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<b>1</b>	DF = 35000/16	B1	
		M1	For using Newton's second law
	DF – 1150g sin1.2° – 975 = 1150a	A1	
	Acceleration is 0.845 ms <sup>-2</sup>	A1	
<b>[4]</b>			
<b>2</b>	<b>(i)</b> Acceleration is 0.09 ms <sup>-2</sup>	B1	
	<b>[1]</b>		
	<b>(ii)</b> [D = ½ (8 + 4)0.18 or D = (0 + ½ 0.09 × 2 <sup>2</sup> ) + (0.18 × 4 + ½ 0 × 4 <sup>2</sup> ) + (0.18 × 2 – ½ 0.09 × 2 <sup>2</sup> )] Distance is 1.08 m	M1 A1	For using the idea that area represents distance or for repeated use of s = ut + ½ at <sup>2</sup>
<b>[2]</b>			
<b>3</b>	<b>(iii)</b> [½ 3V = 1.08] Greatest speed is 0.72 ms <sup>-1</sup>	M1 A1	For using area of triangle = area of trapezium
	<b>[2]</b>		
	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 <sup>-1</sup> B1 from ½ (0 + V) × 3 = 1.08 or from ½ (0 + V) × 1.5 = ½ 1.08		
<b>3</b>	<b>(i)</b> [R + 7sin45° = 0.8g] Normal component is 3.05 N	M1 A1	For resolving forces vertically (needs 3 terms) AG
	<b>[2]</b>		
	<b>(ii)</b> F = 7cos45° Coefficient is 1.62	B1 M1 A1	For using μ = F/3.05
<b>[3]</b>			
<b>4</b>		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 <sup>2</sup> = X <sup>2</sup> + Y <sup>2</sup>
	Magnitude is 500N	A1ft	ft 264N 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
<b>[7]</b>			

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Alternative for 4	M1	For finding the resultant in magnitude and direction of <b>two</b> forces and obtaining a triangle enabling the calculation of the resultant of the <b>three</b> forces
Triangle has sides 403, 250 and R	A1	or equivalent for different choice of two forces*
Triangle has angle opposite R equal to $97.1^\circ$	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 $36.9^\circ$	A1	
<b>5 (i)</b>	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 $3 \text{ ms}^{-1}$	A1	
		<b>[3]</b>
<b>(ii)</b> [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	
		<b>[4]</b>
<b>6 (i)</b>	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	A1	
$(0.45 + 0.2)a = 0.45g - F$		
$F = 0.3 \times 0.2g$	B1	
	M1	For substituting for F and solving for a
Acceleration is $6 \text{ ms}^{-2}$	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 $3.95 \text{ ms}^{-1}$	A1	AG
		<b>[7]</b>
<b>(ii)</b> $0.2a_2 = -0.06g$	B1ft	ft incorrect F
	M1	For using $v^2 = 3.95^2 + 2a_2[2.1 - \text{distance moved by B}]$
$v^2 = 15.6 + 2(-3)(0.8)$	A1	
Speed is $3.29 \text{ ms}^{-1}$	A1	
		<b>[4]</b>
Alternative for <b>6(ii)</b>		
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 $3.29 \text{ ms}^{-1}$	A1	

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7	(i)	M1	For integrating $v_1$ to find $s_1$
	$\int_0^{15} v_1 dt = 225 \rightarrow$	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)	B1	
	$s_2(t) = Bt^{-1}/(-1) (+ C)$		
	$[-3375/15 + C = 225]$	M1	For using $s_2(15) = 225$ to find C
Distance travelled is $[450 - 3375/t]$ m (for $t \geq 15$ )	A1		
		[3]	
(iii)	M1	For attempting to solve $s_2(t) = 315$	
$[450 - 3375/t = 315]$			
$[v = 3375/25^2]$	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 $t \geq 15$ )	A1		