR for candidates who assume without justification that the speed is constant (max 1/2) t = 76 ÷ 1.5 = 50.6…s rate = WD/t = 4960÷50.6.. = 97.1W B1
2			M1		For using 'loss of PE = gain in KE + WD against resistance'
		PE loss = ½ 8($8^2 - 3^2$) + 120 (= 340 J)	A1		
		[340 = 8gh]	DM1		For using PE = mgh
		Height is 4.25 m	A1	**[4]**	
					SR for candidates who assume without justification that the resistance to motion is constant, usually implicitly by using constant acceleration formulae (max 3/4) For using Newton's second law with 3 terms, $v^2 - u^2 = 2as$ and h = s sinα M1 For attempting to eliminate α, a and s from the equations (80sinα – 120/s = 8a 64 – 9 = 2as, h = s sinα) M1 80s sinα – 120 = 4(64 – 9) → 80h – 120 = 220 → h = 4.25 A1
3	**(i)**	[½ 5 × 50 + ½ 7(8 + 50) + 90 × 8]	M1		For using the area property for distance or s = ½ (u + v)t
		Distance is 1048 m	A1	**[2]**	AG
	(ii)		M1		For use of the gradient property for acceleration (deceleration)
		a = (8 – 50)/(12 – 5) or d = (50 – 8)/(12 – 5)	A1		
			M1		For using Newton's second law (3 terms)
		850 – F = 85a (or –85d)	A1		
		Upward force is 1360 N	A1	**[5]**	

4	**(i)**	M1		For resolving forces in the **i** and **j** directions
	$F\cos\theta = 12\cos30°$ (= 10.932)	A1		
	$F\sin\theta = 10 - 12\sin30°$ (= 4)	A1		
		M1		For using $F^2 = X^2 + Y^2$ or $\tan\theta = Y/X$
	F = 11.1 or θ = 21.1 (accept 21.0)	A1		
	θ = 21.1 (accept 21.0) or F = 11.1	B1	**[6]**	
				SR for candidates who consistently have cos for sin and vice versa (max 4/6) M1 as above (resolving) A1 for $F\sin\theta = 12\sin30°$ and $F\cos\theta = 10 - 12\cos30°$ M1 as above F^2 = ... & $\tan\theta$ =.... A1 for F = 6.01 and θ = 93.7
	(ii) Magnitude is 12N	B1		
	Direction is 30° clockwise from +ve 'x' axis	B1	**[2]**	
	alternative for 4(i)			
	For triangle of forces with sides 12, F and 10 and at least one of the angles $(90° - \theta)$ or 60° or $(\theta + 30°)$	B1		
		M1		For use of cosine rule (with θ absent) or use of sine rule (with F absent) and use of $\sin(A \pm B) = \sin A\cos B \pm \sin B\cos A$
	$F^2 = 12^2 + 10^2 - 2 \times 12 \times 10\cos60°$ or $(12\cos30°)\sin\theta = (10 - 12\sin30°)\cos\theta$	A1		
	F = 11.1 or θ = 21.1 (accept 21.0)	A1		
		M1		For correct method for θ or F
	θ = 21.1 (accept 21.0) or F = 11.1	A1	**[6]**	
	second alternative for 4(i)			
	For using Lami's theorem with 12 N and 10 N	M1		
	$12/\sin(90 + \theta) = 10/\sin(150 - \theta)$	A1		
	$12/\cos\theta = 20 \div (\cos\theta + 3^{½}\sin\theta)$ $\rightarrow 12 \times 3^{½}\sin\theta = 8\cos\theta$ $\rightarrow \tan\theta = 2 \div (3 \times 3^{½})$ $\rightarrow \theta = 21.1$	A1		
	For using Lami's theorem with F N and (12 N or 10 N)	M1		
	$F/\sin120° = 12/\sin111.1°$ (or $10/\sin128.9°$)	A1		
	F = 11.1	A1	**[6]**	

	Alternative for 4(ii)				
		For X = 11.1cos21.1° and Y = 11.1sin21.1° – 10, $R^2 = X^2 + Y^2$ and tanΦ = Y/X	M1		
		Magnitude 12 N and direction 30° clockwise from +ve x-axis	A1	**[2]**	
5	**(i)**		M1		For using 0 = u – gt to find times at maximum heights.
		Times to max. height are 1.2s and 0.7s	A1		
		Range of values is $0.7 < t < 1.2$	A1	**[3]**	
	(ii)		M1		For using $h = ut – ½ gt^2$ and attempting to solve $3h_A = 8h_B$ for t
		$36t – 1.5gt^2 = 56t – 4gt^2$	A1		
		$t = 8/g$	A1		
			M1		For using v = u – gt
		Velocities are $4ms^{-1}$ and $–1ms^{-1}$	A1	**[5]**	
	Alternative for part 5(ii)				
		For using $3h_P = 8h_Q \rightarrow 3(v_P^2 – 144) \div (–20) = 8(v_Q^2 – 49) \div (–20) \rightarrow 3v_P^2 – 8v_Q^2 = 40$	B1		
		For using $v_P = 12 – 10t$ and $v_Q = 7 – 10t$ $\rightarrow$ $v_P – v_Q = 5$	B1		
		For eliminating v_Q (or v_P) and solving for v_P (or v_Q).	M1		
		$v_P^2 – 16v_P + 48 = 0 \rightarrow v_P = 4$ (or 4, 12)	A1		
		Upward velocities are 4 ms^{-1} and –1 ms^{-1}	A1	**[5]**	
6	**(i)**		M1		For resolving forces on R vertically
		$2T \cos\alpha = 0.6g$	A1		Where α = ½ angle ARB
		Tension is 5N	A1	**[3]**	
	(ii)	[$F = T \sin\alpha$]	M1		For resolving forces on B horizontally
		Frictional component is 4N	A1		
		[$N = 0.4g + T \cos\alpha$]	M1		For resolving forces on B vertically
		Normal component is 7 N	A1	**[4]**	
	(iii)		M1		For using $\mu = F/N$
		Coefficient is 4/7 or 0.571	A1ft	**[2]**	ft conditional on both M1 marks scored in **(ii)**; ft F and/or N

	Alternative for Q6(i)/(ii)				
	(i)	For finding the relevant angles and using Lami's theorem	M1		
		$6/\sin 106.26° = T/\sin 126.87°$	A1		
		Tension is 5N	A1	**[3]**	
	(ii)	$F/\sin 126.87° = 5/\sin 90°$	B1		
		Frictional component is 4N	B1		
		$(R - 4)/\sin 143.13° = 5/\sin 90°$	B1		
		Normal component is 7 N	B1	**[4]**	
7	**(i)**	$[1.3 = 0.9 + 0.004T,$ $1.3^2 = 0.9^2 + 2 \times 0.004S]$	M1		For using $v = u + at$ or $v^2 = u^2 + 2as$
		Time is 100 s (or distance is 110 m)	A1		
		Distance is 110 m (or time is 100 s)	B1	**[3]**	
	(ii)	$\int kt^3 dt = ¼ kt^4$	B1		
		$[k(¼ 100^4 - 0) = 110]$	M1		For using limits 0 to T and equating definite integral to S
		$k = 4.4 \times 10^{-6}$	A1		
		$[v_W = 0.9 + 0.004 \times 64.05,$ $v_C = 4.4 \times 10^{-6} \times 64.05^3]$	M1		For attempting to find the speed of the walker and of the cyclist.
		Both are equal to 1.16 ms^{-1} correct to 3 sf.	A1	**[5]**	
	(iii)	Acceleration = $3kt^2$	B1		
		Acceleration at B is 0.132 ms^{-2}	B1	**[2]**	