Newton's Laws of Motion 2 MS

Q1.

4 **(i)**		**M1**		For applying Newton's second law to A or to B or for using $m_A g - m_B g = (m_A + m_B)a$
	$0.35g - T = 0.35a$ $T - 0.15g = 0.15a$ $(0.35 - 0.15)g = (0.35 + 0.15)a$	**A1**		Two of the three equations
	Acceleration is 4 ms^{-2}	**B1**		
	Tension is 2.1 N	**B1**	4	
(ii)	$[v_1^2 = 0 + 8 \times 1.6\ (= 12.8)]$	**M1**		For using $v_1^2 = 0 + 2a \times 1.6$
	$[H = 1.6 + (-12.8) \div (-20)]$	**M1**		For using $H = 1.6 + (0 - v_1^2)/(-2g)$ or for using $h = (0 - v_1^2)/(-2g)$
	Greatest height is 2.24 m	**A1**	3	

Q2.

6 **(i)**	$[T = 0.8a$ for A $2 - T = 0.2a$ for B $0.2g = (0.2 + 0.8)a$ system]	**M1**		For applying Newton's 2nd law either to particle A or to particle B or to the system
		M1		For applying N2 to a second particle (if needed) and solving for a
	$[a = 2]$	**A1**		
	$[2.5 = ½ \times 2 \times t^2]$	**M1**		A complete method for finding t such as using $s = ut + ½at^2$
	$t = 1.58$ s	**A1**	5	Allow $t = \frac{1}{2}\sqrt{10}$
First Alternative Method for 6(i)				
(i)	$[0.2 \times g \times 2.5$ or $½(0.2 + 0.8)v^2]$	**M1**		Finding PE loss or KE gain (system)
	$[0.2 \times g \times 2.5 = ½(0.2 + 0.8)v^2]$	**M1**		Using PE loss = KE gain and find v
	$[v^2 = 10]$	**A1**		
	$[2.5 = ½\,(0 + \sqrt{10})t]$	**M1**		For using $s = ½(u + v)t$
	$t = 1.58$ s	**A1**	5	Allow $t = \frac{1}{2}\sqrt{10}$

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Q3.

6 (i) (a)	$1.3g - T = 1.3a$ and $T - 0.7g = 0.7a$ or $1.3g - 0.7g = (1.3 + 0.7)a$ and either $1.3g - T = 1.3a$ or $T - 0.7g = 0.7a$	M1 A1		For applying Newton's Second Law to one particle or for using $m_1g - m_2g = (m_1 + m_2)a$
	Tension is 9.1 N	B1		
(b)	Acceleration is 3 ms^{-2}	B1		
	$[2 = \frac{1}{2} \times 3 \times t^2]$	M1		For using $s = \frac{1}{2} at^2$
	Time taken is 1.15 seconds	A1	6	
(ii)	$[v^2 = 2 \times 3 \times 2]$	M1		For using $v^2 = u^2 + 2as$ to find the speed on reaching plane
	$v = \sqrt{12}(3.464)$	A1ft		ft$\sqrt{(4a)}$orat from (i)
	$[0 = 12 - 2gs \rightarrow s = ...]$	M1		For using $v^2 = u^2 + 2as$ to find the distance 0.7 kg particle continues upwards
	Greatest height is 4.6 m	A1	4	
Alternative				
(ii)	$[1.3g \times 2 = \frac{1}{2}(1.3)v^2 + 9.1 \times 2]$ or $[9.1 \times 2 = \frac{1}{2}(0.7)v^2 + 0.7g \times 2]$	M1		For using PE loss = KE gain + WD_T for 1.3 kg or for using WD_T = KE gain + PE gain for 0.7 kg
	$v = \sqrt{12}(3.464)$	A1ft		ft$\sqrt{(4a)}$ or at from (i)
	$[\frac{1}{2} \times 0.7v^2 = 0.7gs \rightarrow s = ...]$	M1		For using KE loss = PE gain
	Greatest height is 4.6 m	A1	4	

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Q4.

1	[$0.4g - T = 0.4a$ $T = 0.6a$ System equation $0.4g = (0.4 + 0.6)a$]	M1 M1		For applying Newton's 2nd law to either particle or to the system For applying Newton's 2nd law to the other particle and attempt to solve for a and T
	$a = 4\,\text{ms}^{-2}$	A1		
	$T = 2.4\,\text{N}$	A1	[4]	

Q5.

2 (i)	$2 = 5a \rightarrow a = 0.4\ \text{ms}^{-2}$	B1		
	[$0.1g\sin 20 - F = 0.1 \times 0.4$]	M1		For applying Newton's 2nd law to the particle
	$F = 0.302\,\text{N}$ AG	A1	[3]	
(ii)	[$R = 0.1g\cos 20$ ($= 0.9397$)]	M1		For attempting to find R and using $\mu = F/R$
	$\mu = 0.3020/0.9397 = 0.321$	A1	[2]	

Q6.

3 (i)	[$7g - T = 7a$ **and** $T - 3g = 3a$] or [$7g - 3g = 10a$]	M1		For applying Newton's second law to P **and** to Q or for using $m_Pg - m_Qg = (m_P + m_Q)a$
	Acceleration is $4\,\text{ms}^{-2}$	A1		
	[$v^2 = 0 + 2 \times 4 \times 0.4$] ($v^2 = 3.2$)	M1		For using $v^2 = u^2 + 2as$
	Speed is $1.79\,\text{ms}^{-1}$	A1	[4]	
(ii)	[$0 = 3.2 + 2 \times (-g) \times s$] ($s = 0.16$)	M1		For using $0 = u^2 + 2(-g)s$
	$0.16 + 0.4 = 0.56$ So particle Q does not come to rest before it reaches the pulley	A1	[2]	
	Alternative			
	[$v^2 = 3.2 + 2 \times (-g) \times 0.1$]	M1		For using $v^2 = u^2 + 2(-g)(0.1)$
	$v = \sqrt{1.2}$ ($= 1.10$) So particle Q does not come to rest before it reaches the pulley	A1	[2]	

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Q7.

7 **(i)**	$R = 50g\cos 10°$ and $F = 50g\sin 10°$	**B1**		
	$\mu \geqslant 0.176$	**B1**	[2]	$\mu \geqslant F \div R$ Allow $\mu \geqslant \tan 10°$
(ii)	PE loss = $50g \times d\sin 10°$	**B1**		$d = 5$ or $d = 10$
	WD against friction = $0.19 \times 50g\cos 10° \times d$	**B1**		$d = 5$ or $d = 10$
		M1		For using WD by 50 N force + PE loss – WD against friction = KE gain
	$50 \times 5 + 50g \times 10\sin 10° - 0.19 \times 50g\cos 10° \times 10 = 0.5 \times 50v^2$	**A1**		
	Speed is 2.70 ms^{-1}	**A1**	[5]	
				SC for candidates using Newton's Second law: max 2/5 B1 $v = 2.94\text{ ms}^{-1}$ after 5 m B1 Speed is 2.70 ms^{-1}
(iii)	$50g\sin 20° -$ $0.19 \times 50g\cos 20° = 50a$	**M1**		For using Newton's Second Law
	Acceleration is 1.63 ms^{-2}	**A1**	[2]	

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Q8.

6(i)		**M1**	Apply Newton's law to either of the particles
	$12 - T = 1.2a$ and $T - 8 = 0.8a$	**A1**	Both equations correct
		M1	Solve for a and T
	$a = 2\,\text{m s}^{-2}$ and $T = 9.6\,\text{N}$	**A1**	
	Total:	**4**	
6(ii)	$[0.64 = ½ \times 2 \times t_1^2]$ $[v = 2t_1]$	**M1**	Attempt to find time t_1 taken for 1.2 kg particle to reach ground and/or its speed v at the ground
	$t_1 = 0.8$	**A1**	
	$v = 2 \times 0.8 = 1.6$	**A1**	
	$[0 = 1.6 - 10t_2]$ $[1.6^2 = 2 \times 10 \times s_2]$	**M1**	For attempting to find the time t_2 and/or distance travelled s_2 as 0.8 kg particle comes to rest
	$t_2 = 0.16$	**A1**	
	$s_2 = 0.128$	**A1**	
	$t_3 = 1 - 0.8 - 0.16 = 0.04$ $s_3 = ½ \times 10 \times 0.04^2$	**B1**	Finding the distance s_3 travelled downwards in t_3 seconds
	Total distance travelled = $0.64 + 0.128 + 0.008 = 0.776\,\text{m}$	**B1**	
	Total:	**8**	