1 **(i)**	PE gain = $50g \times 3.5$ (=1750)	**B1**		
	[WD = $50g \times 3.5 + 25 \times 3.5$]	**M1**		For using WD = PE gain + WD against resistance
	Work done = 1837.5 J or 1840 J	**A1**	[3]	
(ii)	[P = 1837.5/2] or [$P/v = 50g + 25$ **and** $3.5=2v$]	**M1**		For using P = WD/t or for using $P = Fv$ **and** $s = v$t
	Power = 919 W	**A1**	[2]	
2		**M1**		For resolving horizontally
		M1		For resolving vertically
	$T_A \cos 50° - T_B \cos 10° = 0$ **and** $T_A \sin 50° - T_B \sin 10° - 20\,g = 0$	**A1**		
		M1		For solving equations to find T_A and T_B
	Tension in PA is 306 N Tension in PB is 200 N	**A1**	[5]	
	Alternative (Lami's Theorem)			
	[$T_A/\sin 80° = T_B/\sin 140° = 20g/\sin 140°$]	**M1**		For applying Lami's Theorem
	[$T_A = 20g \sin 80°/\sin 140°$]	**M1**		For solving for T_A
	Tension in PA is 306 N	**A1**		
	[$T_B = 20g \sin 140°/\sin 140°$]	**M1**		For solving for T_B
	Tension in PB is 200 N	**A1**	[5]	

3 **(i)**	$[7g - T = 7a$ **and** $T - 3g = 3a]$ or $[7g - 3g = 10a]$	**M1**		For applying Newton's second law to P **and** to Q or for using $m_Pg - m_Qg = (m_P + m_Q)a$
	Acceleration is $4\,\text{ms}^{-2}$	**A1**		
	$[v^2 = 0 + 2 \times 4 \times 0.4]$ $(v^2 = 3.2)$	**M1**		For using $v^2 = u^2 + 2as$
	Speed is $1.79\,\text{ms}^{-1}$	**A1**	[4]	
(ii)	$[0 = 3.2 + 2 \times (-g) \times s]$ $(s = 0.16)$	**M1**		For using $0 = u^2 + 2(-g)s$
	$0.16 + 0.4 = 0.56$ So particle Q does not come to rest before it reaches the pulley	**A1**	[2]	
	Alternative			
	$[v^2 = 3.2 + 2 \times (-g) \times 0.1]$	**M1**		For using $v^2 = u^2 + 2(-g)(0.1)$
	$v = \sqrt{1.2}$ $(= 1.10)$ So particle Q does not come to rest before it reaches the pulley	**A1**	[2]	
4 **(i)**	$s_A = \frac{1}{2}g \times 2.5^2$ $(= 31.25)$	**B1**		
	$[s_B = 20 \times 1.5 - \frac{1}{2}g \times 1.5^2]$ $(= 18.75)$	**M1**		For using $s = ut + \frac{1}{2}at^2$
	$\frac{1}{2}g \times 2.5^2 + 20 \times 1.5 - \frac{1}{2}g \times 1.5^2$ Height is 50 m AG	**A1**	[3]	
(ii)	$50 = 0.5gt_A^2$ $(t_A = 3.16)$	**B1**		For using $s = \frac{1}{2}at^2$
	$t_B = \sqrt{10} - 1 = 2.16$	**B1**		
	To top, $0^2 = 20^2 - 2gs_B$ $\rightarrow s_B = 20$	**B1**		
	To top, $[0 = 20 - gt_B]$ $\rightarrow t_B = 2$ Downwards, $[s_B = \frac{1}{2}g(0.16)^2]$ $(= 0.13)$	**M1**		For using $v = u + at$ to find time to top for B **and** $s = \frac{1}{2}at^2$ to find downwards distance for B
	Total distance is 20.1 m	**A1**	[5]	

5 (i)	$6t - 0.3t^2 = 0 \rightarrow t = 20$ (or 0)	**B1**		
	$[s = 6t^2/2 - 0.3t^3/3$ (+C)]	**M1**		For integrating $v(t)$ to obtain $s(t)$
	$[s = 6(20)^2/2 - 0.3(20)^3/3]$	**DM1**		For evaluating $s(t)$ when v=0
	Distance OX is 400 m	**A1**	[4]	
(ii)	$[v = kt - 6t^2$ (+C)]	**M1***		For integrating $a(t)$ to obtain $v(t)$
	$[s = kt^2/2 - 6t^3/3]$	**M1***		For integrating $v(t)$ to obtain $s(t)$ and for using $s(0) = 0$
	$[400 = 0.5k \times 10^2 - 2 \times 10^3]$	**DM1**		For using $t = 10$ and $s = 400$ to form equation in k
	$k = 48$	**A1**	[4]	
6 (i)	Driving force = 160/5 (= 32 N)	**B1**		
	$[160/5 - 20 = m \times 0.15]$	**M1**		For using Newton's Second Law
	Total mass is 80 kg AG	**A1**	[3]	
(ii)	$[300/v - 20 - 80g\sin 2° = 0]$	**M1**		For resolving up hill
	Speed is 6.26 ms^{-1} AG	**A1**	[2]	
(iii)	Driving force = $300/(0.9 \times 6.26)$ (= 53.2 N)	**B1**		
		M1		For using Newton's Second Law
	$300/(0.9 \times 6.26) - 20 - 80g\sin 2° = 80a$	**A1**		
	Acceleration is 0.0666 ms^{-2}	**A1**	[4]	

7 **(i)**	$R = 50g\cos 10°$ and $F = 50g\sin 10°$	**B1**		
	$\mu \geqslant 0.176$	**B1**	[2]	$\mu \geqslant F \div R$ Allow $\mu \geqslant \tan 10°$
(ii)	PE loss = $50g \times d\sin 10^o$	**B1**		$d = 5$ or $d = 10$
	WD against friction = $0.19 \times 50g\cos 10° \times d$	**B1**		$d = 5$ or $d = 10$
		M1		For using WD by 50 N force + PE loss – WD against friction = KE gain
	$50 \times 5 + 50g \times 10\sin 10° - 0.19 \times 50g\cos 10° \times 10 = 0.5 \times 50v^2$	**A1**		
	Speed is $2.70\,\text{ms}^{-1}$	**A1**	[5]	
				SC for candidates using Newton's Second law: max 2/5 B1 $v = 2.94\ \text{ms}^{-1}$ after 5 m B1 Speed is $2.70\,\text{ms}^{-1}$
(iii)	$50g\sin 20^o - 0.19 \times 50g\cos 20^o = 50a$	**M1**		For using Newton's Second Law
	Acceleration is $1.63\,\text{ms}^{-2}$	**A1**	[2]	