1	[WD = 500 × 2.75 × 40]	M1		For using WD = Fs or for using WD = Pt
	Work done = 55000 J	A1		
		M1		For using Power = ΔWD÷Δt or for using $P = Fv$
	Power = $\frac{55000}{40}$ = 1375 W or Power = 500 × 2.75 = 1375 W	A1	4	
2 (i)		B1	1	After B reaches the floor, A continues at constant speed until it reaches the pulley (no tension and the surface is smooth). Thus A's speed when B reaches the floor is the same as A's speed (3 ms^{-1}) when it reaches the pulley. Until the instant when B reached the floor, A and B have the same speed and hence B reaches the floor with speed 3 ms^{-1}.
(ii)	Loss of PE = 0.15gh	B1		
	Gain of KE = $\frac{1}{2}$ (0.35 + 0.15) × 3^2	B1		
	1.5h = 0.25 × 9	M1		For using loss of PE = gain of KE
	h = 1.5	A1	4	
Alternative Method for part (ii)				
(ii)	[0.15g – T = 0.15a and T = 0.35a or 0.15g = (0.35+0.15)a] ➔ a = ...	M1		For applying Newton's second law to A and to B or for using $m_Bg = (m_A+m_B)a$ to find a
	a = 3ms^{-2}	A1		
	[3^2 = 0 + 2 × 3h]	M1		For using $v^2 = u^2 + 2as$
	h = 1.5	A1	4	

Alternative Method for part (ii)				
(ii)	[0.15g – T = 0.15a and T = 0.35a ➔ T = ...	M1		For applying Newton's second law to A and to B to find T
	T = 1.05N	A1		
	$\left[0.15gh - \frac{1}{2} \times 0.15 \times 3^2 = 1.05h\right]$ or $\left[\frac{1}{2} \times 0.35 \times 3^2 = 1.05h\right]$	M1		For using PE_B loss – KE_B gain= WD against T or for using KE_A gain = WD by T
	h = 1.5	A1	4	
3		M1		For using DF = P/v and for applying Newton's 2nd law at one or both points
	$\frac{P}{4.5} - R = 860 \times 4$	A1		
	$\frac{P}{22.5} - R = 860 \times 0.3$	A1		
		M1		For eliminating R to find P or for eliminating P to find R
	$\frac{P}{4.5} - \frac{P}{22.5} = 860(4 - 0.3)$ ➔ P = 17900 or –4.5R + 22.5R = 860(4 × 4.5–0.3 × 22.5) ➔ R = 537.5	A1		
	R = 537.5	B1	6	Accept 538
4	KE loss = $\frac{1}{2} \times 12000(24^2 - 16^2)$	B1		
	PE gain = 12000g × 25	B1		
		M1		For using WD by DF = PE gain – KE loss + WD against resistance

	WD by DF = 3000000 – 1920000 + 7500×500	A1		
		M1		For using DF = WD by DF÷500
	Driving force = 4830000÷500 Driving force is 9660 N	A1	6	
Alternative Method for 4				
4	$[16^2 = 24^2 + 2 \times 500a]$	M1		For using $v^2 = u^2 + 2as$
	$a = -0.32$ ms^{-2}	A1		
	Weight component down hill = 12000*g* × 25/500	B1		
		M1		For using Newton's 2nd law
	$DF - 7500 - 12000g \times \frac{25}{500} = 12000 \times (-0.32)$	A1		
	Driving force is 9660 N	A1	6	
5 (i)	*x*-component = 4+8cos30°+12cos60° [= 10 + 4√3]	B1		16.928
	y-component = 8sin30°+12sin60°+16 [= 20 + 6√3]	B1		30.392
		M1		For using $R^2 = X^2 + Y^2$ or $\tan\theta = Y \div X$
	R = 34.8 or *θ* = 60.9° with the 4N force	A1		
	θ = 60.9° with the 4N force or *R* = 34.8	B1	5	
(ii)	*R* = 34.8	B1√		ft *R* from **(i)**
	θ = 29.1° with the 16N force	B1√	2	ft 90 – *θ* from **(i)**

6 **(i)**		M1		For resolving forces down the plane
	$20 + 5g\sin10° - F = 0$	A1		
	$R = 5g\cos10°$	B1		
	$[\mu = (20 + 8.6824) \div 49.24]$	M1		For using $\mu = F \div R$
	Coefficient of friction is 0.582	A1	5	
(ii)		M1		For using Newton's 2nd law
	$5g\sin10° - 0.582 \times 49.24 = 5a$	A1√		ft μ from **(i)** ($\mu > 0$)
	$[0 = 2.5^2 - 2 \times 4s]$	M1		For using $v^2 = u^2 + 2as$
	Distance is 0.781 m	A1	4	
Alternative Method for part (ii)				
(ii)	PE loss = $5gd\sin10°$	B1		
		M1		For using KE loss + PE loss = WD against friction
	$\frac{1}{2} \times 5 \times 2.5^2 + 5gd\sin10° = 0.582 \times 5gd\cos10°$	A1√		ft μ ($\mu > 0$)
	Distance is 0.781 m	A1	4	
7 **(i)**	$[0.0001t(t - 50)(t - 100) = 0$ or $v(0) = 0, v(50) = 0, v(100) = 0]$	M1		Either factorise $v(t)$ and solve $v(t) = 0$ or evaluate $v(0)$, $v(50)$ and $v(100)$
	$v(t) = 0$ when $t = 0, 50$ & 100	A1	2	
(ii)	$[0.0003t^2 - 0.03t + 0.5 = 0]$	M1		For using $a(t) = \frac{dv}{dt}$
	$t^2 - 100t + 1667 = 0$ ➔ $t = \left[\frac{1}{2}\left\{100 \pm \sqrt{(100^2 - 4 \times 1667)}\right\}\right]$	dM1		For solving $a(t) = 0$

	$a = 0$ when $t = 21.1$ and when $t = 78.9$	A1		
	$v(21.1) = 4.81$	B1		
	$v(78.9) = -4.81$	B1		
	Convex curve from (0,0) to (50,0) with $v > 0$ and has a maximum point.	B1		
	The curve for (50, 0) to (100, 0) is exactly the same as the first curve positioned by rotating the first curve through 180° about the point (50, 0).	B1	7	
(iii)		M1		For integrating $v(t)$ to obtain $s(t)$
	$s(t) = 0.000025t^4 - 0.005t^3 + 0.25t^2$ $(+ c)$	A1		
	[156.25 – 625 + 625]	M1		For using lower and upper limits of 0 and 50 respectively.
	Greatest distance is 156 m	A1	4	