Question	Answer	Marks	Guidance
1	$20\,000 = V \times 1250g$	M1	Use of $P = Fv$ with $F = mg$
	$V = 1.6$	A1	
		2	

Question	Answer	Marks	Guidance
2	Initial $KE = \frac{1}{2} \times 75 \times 10^2$ Final $KE = \frac{1}{2} \times 75 \times 5^2$	B1	Either correct
	PE gained $= 75g \times 700 \sin 1.5$ [=13 743]	B1	
	WD by $F = F \times 700$	B1	For WD by $F = F \times d$
	WD by F + Initial KE = Final KE + PE gain + 2000	M1	Use of work-energy equation. 5 dimensionally correct terms.
	$F = 18.5$	A1	
		5	

Question	Answer	Marks	Guidance
3(i)	$R = 3\,g\cos 60$	B1	
	Use $F = \mu R$	M1	
	[$3g\sin 60 - \mu 3g\cos 60 - 15 = 0$]	M1	Resolve forces parallel to the plane, 3 terms
		A1	Correct equation
	$\mu = 0.732$	A1	Allow $\mu = \sqrt{3} - 1$
		5	
3(ii)	[Maximum force = $3g\sin 60 + F$ $= 3\sin 60 + \mu 3g\cos 60$]	M1	
	$X = 37(.0)$	A1	Allow $X = 15\left(2\sqrt{3} - 1\right)$
		2	

Question	Answer	Marks	Guidance
4(i)	Apply Newton's second law to either or to the system	M1	
	Block A: $T - 4g \times \frac{7}{25} = 4a$ Block B: $36 - T - 5g \times \frac{7}{25} = 5a$ System: $36 - 5g \times \frac{7}{25} - 4g \times \frac{7}{25} = 9a$	A1	Any two correct. Allow α = 16.3 used.
	Either solving the system for a or solving a pair of simultaneous equations for either a or T	M1	
	$a = 1.2 \text{ ms}^{-2}$	A1	
	$T = 16$ N	A1	
		5	
4(ii)	$\left[0.65 = 1 \times t + \frac{1}{2} \times 1.2t^2\right]$	M1	Use constant acceleration equation(s) with $u = 1$ and solve a 3 term quadratic equation to find t
	$t = 0.5$ s	A1	
	Alternative method for question 4(ii)		
	$v^2 = 1^2 + 2 \times 1.2 \times 0.65$ [$v = 1.6$] and $0.65 = \frac{1}{2}(1+v) \times t$	M1	Use relevant constant acceleration equations with $u = 1$ in a complete method to find t
	$t = 0.5$ s	A1	
		2	

Question	Answer	Marks	Guidance
5(i)	Resolve forces either horizontally or vertically	M1	
	$7.5\cos60 + 4.5\cos20 = F\cos\theta$ [= 7.97861]	A1	
	$7.5\sin60 - 4.5\sin20 = F\sin\theta$ [= 4.95609]	A1	
	$F = \sqrt{(7.98^2 + 4.96^2)}$	M1	Use Pythagoras or use the value found for θ to find F
	$\theta = \tan^{-1}(\frac{4.96}{7.98})$	M1	Use trigonometry or the value found for F to find θ
	$F = 9.39$ and $\theta = 31.8$	A1	
	Alternative method for question 5(i)		
	$\frac{F}{\sin 80} = \frac{4.5}{\sin(120+\theta)} = \frac{7.5}{\sin(160-\theta)}$	M1	Attempt to use Lami
		A1	One correct pair of terms
		A1	A second correct pair of terms
	$[4.5\sin(160 - \theta) = 7.5\sin(120 + \theta)]$	M1	Attempt to solve for θ
	Use the θ value found by valid trigonometry to find F	M1	
	$F = 9.39$ and $\theta = 31.8$	A1	

Question	Answer	Marks	Guidance
5(i)	**Alternative method for question 5(i)**		
	Forces 4.5, 7.5, F opposite angles $60 - \theta$, $\theta + 20$, 100	**M1**	Illustrate a triangle of forces
	$[F^2 = 4.5^2 + 7.5^2 - 2 \times 4.5 \times 7.5 \times \cos 100]$	**M1**	For application of cosine rule to find F
		A1	Correct equation
	$\left[\frac{9.39}{\sin 100} = \frac{4.5}{\sin(60-\theta)} = \frac{7.5}{\sin(\theta+20)}\right]$	**M1**	One application of the sine rule to find θ
		A1	Correct equation
	$F = 9.39$ and $\theta = 31.8$	**A1**	
		6	
5(ii)	$9.5\cos 30 - 7.5\cos 60 - 4.5\cos 20 = m \times 1.5$	**M1**	Apply Newton's second law to the ring along AB (4 terms)
	$m = 0.166$ kg	**A1**	
		2	

Question	Answer	Marks	Guidance
6(i)	$0.4g \times 1.8 = \frac{1}{2} \times 0.4 \times v^2$	**M1**	KE gain = PE lost
	$v = 6\ \text{ms}^{-1}$	**A1**	
	Alternative method for question 6(i)		
	$v^2 = 0^2 + 2 \times g \times 1.8$	**M1**	Use constant acceleration equation(s) with $a = g$ to find v
	$v = 6\ \text{ms}^{-1}$	**A1**	
		2	
6(ii)	$0.4g - 5.6 = 0.4a$	**M1**	Use Newton's second law for the particle in the vertical (3 terms)
	$a = -4\ \text{ms}^{-2}$	**A1**	
	$0 = 6 - 4t$	**M1**	Use of constant acceleration equation(s) such as $v = u + at$ to find t
	$t = 1.5$ s	**A1**	
		4	
6(iii)	Straight line starting at (0,0) with positive gradient	**B1**	
	Second straight line starting at end of the first line with negative gradient and ending with $v = 0$	**B1**	
	All correct, start at (0, 0) with max velocity $v = 6$ at $t = 0.6$ i.e. (0.6, 6) and finishing at (2.1, 0)	**B1FT**	FT on *their* v from **(i)** and/or *their* t from **(ii)**
		3	

Question	Answer	Marks	Guidance
7(i)	$0.6t^2 - 0.12t^3 = 0$	**M1**	For attempting to solve $v = 0$
	$(t = 0 \text{ or})\ t = 5$	**A1**	
	$\int v\, dt = 0.2t^3 - 0.03t^4$	***M1**	For integrating the velocity
	$OP = [0.2 \times 5^3 - 0.03 \times 5^4] - [0]$	**DM1**	Use limits to find OP
	Distance = 6.25 m	**A1**	AG
		5	
7(ii)	$k \times 5^3 + c \times 5^5 = 6.25$	**B1**	Using $s = 6.25$ at $t = 5$ to set up equation in k and c
	$v = 3kt^2 + 5ct^4$	***M1**	For differentiating s to find v
	$1.25 = 3k \times 5^2 + 5c \times 5^4$	**DM1**	For using the given value of $v = 1.25$ in the expression for v
	$125k + 3125c = 6.25$ $75k + 3125c = 1.25$	**M1**	For attempting to solve a pair of simultaneous equations in k and c and finding a value of either k or c
	$k = 0.1,\ c = -0.002$	**A1**	
		5	
7(iii)	$a = 0.6t - 0.04t^3$	**M1**	For differentiating their expression for v
	At $t = 5$, $a = -2$ Acceleration = $-2\ \text{ms}^{-2}$	**A1**	
		2	