1	**(i)**	PE loss = $0.8g \times (2.5 - 1.8)$ (= 5.6J)	B1		
		Work done is 5.6 J	B1	2	
	(ii)		M1		For using KE gain = PE loss – WD against resistance
		$\frac{1}{2}\ 0.8v^2 = 0.8g \times 2.5 - 0.6 \times 5.6$	A1ft		
		Speed at B is 6.45 ms^{-1}	A1	3	
2	**(i)**	$[a = 0.2 + 0.012t]$	M1		For differentiating to find $a(t)$.
		$[0.2 + 0.012t = 2.5 \times 0.2]]$	M1		For attempting to solve $a(t) = 2.5a(0)$
		$t = 25$	A1	3	AG
	(ii)	$[s = 0.1t^2 + 0.002t^3\ \ (+ C)]$	M1		For integrating to find $s(t)$
		$[s = 0.1 \times 625 + 0.002 \times 15625]$	DM1		For using limits 0 to 25 or evaluating $s(t)$ with $C = 0$ (which may be implied by its absence)
		Displacement is 93.75 (accept 93.7 or 93.8)	A1	3	
3	**(i)**	$[0 = 8^2 - 2gs]$	M1		For using $0 = u^2 - 2gs$
		Maximum height is 3.2 m	A1		
		$[v^2 = 8^2 - 2g \times 1.6]$	M1		For using $v^2 = u^2 - 2gs$
		Speed is 5.66 ms^{-1}	A1	4	
	(ii)	$[5.65685... = 8 - 10t]$	M1		For using $v = u - gt$
		Time is 0.234 s	A1	2	
4		$[T_1 \sin APN = T_2 \sin BPN]$	M1		For resolving forces horizontally
		$(12 \div 13)T_1 = (15 \div 25)T_2$ or $T_1 \sin 67.4^\circ = T_2 \sin 36.9^\circ$	A1		AEF
		$[T_1 \cos APN + T_2 \cos BPN = 21]$	M1		For resolving forces vertically
		$(5 \div 13)T_1 + (20 \div 25)T_2 = 21$ or $T_1 \cos 67.4^\circ + T_2 \cos 36.9^\circ = 21$	A1		AEF
			M1		For solving for T_1 and T_2
		Tension in S_1 is 13 N, tension in S_2 is 20 N	A1	6	

	Alternative solution using Lami's Theorem			
4	$[T_1/\sin(180 - BPN) = 21/\sin(APN + BPN)]$	M1		For using Lami's Theorem to form an equation in T_1
	$T_1/\sin(180 - \cos^{-1}(20/25)) = 21/\sin(\cos^{-1}(20/25) + \cos^{-1}(20/52))$ or $T_1/\sin(180 - 36.9) = 21/\sin(36.9 + 67.4)$	A1		AEF
	$[T_2/\sin(180 - APN) = 21/\sin(APN + BPN)]$	M1		For using Lami's Theorem to form an equation in T_2
	$T_2/\sin(180 - \cos^{-1}(20/52)) = 21/\sin(\cos^{-1}(20/25) + \cos^{-1}(20/52))$ or $T_2/\sin(180\text{-}67.4) = 21/\sin(36.9 + 67.4)$	A1		AEF
		M1		For solving for T_1 and T_2
	Tension in S_1 is 13 N, tension in S_2 is 20 N	A1	6	
	Alternative solution using Sine Rule			
4	$[T_1/\sin BPN = 21/\sin(180 - (APN + BPN))]$	M1		For using the Sine Rule on a triangle of forces to form an equation in T_1
	$T_1/(15/25) = 21/\sin(\cos^{-1}(20/25) + \cos^{-1}(20/52))$ or $T_1/\sin 36.9^\circ = 21/\sin(180 - (36.9 + 67.4))$	A1		AEF
	$[T_2/\sin APN = 21/\sin(180 - (APN + BPN))]$	M1		For using the Sine Rule to form an equation in T_2
	$T_2/(12/13) = 21/\sin(\cos^{-1}(20/25) + \cos^{-1}(20/52))$ or $T_2/\sin 67.4^0 = 21/\sin(180 - (36.9 + 67.4))$	A1		AEF
		M1		For solving for T_1 and T_2
	Tension in S_1 is 13 N, tension in S_2 is 20 N	A1	6	

5	**(i)**	$[\frac{1}{2} 12(7^2 - 3^2)]$	M1		For using KE = $\frac{1}{2} m(v_B^2 - v_A^2)$
		Increase is 240 J	A1	2	
	(ii)		M1		For using mgh = KE gain
		$12g \times AB\sin 10^o = 240$	A1ft		
		Distance is 11.5 m	A1	3	
					SR for candidates who avoid 'hence' (max 2/3) For using Newton's Second Law and $v^2 = u^2 + 2as$ [$12g\sin 10^o = 12a$ $7^2 = 3^2 + 2(g\sin 10^o \times AB)$] M1 11.5 m A1
	(iii)		M1		For using $F(AB)\cos 10^o$ = PE gain or for using Newton's 2nd law with $a = 0$.
		F x $11.5\cos 10^o = 240$ or $F\cos 10^o - 12g\sin 10^o = 0$	A1ft		
		Magnitude is 21.2 N	A1	3	
6		[$P = \pm$ F + $0.6g\sin 25^o$]	M1		For resolving forces in the direction of P
		P_{max} = F + $0.6g\sin 25^o$ or 'P = F + $0.6g\sin 25^o$ when the particle is about to slide upwards'	A1		
		P_{min} = - F + $0.6g\sin 25^o$ or 'P = – F + $0.6g\sin 25^o$ when the particle is about to slide downwards'	A1		
		$R = 0.6g\cos 25^o$	B1		
		[F = $0.36 \times 0.6g\cos 25^o$]	M1		For using F = μR
		[$P_{max} = 0.36 \times 0.6g\cos 25^o + 0.6g\sin 25^o$, $P_{min} = -0.36 \times 0.6g\cos 25^o + 0.6g\sin 25^o$]	DM1		For substituting for F to obtain values of P_{max} and P_{min}
		P_{max} = 4.49, P_{min} = 0.578 (accept 0.58)	A1		Dependent on first M mark
			M1		For identifying range of value for equilibrium
		Set of values is $\{P; 0.578 \leq P \leq 4.49\}$	A1	9	AEF; Accept 0.58 instead of 0.578 and accept < instead of ≤

7	**(i)**		M1		For applying Newton's 2nd law to *A* or to *B*.
		$0.32g - T = 0.32a$ (or $T = 0.48a$)	A1		
		$T = 0.48a$ (or $0.32g - T = 0.32a$) OR $0.32g = (0.32 + 0.48)a$	B1		
			M1		For solving for a and T
		Acceleration is 4 ms^{-2} and tension is 1.92 N	A1	5	
	(ii)	$[0.98 = ½\ 4t^2]$	M1		For using $s = ½\ at^2$
		Time taken is 0.7 s	A1	2	
	(iii)		M1		For using $v = at$ for taut stage and $t = d/v$ for slack stage
		$v = 4 \times 0.7$ and $t = (1.4 - 0.98)/v$ (= 0.15)	A1ft		ft a from **(i)** and /or t from **(ii)** (a>0, a≠g)
	Time taken is 0.85 s		A1	3	