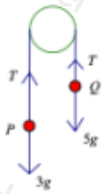
Question Number	Scheme	Marks	Notes
7			
(a)	$3g - T = 3a$	M1 A1	Eqn of motion for Q: must have the correct terms but condone sign errors Correct equation
	$T - 2g\cos 60 = 2a \qquad (T - g = 2a)$	M1 A1	Eqn of motion for P: must have the correct terms but condone sign errors. Weight must be resolved. Correct equation
	Allow M1A1 for $3g - 2g\cos 60 = 5a$ in place of either of these two equations		
	$2g = 5a \qquad a = \frac{2g}{5}$ *	DM1 A1	Use an exact method to solve for a (i.e. not the equation solver on their calculator). Dependent on the first 2 M marks or the M for the combined equation. Given answer derived correctly from exact working.
	$T = 2\times\frac{2g}{5} + g = \frac{9g}{5}$	M1 A1 (8)	Use given acceleration to solve for T. accept 18 or 17.6
(b)	$v^2 = 2\times\frac{2g}{5}\times 0.6 = \frac{2.4g}{5}$	M1	Use the given acceleration to find the speed
	$v = \frac{2}{5}\sqrt{3g}$ oe involving g	A1 (2)	Accept 2.2 or 2.17

Question Number	Scheme	Marks	Notes
(c)	String slack: accel of P (up plane) $= -g\cos 60 = -\frac{1}{2}g$	B1	
	$0 = \frac{2.4g}{5} - gs$	M1	Use of $v^2 = u^2 + 2as$ or equivalent for their acceleration $\neq \frac{2g}{5}$
	$s = \frac{2.4g}{5} \times \frac{1}{g} = \frac{2.4}{5} = 0.48$	A1	
	Total dist = 1.08 m	A1ft (4)	0.6 + their 0.48
(d)	$0 = \frac{2}{5}\sqrt{3g} - \frac{g}{2}t \quad (0 = 2.17 - 4.9t)$	M1	Use of $v = u + at$ or equivalent with their acceleration $\neq \frac{2g}{5}$ to find t.
	$t = \frac{4\sqrt{3g}}{5g} = 0.4426\ldots$ $= 0.44$ or 0.443	A1 (2)	only
		[16]	

Question Number	Scheme	Marks	Notes
7.(a)	$F = 0.25R$	B1	
	$\sin\alpha = \frac{3}{5}$ or $\cos\alpha = \frac{4}{5}$ $\sin\beta = \frac{4}{5}$ or $\cos\beta = \frac{3}{5}$	B1	Use of correct trig ratios for α or β
	$R = 4g\cos\alpha$ (31.36)	M1	Normal reaction on P Condone trig confusion (using α)
		A1	Correct equation
	$T + F = 4g\sin\alpha$	M1	Equation of motion for P. Requires all 3 terms. Condone consistent trig confusion Condone an acceleration not equated to 0 : $T + F - 4g\sin\alpha = 4a$
	$(T + 7.84 = 23.52)$ $(T = 15.68)$	A1	Correct equation
	$T = mg\sin\beta$	M1	Equation of motion for Q Condone trig confusion Condone an acceleration not equated to 0: $T - mg\sin\beta = -ma$
	$(T = 7.84m)$	A1	Correct equation
	Solve for m	DM1	Dependent on the 3 preceding M marks Not available if their equations used $a \neq 0$
	$m = 2$	A1	
	NB Condone a whole system equation $4g\sin\alpha - F = mg\sin\beta$ followed by $m = 2$ for 6/6 M2 for an equation with all 3 terms. Condon trig confusion. Condone an acceleration $\neq 0$ A2 (-1 each error) for a correct equation:		
		(10)	
7.(b)	$F = \sqrt{T^2 + T^2}$ or $2T\cos 45°$ or $\frac{T}{\cos 45}$	M1	Complete method for finding F in terms of T Accept $\sqrt{(R_h)^2 + (R_v)^2}$
		A1	Correct expression in T
		DM1	Substitute their T into a correct expression Dependent on the previous M mark
	$F = \sqrt{2}\frac{8g}{5} = 22$ or 22.2 (N)	A1	Watch out - resolving vertically is not a correct method and gives 21.9 N.
		(4)	
7.(c)	Along the angle bisector at the pulley	B1 (1)	Or equivalent - accept angle + arrow shown on diagram. ($8.1°$ to downward vertical) Do not accept a bearing
		[15]	

Q	Scheme	Marks	Notes
5a			**N.B.** If they use $3m$ AND $5m$ consistently, can score for (a), (b) and (c), Max M1A0 in (a) Max M1A0 DM1 A0 in (b) Max M1A0 in (c). Max B1M1A1**ft**M1A0 in (d).
	Equation of motion for P	M1	Require all terms. Condone sign errors
	$T-3g=3a$ oe	A1	Correct unsimplified equation
		[2]	
5b	Equation of motion for Q	M1	Require all terms. Condone sign errors
	$Q:5g-T=5a$ oe	A1	Second correct equation.
			Condone combined equation $5g-3g=(5+3)a$ in place of one of the above
	Solve for T	**D**M1	Dependent on both previous M marks, for solving for T. **N.B.** They could solve using a calculator, in which case this DM could be implied by a correct answer.
	$T=36.8$	A1	Accept $\frac{15g}{4}$ oe or 37 **N.B.** Must be a numerical value.
		[4]	
5c	Force on pulley $=2T$	M1	Correct for their T, provided $T\neq 0$
	$F=73.5$	A1**ft**	Accept $\frac{15g}{2}$ or 74 (not 73.6), ft on their T value. **N.B.** Must be a numerical value.
		[2]	
5d	Use of $a=\frac{g}{4}$ oe	B1	Must be used in (d).
	Complete method to find v or v^2 with $a\neq g$	M1	M0 if $s=8$ is used
	$v^2=2\times a\times 2$ $\left(v^2=2\times\frac{g}{4}\times 2\right)$	A1**ft**	Correct unsimplified equation in v or v^2. ft on their $a\neq\pm g$
	Speed at ground	M1	Complete method with $a=\pm g$, $s=8$, and a calculated v^2 at $s=2$, condone sign errors.
	$w^2=v^2+2\times g\times 8$ $w=12.9(13)\left(\text{ms}^{-1}\right)$	A1	3 sf or 2 sf **N.B.** Only penalise overaccuracy after $g=9.8$, ONCE for the whole question.
		[5]	
		(13)	

Question Number	Scheme	Marks
8(a)	$1.4^2 = 2a \times 0.5 \Rightarrow a = 1.96 \text{ ms}^{-2}$ $3g - T = 3a$ or $-3a$ $T = 23.5 \text{ N}$ or $24 N$	M1 A1 M1 A1 A1 (5)
(b)	$F = \mu R$ $R = 2g\cos\alpha$ $T - 2g\sin\alpha - F = 2a$ or $-2a$ $\mu = 0.5$	B1 M1 A1 M1 A1 A1 **DM**1 A1 (8) **13**
	Notes	
8(a)	First M1 for using one or more *suvat* formulae to produce an equation in a only First A1 for 1.96 (or -1.96 but only if correctly used in the second equation, in which case they *could* score 5/5) Second M1 for resolving vertically for Q (correct no. of terms but condone sign errors) Second A1 for a correct equation provided a used consistently in their two equations (but a does not need to be substituted) **N.B.** If they haven't found a value for a, the A1 can be scored for either $3a$ or $-3a$ in the equation of motion. Third A1 for 23.5 or 24	
(b)	B1 for $F = \mu R$ seen First M1 for resolving perpendicular to the plane (correct no. of terms with $2g$ resolved) First A1 for a correct equation (M1A0 for $R = mg\cos\alpha$) Second M1 for resolving parallel to the plane (correct no. of terms with $2g$ resolved but condone sign errors) Second A1 and third A1 for a correct equation (A1A0 for one error) N.B. Neither T nor F nor a needs to be substituted. Third M1 dependent on both previous M marks, for solving for μ(a *numerical* value) Fourth A1 for $\mu = 0.5$ (A0 for 0.499)	

8a	Equation of motion for P **N.B.** In (a) and (b), for both equations of motion, must be using the correct mass to score the M mark.	M1	Dimensionally correct. Need all terms. Condone sign errors. **N.B**. Allow if a is used instead of $\frac{1}{5}g$
	$T - kMg = \frac{1}{5}kMg$	A1	Correct only. **N.B.** A0 if a is used here unless subsequently is replaced by $\frac{1}{5}g$ at any stage in the question.
		(2)	
8b	Another equation of motion	M1	Condone whole system equation. **N.B**. Allow if a is used instead of $\frac{1}{5}g$
	For Q: $3Mg - T = \frac{3}{5}Mg$ **OR** For system: $3Mg - kMg = \frac{1}{5}(kM + 3M)g$	A1	or equivalent in either case. **N.B.** A0 if a is used here unless subsequently is replaced by $\frac{1}{5}g$ at any stage.
	Obtain $k = 2$	A1	Correct only
		(3)	
8c	Complete method to obtain equation in T only e.g. $T - g = \frac{1}{5}g$ **OR** $1.5g - T = \frac{3}{5} \times 0.5g$	M1	Use of their $k = 2$ and/or $M = 0.5$ in **their** equation of motion for P or Q Condone sign errors.
	Use of force = $2T$	M1	Their T must be substituted. Independent M mark.
	$\frac{12}{5}g = 24$ or 23.5(N)	A1	2 sf or 3 sf only Allow $\frac{12}{5}g$ oe
		(3)	
8d	Complete method to obtain the speed of Q when it hits the ground, must be using $a = \frac{1}{5}g$ and $s = 2.5$ e.g. $v = \sqrt{2 \times \frac{1}{5}g \times 2.5}$	M1	Condone sign errors.

	$v=\sqrt{g}=\frac{7}{\sqrt{5}}=3.13049...$	A1	Any of these but allow 3.1 or better
	$\pm 1.5\left(0.4-(-v)\right)$	M1	Condone sign errors, v does not need to be substituted. **N.B.** Allow use of $3M$, M or 0.5 for mass.
	$=\pm 1.5\left(0.4+\sqrt{g}\right)$ oe	A1	Or with $\sqrt{g}$ = 3.1 or better
	Obtain 5.3 or 5.30 (Ns)	A1	2 sf or 3 sf only
		(5)	
8e	Use of *suvat* with correct acceleration to find an equation in t_1 OR t_2 only. e.g. For t_1, any of : $\sqrt{g}=\frac{1}{5}gt_1$ $2.5=\frac{1}{2}\times\frac{1}{5}gt_1^2$ $2.5=\frac{1}{2}(0+\sqrt{g})t_1$ $2.5=\sqrt{g}t_1-\frac{1}{2}\times\frac{1}{5}gt_1^2$ **OR** e.g. For t_2 $0=\sqrt{g}-gt_2$ or any other complete method e.g. find s (0.5) and use it to find t_2	M1	Complete *suvat* method to find an equation in a relevant time. Condone sign errors. **N.B**. If using their v ($\sqrt{g}$) from part (d), it must have come from a correct method. **N.B.** t_1 may have been found in (d) but must be used in (e) to gain credit.
	Obtain $t_1=\frac{5}{\sqrt{g}}=\frac{5\sqrt{5}}{7}=1.5971..$ **OR** $t_2=\frac{1}{\sqrt{g}}=\frac{\sqrt{5}}{7}=0.319438..$	A1	Any of these but allow t_1 = 1.6 or better **OR** Any of these but allow $t_2=0.3$ or better
	Complete correct method for total time = t_1+t_2	M1	Correct use of *suvat* and correct accelerations
	$1.9(\text{s})$ or $1.92(\text{s})$	A1	2 sf or 3 sf only
		(4)	
		(17)	

Question	Scheme	Marks	Notes
8. (a)			
	$R = mg$	B1	Resolve vertically at Q
	$F = \frac{1}{2}R$	B1	Use of $F = \mu R$
	$T - F = ma$	M1	Equation of motion for Q No missing/additional terms Condone sign error(s)
		A1	
	$2mg\sin\alpha - T = 2ma$	M1	Equation of motion for P No missing/additional terms Condone sign error(s) and sin/cos confusion
		A1	
(i)		dM1	Solve for a or T Dependent on 2 correct equations (one of which could be for the whole system)
	$a = \frac{7g}{30} = 2.3$ or $2.29\ \text{ms}^{-2}$	A1	a or T correct
(ii)	$T = \frac{7mg}{30} + \frac{mg}{2}$	dM1	Solve for second unknown Dependent on 2 correct equations (one of which could be for the whole system)
	$= \frac{11mg}{15}$	A1 (10)	Both correct Accept $T = 7.2m$ or better
(b)	$a = 0 \Rightarrow 2mg\sin\alpha - T = 0$	M1	Use equation of motion of P to find T.
	$\Rightarrow T = \frac{6mg}{5}$	A1	$(11.76m)$
	$\mu mg \geq \frac{6mg}{5}$	dM1	For Q, $T \leq \mu R$. Dependent on preceding M Condone use of $T = \mu R$
	Least value is 1.2	A1 (4)	
(b) alt	$2mg\sin\alpha - \mu R = 0$	M1A1	Using the combined equation
	$\frac{6}{5}mg = \mu mg$	M1	Substitute for trig and R and solve
	Least value is 1.2	A1 (4)	
		[14]	