1	DF = 35000/16	B1		
		M1		For using Newton's second law
	DF – 1150g sin1.2° – 975 = 1150a	A1		
	Acceleration is 0.845 ms^{-2}	A1		
			[4]	
2	**(i)** Acceleration is 0.09 ms^{-2}	B1		
			[1]	
	(ii) [D = ½ (8 + 4)0.18 or D = (0 + ½ 0.09 × 2^2) + (0.18 × 4 + ½ 0 × 4^2) + (0.18 × 2 – ½ 0.09 × 2^2)]	M1		For using the idea that area represents distance or for repeated use of $s = ut + ½ at^2$
	Distance is 1.08 m	A1		
			[2]	
	(iii) [½ 3V = 1.08]	M1		For using area of triangle = area of trapezium
	Greatest speed is 0.72 ms^{-1}	A1		
			[2]	
				SR (max 1 out of 2) for candidates who assume (implicitly) that speed is greatest at a specific time (t = 11 or t = 9.5) 0.72 ms^{-1} B1 from ½ (0 + V) × 3 = 1.08 or from ½ (0 + V) × 1.5 = ½ 1.08
3	**(i)** [R + 7sin45° = 0.8g]	M1		For resolving forces vertically (needs 3 terms)
	Normal component is 3.05 N	A1		AG
			[2]	
	(ii) F = 7cos45°	B1		
		M1		For using μ = F/3.05
	Coefficient is 1.62	A1		
			[3]	
4		M1		For resolving forces in the *x*-direction or in the *y*-direction
	X = 160 + 250cos α	A1		
	Y = 370 – 250sin α	A1		
		M1		For using $R^2 = X^2 + Y^2$
	Magnitude is 500 N	A1ft		ft 264 N for consistent sin/cos mix
		M1		For using tan θ = Y/X
	Required angle is 36.9° (or 0.644 rads)	A1ft		ft 29.5° for consistent sin/cos mix
			[7]	

Alternative for **4**			M1	For finding the resultant in magnitude and direction of **two** forces and obtaining a triangle enabling the calculation of the resultant of the **three** forces
	Triangle has sides 403, 250 and R		A1	or equivalent for different choice of two forces*
	Triangle has angle opposite R equal to 97.1°		A1	As *
	$[R^2 = 403^2 + 250^2 – 2 \times 403 \times 250\cos 97.1^\circ]$		M1	For using cosine rule to find R
	Magnitude is 500 N		A1	
	$[\sin(66.6^\circ – z) \div 250 = \sin 97.1^\circ \div R]$		M1	For using sine rule to find z
	Required angle is 36.9°		A1	
5	**(i)**		M1	For using KE loss = PE gain or $0^2 = u^2 – 2(g \sin\alpha)(0.45/\sin\alpha)$
		$\frac{1}{2}(m)u^2 = (m)g(0.45)$	A1	
		Speed is 3 ms^{-1}	A1	
			[3]	
	(ii)	$[\text{PE gain} = \frac{1}{2}\ 0.3 \times 3^2 – 0.39]$	M1	For using PE gain = KE lost – WD
		PE gain is 0.96 J	A1ft	ft incorrect u
		$[0.3gh = 0.96]$	DM1	For using PE = mgh; dependent on the given WD being reflected in the value for PE used
		R is 0.32 m higher than the level of P	A1	
			[4]	
6	**(i)**		M1	For applying Newton's second law to *A* or to *B* or using (M + m)a = Mg – F
		0.45a = 0.45g – T and 0.2a = T – F or (0.45 + 0.2)a = 0.45g – F	A1	
		F = 0.3 × 0.2g	B1	
			M1	For substituting for F and solving for a
		Acceleration is 6 ms^{-2}	A1	
		$[v^2 = 2 \times 6 \times [2 – (2.8 – 2.1)]$	M1	For using $v^2 = (0^2) + 2as$ (s must be less than 2)
		Speed is 3.95 ms^{-1}	A1	AG
			[7]	
	(ii)	$0.2a_2 = –0.06g$	B1ft	ft incorrect F
			M1	For using $v^2 = 3.95^2 +$ $2a_2$[2.1 – distance moved by B]
		$v^2 = 15.6 + 2(–3)(0.8)$	A1	
		Speed is 3.29 ms^{-1}	A1	
			[4]	
Alternative for **6(ii)**				
	WD against friction = $0.06g \times [2.1 – (2 – 0.7)]$		B1	
			M1	For using KE loss = WD against friction
	$\frac{1}{2}\ 0.2 \times 3.95^2 – \frac{1}{2}\ 0.2v^2 = 0.48$		A1	
	Speed is 3.29 ms^{-1}		A1	

7	**(i)**		M1	For integrating v_1 to find s_1
		$\int_0^{15} v_1 dt = 225$ ➔	A1	
		$A[(15^2/2 - 0.05 \times 15^3/3) - (0 - 0)] = 225$		
		$A = 4$	A1	
		$[4(15 - 0.05 \times 15^2) = B/15^2]$	M1	For using $v_1(15) = v_2(15)$
		$B = 3375$	A1	AG
			[5]	
	(ii)	$s_2(t) = Bt^{-1}/(-1)$ (+ C)	B1	
		$[-3375/15 + C = 225]$	M1	For using $s_2(15) = 225$ to find C
		Distance travelled is $[450 - 3375/t]$ m (for $t \geqslant 15$)	A1	
			[3]	
	(iii)	$[450 - 3375/t = 315]$	M1	For attempting to solve $s_2(t) = 315$
		$[v = 3375/25^2]$	M1	For substituting into $v = 3375/t^2$
		Speed is $5.4\,\text{ms}^{-1}$	A1	
			[3]	
Alternative for **7(ii)**				
		$s = \int_{15}^{t} 3375t^{-2} dt = -3375(\frac{1}{t} - \frac{1}{15})$	B1	
		$= 225 - 3375/t$		
		Distance travelled $= 225 + (225 - 3375/t)$	M1	
		Distance travelled is $[450 - 3375/t]$ m (for $t \geqslant 15$)	A1	