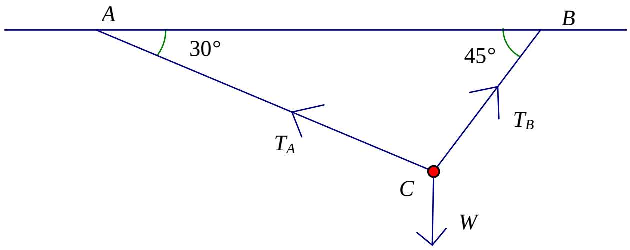
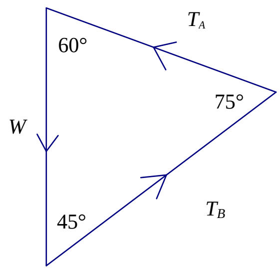
Mark Scheme (Results)

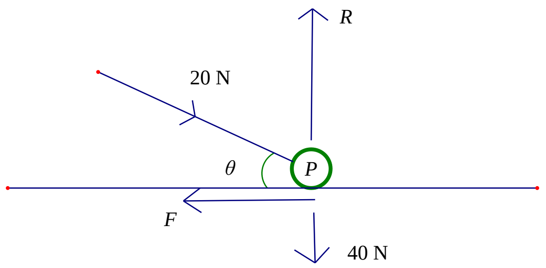
January 2018

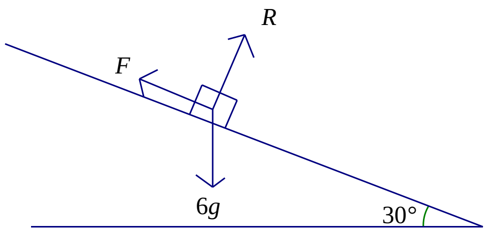
Pearson Edexcel
International Advanced Subsidiary Level
In Mechanics M1 (WME01)
Paper 01

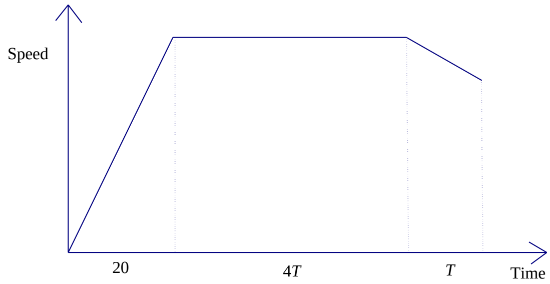
January 2018
Mechanics 1 - WME01
Mark Scheme

Question Number	Scheme	Marks
1		
	N.B. If they assume that the tensions are the same, can score max:M0A0M1A0DM0A0A0. **If they use the same angles, can score max: M1A0M1A0DM0A0A0**	
	Resolve parallel to AB: $T_A \cos 30 = T_B \cos 45$	M1A1
	Resolve perpendicular to AB: $W = T_A \sin 30 + T_B \sin 45$	M1A1
	Solve for T_A or T_B	**DM**1
	$T_A = \dfrac{2}{1+\sqrt{3}} W \left(= 0.73W\right)$ (or better)	A1
	$T_B = \dfrac{\sqrt{6}}{1+\sqrt{3}} W \left(= 0.90W\right)$ (or better)	A1
		(7)
	Alternative (triangle of forces):	
		
	Sine rule for T_A: $\dfrac{T_A}{\sin 45} = \dfrac{W}{\sin 75}$ M1A1	
	Sine rule for T_B: $\dfrac{T_B}{\sin 60} = \dfrac{W}{\sin 75}$ M1A1	
	Solve for T_A or T_B: $T_A = 0.73W$ (or better) **DM**1A1	
	$T_B = 0.90W$ (or better) A1	
	(7)	
		[7]

Question Number	Scheme	Marks
	Notes for question 1	
1	First M1 for resolving horizontally with usual rules	
	First A1 for a correct equation	
	Second M1 for resolving vertically with usual rules	
	Second A1 for a correct equation	
	Third **DM**1, dependent on both previous M marks, for solving for either T_A or T_B	
	Third A1 for $T_A = 0.73W$ or better or any correct surd answer **but** A0 for $\frac{W}{k}$, where k is a decimal. Allow 'invisible brackets'	
	Fourth A1 for $T_B = 0.90W$ or better ($0.9W$ is A0) or any correct surd answer **but** A0 for $\frac{W}{k}$, where k is a decimal.	
	Alternative using sine rule or Lami's Theorem	
	First M1A1 for $\frac{T_A}{\sin 45} = \frac{W}{\sin 75}$ oe (e.g. allow sin 105 or reciprocals)	
	Second M1 for $\frac{T_B}{\sin 60} = \frac{W}{\sin 75}$ (allow sin 30 and/or sin 105)	
	Second A1 for $\frac{T_B}{\sin 60} = \frac{W}{\sin 75}$	
	Third **DM**1, dependent on either previous M mark, for solving for either T_A or T_B	
	Third A1 for $T_A = 0.73W$ or better or any correct surd answer **but** A0 for $\frac{W}{k}$, where k is a decimal.	
	Fourth A1 for $T_B = 0.90W$ or better or any correct surd answer **but** A0 for $\frac{W}{k}$, where k is a decimal.	

Question Number	Scheme	Marks
2.		
	Resolve horizontally: $F = 20\cos\theta$ **Their** F e.g. allow μR	M1A1
	Resolve vertically: $R = 40 + 20\sin\theta$	M1A1
	Use of $F \le \mu R$: $20\cos\theta \le \mu(40 + 20\sin\theta)$	**DM**1
	$\mu \ge \dfrac{20\cos\theta}{40+20\sin\theta} \Rightarrow \mu \ge \dfrac{\cos\theta}{2+\sin\theta}$ **Given Answer**	A1
		[6]
	Notes for question 2	
2	First M1 for resolving horizontally with usual rules	
	First A1 for a correct **equation**	
	Second M1 for resolving vertically with usual rules	
	Second A1 for a correct **equation**	
	Third **DM**1, dependent on both previous M marks, for use of $F \le \mu R$ to give **inequality** in θ only. (N.B. If they use $F = \mu R$ in the horizontal resolution, this mark is not available)	
	Third A1 for given answer	

Question Number	Scheme	Marks
4a		
	Perpendicular to plane: $R = 6g\cos 30$	B1
	Parallel to plane: $6g\sin 30 - F = 6a$ **N.B.** Could be their F	M1A1
	$F = \frac{1}{4}R$ seen. **N.B.** Could be their R	B1
	Solve for a : $a = 2.78$ (2.8) (ms^{-2})	M1A1
		(6)
4b	Use of *suvat*: $v^2 = u^2 + 2as = 2\times 2.78\times 10$	M1
	$v = 7.45417... = 7.45$ (7.5) (ms^{-1})	A1
		(2)
		[8]
	Notes for question 4	
4a	First B1 for R = 6gcos 30 seen	
	First M1 for resolving parallel to the plane with usual rules	
	First A1 for a correct equation **N.B.** F does not need to be substituted for this A mark	
	Second B1 for $F = \frac{1}{4}R$ seen **N.B.** could be their R	
	Second M1 for solving for a	
	Second A1 for 2.78 or 2.8	
4b	M1 for a complete method for finding v, using their a	
	A1 for 7.45 or 7.5	

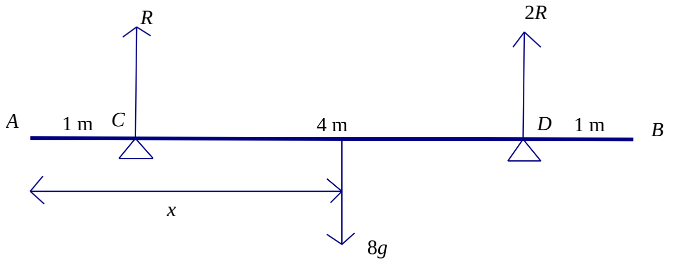
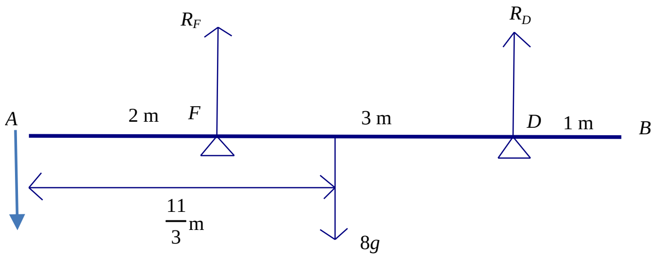
Question Number	Scheme	Marks
5a		
	Basic shape 20, 4T and T placed correctly	B1 **DB**1
		(2)
5b	Use of $v = u + at$: constant speed $= 0.6 \times 20 = 12$ (ms^{-1})	M1A1
	(Speed at end $= 12 - 0.3T$)	
	Using v-t graph: Distance: $705 = \frac{12}{2}\left(4T + \left(20 + 4T\right)\right) + \frac{T}{2}\left(12 + \left(12 - 0.3T\right)\right)$	M1A2
	$= 48T + 120 + 12T - 0.15T^2 = 60T + 120 - 0.15T^2$	
	Form 3 term quadratic and solve for T: $\Rightarrow 3T^2 - 1200T + 11700 = 0 \qquad \left(T^2 - 400T + 3900 = 0\right)$	M1
	$\Rightarrow \left(T - 10\right)\left(T - 390\right) = 0 \qquad T = 10$ only	A1
		(7)
	Alternative:	
	Use of $v = u + at$: constant speed $= 0.6 \times 20 = 12$ (ms^{-1}) M1A1	
	Using $s = ut + \frac{1}{2}at^2$: $705 = \left(0.3 \times 400\right) + \left(4T \times 12\right) + \left(12T - 0.15T^2\right)$ M1A2	
	$\Rightarrow 0.15T^2 - 60T + 585 = 0 \quad \left(T^2 - 400T + 3900 = 0\right)$	
	$\Rightarrow \left(T - 10\right)\left(T - 390\right) = 0 \qquad T = 10$ only M1A1	
	(7)	
5c	Extra time: $(2 \times 20) - \textit{their } T$ **OR** $\frac{12 - 0.3 \times \textit{their}T}{0.3}$	B1
	Total time: $20 + 5T + 40 - T$ (*their T*)	M1
	$= 100$ (s)	A1
		(3)
	Alternative: Total time to decelerate to rest = 12/0.3 = 40 B1	
	Total time A to C $= 20 + 4T + 40 = 100$ M1A1	
		[12]

Question Number	Scheme	Marks
	Notes for question 5	
5a	First B1 for basic shape. Allow if 'extra triangle' on end included, <u>provided *B* clearly marked</u>	
	Second **DB**1 : may use, 20, 20 + 4T, 20 + 5T	
5b	First M1 for attempt to find constant speed ($v = u + at$ or a = gradient) 20 x 0.6	
	First A1 for 12	
	Second (generous) M1 for clear attempt to use 705 = *total* area under the graph to give an equation in T only but must see ½ used somewhere **N.B.** M0 if just a trapezium oe is used	
	Second A1 and Third A1: for any correct equation, -1 e.e.o.o.	
	Third M1 for forming and attempt to solve a 3 term quadratic (need *evidence* of solving e.g. formula or factorising, if T values are incorrect) otherwise this M mark can be implied if they state that T = 10 with no working. (T = 390 NOT needed)	
	Fourth A1 for T = 10.	
	N.B. For total area, could see: Trapezium + Rectangle + Triangle $705 = \frac{12}{2}\left(4T + \left(20 + 4T\right)\right) + T(12 - 0.3T) + \frac{1}{2}T \times 0.3T$ Triangle + Rectangle + Trapezium $705 = \frac{1}{2}.20.12 + (4T \times 12) + \frac{1}{2}T\left(12 + 12 - 0.3T\right)$ Triangle + Rectangle + Rectangle + Triangle $705 = \frac{1}{2}.20.12 + (4T \times 12) + T(12 - 0.3T) + \frac{1}{2}T \times 0.3T$ Triangle + Rectangle + Trapezium (at top) $705 = \frac{1}{2}.20.12 + 5T(12 - 0.3T) + \frac{1}{2}0.3T(5T + 4T)$ Rectangle – triangle– triangle $705 = 12(20 + 5T) - \frac{1}{2}.20.12 - \frac{1}{2}T \times 0.3T$	
5c	B1 for either additional time is $\frac{12}{0.3} - T$ **or** time to decelerate is $\frac{12}{0.3}$	
	M1 for a correct method to find the total time, using *their T* $= 20 + 4T + T + \frac{12}{0.3} - T$ **or** $20 + 4T + \frac{12}{0.3}$	
	A1 for 100 cao	

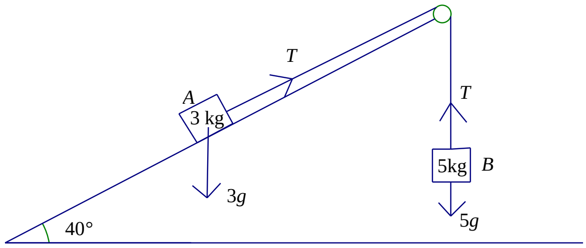
1

Question Number	Scheme	Marks
6a	Resultant force $=(2\mathbf{i}+3\mathbf{j})+(4\mathbf{i}-5\mathbf{j})=6\mathbf{i}-2\mathbf{j}$ (N)	M1
	Use of $\mathbf{F}=m\mathbf{a}$: $6\mathbf{i}-2\mathbf{j}=2\mathbf{a}$, $\mathbf{a}=3\mathbf{i}-\mathbf{j}$	M1
	Magnitude: $\lvert a\rvert=\sqrt{3^2+1^2}=\sqrt{10}\,(=3.2 \text{ or better})$ (ms^{-2})	M1A1
		(4)
6b	$(10\mathbf{i}+2\mathbf{j})=(-u\mathbf{i}+u\mathbf{j})+T(3\mathbf{i}-\mathbf{j})$	M1
	$10=-u+3T$ and $2=u-T$	**DM**1A1**ft**
	$T=6$	A1
	(i) $u=8$	A1
	(ii)	(5)
		[9]
	Notes for question 6	
6a	First M1 for adding forces – must collect **i**’s and **j**’s	
	Second M1 for use of $\mathbf{F}=m\mathbf{a}$ or $F=ma$	
	Third M1 for finding a magnitude	
	A1 for $\sqrt{10}\,(=3.2 \text{ or better})$	
6b	First M1 for use of $\mathbf{v}=\mathbf{u}+\mathbf{a}t$ with their **a** (M0 if clearly using **F** instead of **a**)	
	Second **DM**1, dependent on previous M, for equating cpts of **i** and **j**	
	First A1**ft** for two correct equations following their **a**	
	Second A1 for $T=6$	
	Third A1 for $u=8$	

1

Question Number	Scheme	Marks
7a		
	N.B. If R_C and R_D reversed, can score max: M1A1(if vert res is used)M1A0DM1A0 <u>Consistent omission of *g* in both parts of this question can score all of the marks</u>.	
	Resolve vertically: $3R = 8g$	M1A1
	M(C) : $8g\left(x-1\right) = 4\times 2R$	M1A1
	$8gx = 8g + \frac{64g}{3} = \frac{88g}{3}$, $x = \frac{11}{3}$ **Given Answer**	**DM**1A1
		(6)
	N.B. (Allow R_D instead of $2R_C$ in either equation for M mark)	
	SC: M(G): $R(x-1) = 2R(5-x)$ $x = \frac{11}{3}$ **Given answer**	M2 A2 **DM**1 A1
		(6)
7b	**N.B.** If they use a value for a reaction found in part (a) in their part (b), no marks for part (b) available.	
	 3g N.B. $R_D = kR_F$	
	Resolve vert : $R_F + kR_F = 11g$ (Allow R_D instead of kR_F for M mark))	M1A1
	M(F) : $(kR_F \times 3) + (3g\times 2) = 8g\times \frac{5}{3}$ (Allow R_D instead of kR_F for M mark)	M1A1
	$k = \frac{2}{7}$ oe , 0.29 or better	**DM**1A1
		(6)
		[12]

Question Number	Scheme	Marks
	Notes for question 7	
7a	First M1 for either resolving vertically or taking moments with usual rules First A1 for a correct equation Second M1 for taking moments with usual rules Second A1 for a correct equation **N.B**. Their moments equation(s) may not be in x, if they've clearly defined a different distance and can score the A1 in each case. Third **DM**1, dependent on first two M marks, for solving for x Third A1 for " x (or AG) = 11/3" **GIVEN ANSWER (Must be EXACT)** Possible equations: M(A), $(R\times 1)+(2R\times 5)=8gx$ M(B), $(R\times 5)+(2R\times 1)=8g(6-x)$ M(D), $(R\times 4)=8g(5-x)$ **N.B.** (Allow R_D instead of $2R_C$ in all cases for M mark)	
7b	First M1 for either resolving vertically or taking moments with usual rules First A1 for a correct equation Second M1 for taking moments with usual rules Second A1 for a correct equation Third **DM**1, dependent on first two M marks, for solving for k Third A1 for k = 2/7, any equivalent fraction or 0.29 or better Possible equations: M(A), $2R_F+5kR_F=8g\times\frac{11}{3}$ M(B), $4R_F+(1\times kR_F)=(8g\times\frac{7}{3})+(3g\times 6)$ M(D), $3R_F=8g\times\frac{4}{3}+(3g\times 5)$ M(G), $\frac{5}{3}R_F-\frac{4}{3}kR_F=3g\times\frac{11}{3}$ **N.B.** (Allow R_D instead of kR_F in all cases for M mark)	

Question Number	Scheme	Marks
8a		
	Motion of A : $T - 3g\sin 40 = 3a$	M1A1
	Motion of B : $5g - T = 5a$	M1A1
	Solve for T	**DM**1
	30 (N) or 30.2 (N)	A1
		(6)
8b	$5g - T = 5a \Rightarrow a = \frac{1}{5}(5g - T) = \frac{g}{8}(5 - 3\sin 40)(= 3.76)$ (ms^{-2})	M1
	Use of *suvat* : $v = u + at = 3.76 \times 1.5 = 5.64$ (ms^{-1}) or 5.6 (ms^{-1})	**DM**1A1
		(3)
8c	Distance in first 1.5 seconds: $s = \frac{1}{2}a1.5^2 = 4.23$ (m) **OR**: $v^2 = u^2 + 2as$: $s = \frac{\textit{their}\ (\text{b})^2}{2 \times a} = 4.23$ (m)	M1A1
	New $a = -g\sin 40$ (-ve sign not needed)	B1
	Distance up plane : $v^2 = u^2 + 2as$, $s = \frac{\textit{their}\ (\text{b})^2}{2 \times \text{ new } a}$ (m)	**DM**1
	Total distance: 6.76 (m) (6.8)	A1
		(5)
		[14]
	Notes for question 8	
8a	First M1 for equation of motion for *A*, with usual rules	
	First A1 for a correct equation	
	Second M1 for equation of motion for *B*, with usual rules	
	Second A1 for a correct equation	
	N.B. Either of these can be replaced by the whole system equation:	
	$5g - 3g\sin 40 = 8a$	
	Third **DM**1, dependent on previous two M marks, for solving for *T*	
	Third A1 for 30 or 30.2 (N)	
8b	First M1 for finding a value for *a* (possibly incorrect) This mark could be earned in part (a) BUT MUST BE USED IN (b).	
	Second **DM**1,dependent on previous M, for a complete method to find the speed of *B* as it hits the ground	
	A1 for 5.6 or 5.64 (m s^{-1})	
8c	First M1 for a complete method to find distance fallen by *B* First A1 for 4.23 or better	

Question Number	Scheme	Marks
	B1 for new $a = -g\sin 40$ (- sign not needed) (seen or implied)	
	Second **DM**1, dependent on having found a *new a*, for a complete method to find extra distance moved by *A* up the plane BUT M0 if new *a* is *g*.	
	Second A1 for 6.8 or 6.76 (m).	

Mark Scheme (Results)

January 2018

Pearson Edexcel
International Advanced Subsidiary Level
In Mechanics M2 (WME02)
Paper 01

Jan 2018
Mechanics WME02
Mark Scheme

Q	Scheme	Marks	Notes
1.	Impulse- momentum equation	M1	Must be subtracting velocities (or equivalent). Dimensionally correct.
	$4\mathbf{i}+5\mathbf{j}=\frac{1}{2}(\mathbf{v}-(2\mathbf{i}-3\mathbf{j}))$	A1	Correct unsimplified equation.
	$\mathbf{v}=10\mathbf{i}+7\mathbf{j}$	A1	Seen or implied
	KE Gain	M1	Dimensionally correct. Condone $\pm$ Must be difference of two KE terms.
	$=\frac{1}{2}0.5(10^2+7^2-(2^2+(-3)^2))$	A1ft	Correct unsimplified expression Follow their $\mathbf{v}$. Condone $\pm$
	$=34$ J	A1	CSO
		(6)	
2(a)	Use of $a=\frac{\mathrm{d}v}{\mathrm{d}t}$	M1	Usual rules for differentiation. Condone slip in multiplying brackets
	$v=3t-2t^2-1,\ a=\frac{\mathrm{d}v}{\mathrm{d}t}=3-4t$	A1	
	$t=\frac{1}{2},\quad a=1\ \left(\mathrm{m\ s^{-2}}\right)$	A1	CSO
		(3)	
2(b)	$v=0 => t=0.5$	B1	Seen or implied
	$s=\int 3t-2t^2-1\ \mathrm{d}t$	M1	Usual rules for integration
	$=\frac{3t^2}{2}-\frac{2t^3}{3}-t(+C)(=F(t))$	A1ft	Follow their v
	Correct strategy for distance	M1	For their "0.5" in (0,1) Must take account of change in direction
	$-[F(t)]_0^{0.5}+[F(t)]_{0.5}^1=F(1)-2F(0.5)+F(0)$	A1	Or equivalent, accept $\pm$. For their $F(t)$
	$\left(=\frac{5}{24}+\frac{1}{24}\right)=0.25$ m	A1	CSO
			NB Candidates who show no working and use their calculator to integrate must be starting with the correct function and show no errors in order to be able to score any marks. Full marks are available for a correct answer with no error seen.
		(6)	
		[9]	

Q	Scheme	Marks	Notes
5(a)	Moments about A	M1	or a complete method to form an equation in R and W
	$W\times 8b\cos\theta = R\times 12b$	A1	Correct unsimplified equation
	$R=\frac{2W}{3}\cos\theta=\frac{2W}{3}\times\frac{12}{13}$	DM1	Substitute correctly for trig and solve for R Dependent on preceding M1
	$R=\frac{8W}{13}$	A1	Allow $R=0.615W$
		(4)	
5(b)	Resolve horizontally	M1	Form one equation in X and/or Y
	$(\rightarrow)\ X = R\sin\theta\left(=\frac{40W}{169}\right)$	A1	Correct unsimplified equation
	Resolve vertically	M1	Form a second equation in X and/or Y
	$(\uparrow)\ Y=W-R\cos\theta\left(=\frac{73W}{169}\right)$	A1	Correct unsimplified equation
	Parallel to rod: $W\sin\theta = X\cos\theta + Y\sin\theta$		
	Perpendicular: $R+Y\cos\theta = W\cos\theta + X\sin\theta$		
	$\tan\alpha=\frac{X}{Y}$	DM1	Use their X and Y to find $\tan\alpha$ Dependent on M marks for the two equations
	$\tan\alpha=\frac{40}{73}$ **Given answer**	A1	Obtain given answer from correct work
		(6)	
		[10]	

Q	Scheme	Marks	Notes
7(a)	Horizontal distance in terms of U, t and α	M1	
	$x = Ut\cos\alpha$	A1	Correct unsimplified equation
	Vertical distance in terms of U, t and α	M1	Condone sign error
	$y = Ut\sin\alpha - \frac{1}{2}gt^2$	A1	Correct unsimplified equation
	$y = U\sin\alpha\frac{x}{U\cos\alpha} - \frac{1}{2}g(\frac{x}{U\cos\alpha})^2$	DM1	Substitute for t Dependent on the first 2 M marks
	$y = x\tan\alpha - \frac{gx^2\sec^2\alpha}{2U^2}$	DM1	Simplify the trig. and use Pythagoras Dependent on the first 2 M marks
	$y = x\tan\alpha - \frac{gx^2(1+\tan^2\alpha)}{2U^2}$ given answer	A1	Obtain **given answer** from correct working
		(7)	
(b)	$(\rightarrow)\ v_H = U$	B1	Horizontal component in U, g, T
	$(\downarrow)\ v_V = gT$	B1	Vertical component in U, g, T. Accept $\pm$
	Use of Pythagoras	M1	
	$v = \sqrt{U^2 + g^2T^2}$	A1	Or equivalent. Allow t for T
		(4)	
(b) alt	$-h = d\tan 0 - \frac{gd^2}{2U^2}\left(1+\tan^2 0\right)$	B1	$\left(h = \frac{gd^2}{2U^2}\right)$
	$d = UT\ \left(\Rightarrow h = \frac{gT^2}{2}\right)$	B1	
	$\frac{1}{2}mv^2 - \frac{1}{2}mU^2 = mgh$	M1	Energy equation
	$v^2 = U^2 + 2gh = U^2 + g^2T^2\ ,\ \ v = \sqrt{U^2 + g^2T^2}$	A1	
		(4)	
(c)	$d = UT$	B1	Horizontal distance
	$-h = d\tan\alpha - \frac{gd^2(1+\tan^2\alpha)}{2U^2}$	M1	Substitute for x and y in given equation. Condone sign error
	$h = \frac{1}{2}gT^2$	B1	Vertical distance
	$-\frac{1}{2}gT^2 = d\tan\alpha - \frac{g(UT)^2(1+\tan^2\alpha)}{2U^2}$	M1	Substitute to eliminate U from the equation
	$0 = d\tan\alpha - \frac{gT^2}{2}\tan^2\alpha$	A1	Correct equation in T and d
	$d = \frac{1}{2}gT^2\tan\alpha$ **given answer**	A1	Obtain given answer from correct working
		(6)	
		[17]	