1		M1		For using WD = Fdcos α
	$F \times 5\cos 60^o = 75$	A1		
	Magnitude of the force is 30 N	A1	[3]	
2	[$12 = 15\sin\alpha$]	M1		For resolving forces in the direction of the force of magnitude 12 N
	$\alpha = 53.1$	A1		
	[$F = 15\cos\alpha$]	M1		For resolving forces in the direction of the force of magnitude F N
	F = 9 N	A1	[4]	
2	ALTERNATIVE 1			
	[$F\sin\alpha = 12\cos\alpha$ and $F\cos\alpha + 12\sin\alpha = 15$ ➔ $\sin\alpha \div \cos\alpha = 12\cos\alpha \div 15 - 12\sin\alpha$	M1		For resolving forces in the x and y directions and eliminating F from the resultant equations
	$15\sin\alpha - 12\sin^2\alpha = 12\cos^2\alpha$ ➔ $15\sin\alpha = 12$ ➔ $\alpha = 53.1$	A1		
		M1		For substituting into $F\sin\alpha = 12\cos\alpha$ or $F\cos\alpha + 12\sin\alpha = 15$
	F = 9 N	A1	[4]	
2	ALTERNATIVE 2			
	[$\sin\alpha = 12/15$]	M1		For using correct triangle of forces to find α
	$\alpha = 53.1$	A1		
	[$F^2 = 15^2 - 12^2$]	M1		For using correct triangle of forces to find F
	F = 9 N	A1	[4]	
2	ALTERNATIVE 3			
	[$12 \div \sin(180 - \alpha) = 15 \div \sin 90$ ➔ $12 = 15\sin\alpha$]	M1		For using Lami's rule and $\sin(180^o - \alpha) = \sin\alpha$
	$\alpha = 53.1$	A1		
	[$F \div \sin 143.1 = 15 \div \sin 90$]	M1		For using Lami's rule and value of α to find F
	F = 9 N	A1	[4]	
SR (max 2/4) For candidates who have sin and cos interchanged.				
Allow B1 for $\alpha = 36.9$ and allow B1 for F = 9 following correct work relative to the cos/sin interchange error.				

3	**(i)**		M1		For an attempt to find $v(t)$ using integration of $a(t)$
		$v = 1.2t^{5/3} + 2$	A1		
			DM1		For attempting to solve $v(t) = 3$ for $t^{5/3}$ or For confirming $v = 3$ by substituting $t^{5/3} = 5/6$ into the expression found for $v(t)$
		$t^{5/3} = 5/6$	A1	[4]	AG
	(ii)		M1		For integrating and using s(0) = 0 (may be implied by absence of +C) to find s(t)
		$s = 0.45t^{8/3} + 2t$	A1		
		Distance is 2.13 m	A1	[3]	
4	**(i)**		M1		For resolving forces horizontally
		Horizontal component is $T\cos 25^\circ$ (0.906T)	A1		
			M1		For resolving forces vertically
		Vertical component is $4g + T\sin 25^\circ$ (40 + 0.423T)	A1	[4]	
	(ii)		M1		For using F = 0.4R
		0.906T = 16 + 0.169T	A1ft		May be implied by correct answer for T
		T = 21.7 N	A1	[3]	
5	**(i)**	Tension in S_1 is 30 N	B1		
		Tension in S_2 is 50 N	B1	[2]	
	(ii)		M1		For applying Newton's second law to A or to B
		$3g - T - 1.6 = 3a$ (or $2g + T - 4 = 2a$)	A1		
		$2g + T - 4 = 2a$ (or $3g - T - 1.6 = 3a$) or $(3g + 2g) - (1.6 + 4) = (3 + 2)a$	B1		
		Acceleration is 8.88 ms^{-2}	B1		
		Tension is 1.76 N	A1	[5]	

SR (max. 1 / 2) for candidates who do not give numerical answers in (i).

Allow B1 for Tension in S_1 is 3g and Tension in S_2 is 5g

6	(i)	PE gain = 1250 × 10 x 400 × 0.125	B1		
		WD against resistance is 800 × 400 J	B1		
			M1		For using WD by car's engine = Gain in PE + WD against resistance
		WD by car's engine is 945 000 J (945 kJ)	A1	[4]	
	(ii)				For using P = Fv ➔ $\frac{v_2}{v_1} = \frac{P_2}{P_1} \times \frac{F_1}{F_2}$
		[v_2/6 = 5 × (1/3)]	M1		
		v_2 = 10	A1		
		KE gain = ½ 1250($10^2 - 6^2$)	B1ft		
		[WD by car's engine = 945 000 + 40 000]	M1		For using WD by car's engine = (Gain in PE + WD against resistance) + KE gain
		WD by car's engine is 985 000 J (985 kJ)	A1ft	[5]	ft incorrect ans**(i)**
		Alternative scheme for part (i)			
	(i)		M1		For using Newton's second law with a = 0
		DF = 1250g × 0.125 + 800	A1		
			M1		For using WD = DF × 400
		WD by car's engine is 945 00 J (945 kJ)	A1	[4]	

7	**(i)**	$[-0.12 = 0.15a]$	M1		For using Newton's 2nd law
		$a = -0.8$ ms^{-2}	A1		
		$[v = 3 - 0.8 \times 2]$	M1		For using $v = u + at$ to find speed of approach
		$v_{approach} = 1.4$	A1		
		$[½\ 0.15(1.4^2 - v_r^2)]$	M1		For using KE loss = ½ m$(v_a^2 - v_r^2)$
		$v_{return} = -1$	A1		
			M1		For using $0 = v_{return} + a(t - 2)$
		$t = 3.25$ s when block comes to rest	A1		
					Alternative for the M1 A1 immediately above. $t_{YZ} = 1.25$ B1 $t = 3.25$s when block is at rest B1ft
		For correct sketch	B1ft	[9]	ft incorrect values of v and t (although v_{return} must be negative)
	(ii)	$[XY = ½\ (3 + 1.4) \times 2,\ YZ = ½\ 1.25 \times 1]$	M1		For using area property (or equivalent) to find distances XY and YZ
		s = 4.4 at Y and 3.775 at Z, stated or on graph	A1		(accept 3.77 or 3.78)
		Curve starts at origin, s increases, slope decreases (convex upwards) for $0 < t < 2$, value of s(2) shown	B1ft		ft incorrect value for s(2)
		Curve starts at (2, 4.4), s decreases, magnitude of slope decreases to zero at (3.25, 3.775)	B1ft	[4]	ft incorrect values of s and t