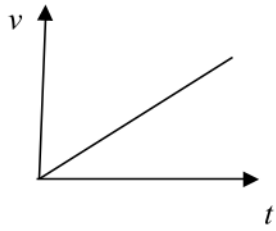
Question	Scheme	Marks	AOs
	Mark parts (a) and (b) together		
2(a)	Equation of motion for A	M1	3.3
	$3mg\sin\alpha - F - T = 3ma$	A1	1.1b
		(2)	
2(b)	Resolve perpendicular to the plane	M1	3.4
	$R = 3mg\cos\alpha$	A1	1.1b
	$F = \frac{1}{6}R$	B1	1.2
	Equation of motion for B **OR** for whole system	M1	3.3
	$T - mg = ma$ **OR** $3mg\sin\alpha - F - mg = 3ma + ma$	A1	1.1b
	Complete method to solve for a	DM1	3.1b
	$a = \frac{1}{10}g$ *	A1*	2.2a
		(7)	
2(c)		B1	1.1b
	e.g. acceleration (of B) is constant; dependent on first B1	DB1	2.4
		(2)	
2(d)	e.g. the tensions in the two equations of motion would be different. Tension on A would be different to tension on B	B1	3.5a
		(1)	
			(12 marks)

Notes: **N.B.** If m's are consistently missing treat as a MR, so max
(a) M1A0 (b) M1A0B0M1A1M1A1 (c) B1B1 (d) B1

For (a) and (b), allow verification, but must see full equations of motion.

2a	M1	Equation in T and a with correct no. of terms, condone sign errors and sin/cos confusion (If one of the 3's is missing, allow M1) N.B. Treat sin(3/5) etc as an A error but allow recovery
	A1	Correct equation (allow $(-a)$ instead of a in <u>both</u> equations)

Question	Scheme	Marks	AOs
7(a)	Resolve vertically	M1	3.1b
	$R + 40\sin\alpha = 20g$	A1	1.1b
	Resolve horizontally	M1	3.1b
	$40\cos\alpha - F = 20a$	A1	1.1b
	$F = 0.14R$	B1	1.2
	$a = 0.396$ or 0.40 (m s^{-2})	A1	2.2a
		(6)	
(b)	Pushing will increase R which will increase available F	B1	2.4
	Increasing F will <u>decrease a</u> * GIVEN ANSWER	B1*	2.4
		(2)	
			(8 marks)

Notes:

(a)

M1: Resolve vertically with usual rules applying

A1: Correct equation**.** Neither g nor $\sin a$ need to be substituted

M1: Apply $F = ma$ horizontally, with usual rules

A1: Neither F nor $\cos a$ need to be substituted

B1: $F = 0.14R$ seen (e.g. on a diagram)

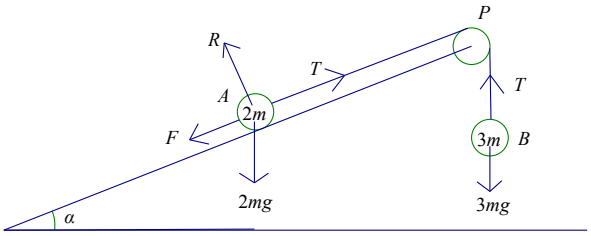
A1: Either answer

(b)

B1: Pushing increases R which produces an increase in available (limiting) friction

B1: F increase produces an <u>a decrease (need to see this)</u>

N.B. It is possible to score B0 B1 but for the B1, some "explanation" is needed to say why friction is increased e.g. by pushing into the ground.

Question	Scheme	Marks	AO
3(a)			
	$R = 2mg\cos\alpha$	B1	3.4
	$F = \frac{2}{3}R$	B1	1.2
	Equation of motion for A:	M1	3.3
	$T - F - 2mg\sin\alpha = 2ma$	A1	1.1b
	Equation of motion for B:	M1	3.3
	$3mg - T = 3ma$	A1	1.1b
	Complete strategy to find an equation in T, m and g only.	M1	3.1b
	$T = \frac{12mg}{5}$ *	A1*	2.2a
		(8)	
(b)	$(F_{\max} =)\frac{16mg}{13} > \frac{10mg}{13}$	M1	2.1
	…… so A will not move.	A1	2.2a
		(2)	
(c)	• Extensible string • Weight of string • Friction at pulley e.g. rough pulley • Allow for the dimensions of the blocks e.g. "Do not model blocks as particles"; "(include) air resistance";"include rotational effects of forces on blocks i.e. spin"	B1 B1	3.5c 3.5c
		(2)	
		(12)	

Question	Scheme	Marks	AOs
1.(a)	Resolve perpendicular to the plane	M1	3.4
	$R = mg\cos\alpha = \frac{4}{5}mg$	A1	1.1b
		(2)	
1(b)	Resolve parallel to the plane or horizontally or vertically	M1	3.4
	$F = mg\sin\alpha$ or $R\sin\alpha = F\cos\alpha$	A1	1.1b
	Use $F = \mu R$ and solve for μ	M1	2.1
	$\mu = \frac{3}{4}$*	A1*	2.2a
		(4)	
1(c)	The forces acting on Q will still balance as the m's cancel oe Other possibilities: e.g. the friction will increase in the same proportion as the weight component or force down the plane. The force pulling the brick down the plane increases by the same amount as the friction oe This mark can be scored if they do the calculation.	B1	2.4
		(1)	
1(d)	Brick Q slides down the plane with **constant** speed.	B1	2.4
	No resultant force down the plane (so no acceleration) oe	B1	2.4
	These marks can be scored if they do the calculation.	**(2)**	
			(9 marks)

Notes:		
1a	M1	Correct no. of terms, condone sin/cos confusion
	A1	cao with no wrong working seen. mgcos36.86 is A0
1b	M1	Correct no. of terms, condone sin/cos confusion
	A1	Correct equation
	M1	Must use $F = \mu R$ (not merely state it) to obtain a numerical value for μ. This is an independent M mark.
	A1*	Given answer correctly obtained
1c	B1	Must have the 3 underlined phrases/word oe
1d	B1	Must say **constant** speed.
	B1	Any appropriate equivalent statement

Question	Scheme	Marks	AOs
7(a)	$R = mg\cos\alpha$	B1	3.1b
	Resolve parallel to the plane	M1	3.1b
	$-F - mg\sin\alpha = -0.8mg$	A1	1.1b
	$F = \mu R$	M1	1.2
	Produce an equation in μ only and solve for μ	M1	2.2a
	$\mu = \frac{1}{4}$	A1	1.1b
		(6)	
(b)	Compare $\mu mg\cos\alpha$ with $mg\sin\alpha$	M1	3.1b
	Deduce an appropriate conclusion	A1 **ft**	2.2a
		(2)	
			(8 marks)

Notes:

(a)

B1: for $R = mg\cos\alpha$

1st M1: for resolving parallel to the plane

1st A1: for a correct equation

2nd M1: for use of $F = \mu R$

3rd M1: for eliminating F and R to give a value for μ

2nd A1: for $\mu = \frac{1}{4}$

(b)

M1: comparing size of limiting friction with weight component down the plane

A1ft: for an appropriate conclusion from their values

General Principles for Mechanics Marking

Question Number	Scheme	Marks
1	$T\cos 70^\circ + R = 40g$	M1A1
	$T\cos 20^\circ = F$	M1A1
	$F = \frac{3}{4}R$	B1
	Eliminate R and solve for T	**DM**1
	$T = 250$ N or 246 N	A1
		7
	Notes	
1	First M1 for resolving vertically with usual rules (must be using either 20^o or 70^o) First A1 for a correct equation Second M1 for resolving horizontally with usual rules (must be using either 20^o or 70^o) Second A1 for a correct equation B1 for $F = \frac{3}{4}R$ seen (could be on a diagram) Third DM1 dependent on previous two M marks Third A1 for either 250 (N) or 246 (N)	
2a	$M(D),\ (1080\times 1)-(400\times 2) = R_C \times 3.5$	M1 A1
	$R_C = 80$ (N)	A1
	$M(C),\ (1080\times 2.5)+(400\times 5.5) = R_D \times 3.5$	M1A1
	$R_D = 1400$ (N)	A1 (6)
	OR $(\uparrow)\ R_C + R_D = 1480$	M1A1
2b	$R_C + (R_C + 520) = 1480$ OR $R_D + (R_D - 520) = 1480$	M1 A1
	$M(D),\ (1080\times 1) - 400(x-4) = R_C \times 3.5$	M1 A1
	$x = 2.5$	A1 (5)
		11
	Notes	
2a	First M1 for a moments equation or a vertical resolution First A1 for a correct equation (R_C and/or R_D do NOT need to be substituted but if one is, it can be their value found from a previous equation)	

Question Number	Scheme	Marks
6c	B1 for $5V$ identified appropriately First M1 for clear attempt to equate the *total* area under graph to 1500. (Must include all 3 parts (if not using the trapezium rule) with $\frac{1}{2}$ seen at least once to give equation in V only; may use (1 triangle + 1 trapezium) or (rectangle - trapezium) (May use *suvat* for one or more parts of the area) A2 for a correct equation, -1 e.e.o.o. Second **DM**1 dependent on first M1 for multiplying out and collecting terms and putting into appropriate form Third A1 for correct equation. **Given answer**	
6d	First M1 for solving their 3 term quadratic equation for V N.B. This M1 can be implied by two correct roots but if either answer incorrect then an explicit method must be shown for this M mark. First A1 for $V = 6$ Second A1 for $V = 75$ B1 on ePEN but treat as **DM**1, dependent on both previous A marks, for either reason	
7a	$T - 3mg\sin\alpha - F = 3ma$	M1A1
	$4mg - T = 4ma$	M1A1 (4)
7b	$F = \frac{1}{4}R;\ R = 3mg\cos\alpha$	B1; M1A1
	$T - 2.4mg = 3ma$ $4mg - T = 4ma$	M1
	$a = \frac{8g}{35}$ **Given answer**	A1 (5)
7c	Particles have same acceleration	B1 (1)
7d	$v^2 = 2 \times \frac{8g}{35} \times 1.75$ (= $0.8g$)	M1 A1
	$-3mg\sin\alpha - F = 3ma'$	M1
	$a' = -0.8g$	A1
	$0 = 0.8g + 2 \times (-0.8g)s$	M1 A1
	Total distance = 0.5 + 1.75 = 2.25 (m) Accept 2.3 (m)	A1 (7)
		17
	Notes	
7a	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.** If using different tension in second equation, M0 for that equation	

Question Number	Scheme	Marks
7b	B1 for $F = \frac{1}{4}R$ seen e.g. on diagram First M1 for resolving for *A* perp to the plane First A1 for correct equation N.B. These first 3 marks can be earned in (a). Second M1 (Hence) for substituting for *R* and *F* and trig. and solving for *a* (must be some evidence of this) their equations of motion from part (a) Second A1 for **given answer (Not available if not using exact values for trig ratios)**	
7c	B1 for particles have same acceleration (B0 for same velocity or if incorrect extras given)	
7d	First M1 for attempt to find speed (or speed^2) when *B* hits the ground (M0 if uses *g*) First A1 for a correct expression Second M1 for attempt to find deceleration of *A* Second A1 for correct deceleration Third M1 for using deceleration (must have found a deceleration) with $v = 0$ to find distance (M0 if uses *g*) Third A1 for a correct equation Fourth A1 for 2.25 (m)	

Question Number	Scheme	Marks
5(a)	(□), $R = 8\cos 50^o + 0.5g\cos 30^o$ (□), $F = 8\cos 40^o - 0.5g\sin 30^o$ $F = \mu R$ $\mu = 0.39$ or 0.392	M1 A2 M1 A2 B1 **DM1** A1 **9**
	Notes	
	First M1 for resolving perpendicular to the plane with usual rules and 8 must be used with 40^o or 50^o and 0.5(g) must be used with 30^o or 60^o First A1 and second A1 for a correct equation – 1 each error (A1A0 or A0A0) Second M1 for resolving parallel to the plane with usual rules and 8 must be used with 40^o or 50^o and 0.5(g) must be used with 30^o or 60^o Third A1 and fourth A1 for a correct equation – 1 each error (A1A0 or A0A0) B1 for $F = \mu R$ seen Third M1 dependent on both previous M marks for solving for μ Fifth A1 for 0.39 or 0.392 **N.B. If they resolve in any other directions e.g. horizontally or vertically, apply similar rules to the above for the M mark in each case.**	

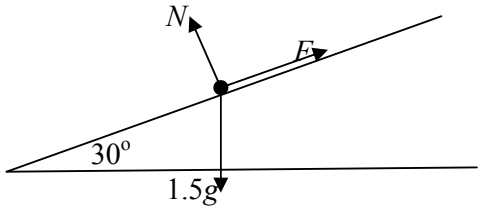
Question Number	Scheme	Marks
8(a)	$1.4^2 = 2a \times 0.5 \Rightarrow a = 1.96 \text{ ms}^{-2}$ $3g - T = 3a$ or $-3a$ $T = 23.5 \text{ N}$ or $24 N$	M1 A1 M1 A1 A1 (5)
(b)	$F = \mu R$ $R = 2g\cos\alpha$ $T - 2g\sin\alpha - F = 2a$ or $-2a$ $\mu = 0.5$	B1 M1 A1 M1 A1 A1 **DM**1 A1 (8) **13**
	Notes	
8(a)	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)	

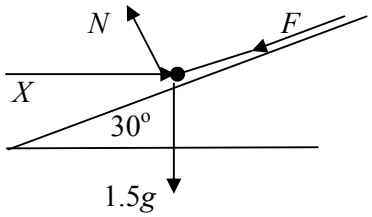
Question	Scheme	Marks	Notes
8. (a)			
	$R = mg$	B1	Resolve vertically at Q
	$F = \frac{1}{2}R$	B1	Use of $F = \mu R$
	$T - F = ma$	M1	Equation of motion for Q No missing/additional terms Condone sign error(s)
		A1	
	$2mg\sin\alpha - T = 2ma$	M1	Equation of motion for P No missing/additional terms Condone 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]	

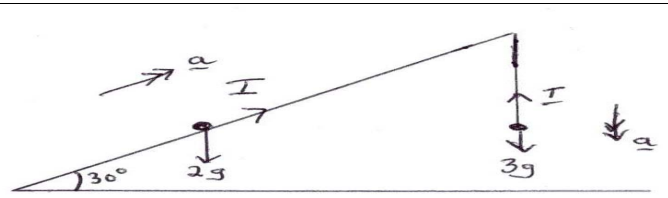
Question Number	Scheme	Marks	Notes
7.(a)	$F = 0.25R$	B1	
	$\sin\alpha = \frac{3}{5}$ or $\cos\alpha = \frac{4}{5}$ $\sin\beta = \frac{4}{5}$ or $\cos\beta = \frac{3}{5}$	B1	Use of correct trig ratios for α or β
	$R = 4g\cos\alpha$ (31.36)	M1	Normal reaction on P Condone trig confusion (using α)
		A1	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]	

3(a)	$5.5 = \frac{1}{2}a.2^2$	M1	Complete method using *suvat* equations to form an equation in *a* only
	$\Rightarrow a = 2.75$	A1	
		(2)	
(b)	$R = 30\sin\alpha + 2g\cos\alpha$	M1	Resolve perpendicular to the plane to find an expression for *R*. Must have all terms. Condone sign errors and sin/cos confusion.
		A2	-1 each error. All correct A1A1, one error A1A0, two or more errors A0A0 ($R = 33.68$)
	$-F + 30\cos\alpha - 2g\sin\alpha = 2\ a$	M1	Equation of motion parallel to the plane with *a* or their *a*. Must have all terms. Condone sign errors and sin/cos confusion.
		A2	-1 each error ($F = 6.74$)
	$\mu = \dfrac{30\cos\alpha - 2g\sin\alpha - 5.5}{30\sin\alpha + 2g\cos\alpha}$	DM1	Use $F = \mu R$ Dependent on the 2 previous M marks
	$= 0.200$ or 0.20	A1	Do not accept 0.2
		(8)	
		10	
4.		M1	Use $s = ut + \dfrac{1}{2}at^2$ or a complete *suvat* route to find h in terms of *t*
	$h = \frac{1}{2}gt^2$	A1	Or $h = \frac{1}{2}g(t+1)^2$. The expression for time used in the first equation defines the expression expected in the second equation.
	$h = 19.6(t-1) + \frac{1}{2}g(t-1)^2$	A1	Or $h = 19.6(t) + \frac{1}{2}g(t)^2$ or $h = 4.9 + \left(9.8t + \dfrac{1}{2}gt^2\right)$
	$\frac{1}{2}gt^2 = 19.6(t-1) + \frac{1}{2}g(t-1)^2$	M1	Equate the two expressions for *h*.
		DM1	Solve for *t*. Dependent on the previous M1.
	$t = 1.5$	A1	Using the "Or" approach gives $t = 0.5$
	$h = 11$ m or 11.0 m	A1	Accept 2 or 3 s.f. only
		7	

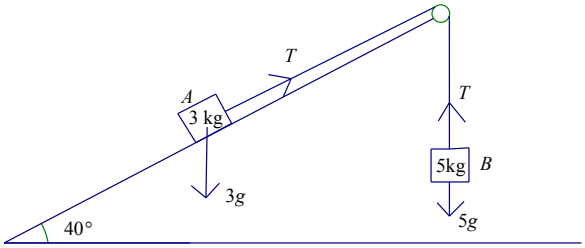
8(a)	$R = mg$	B1	Forces acting vertically on P
	$F = 0.5R$	B1	Use of $F = \mu R$
		M1	One equation of motion. Requires all terms but condone sign errors
	$4mg - T = \pm 4ma$	A1	
		M1	A second equation of motion of P. Requires all terms but condone sign errors
	$T - F = \pm ma$	A1	Signs of a must be consistent
			Condone use of $4mg - F = 5ma$ in place of either of the above equations.
	$4mg - 0.5mg = 5ma$ $a = 0.7g$ or $4mg - T = 4T - 2mg$	DDM1	Solve for T Dependent on the two preceding M marks
	$T = 1.2mg$	A1	
		(8)	
(b)	$v^2 = 2 \text{ x } 0.7\text{gh}$	M1	Complete method to an equation in v or v^2
	$v = \sqrt{1.4gh}$ *	A1	Obtain **given answer** or exact equivalent from exact working with no errors seen.
		(2)	
(c)	$-0.5mg = ma'$	M1	Complete method to find the deceleration of P
	$\Rightarrow a' = -0.5g$	A1	
		M1	Complete method to find additional distance on terms of h $\left(a \neq 0.7g, a \neq g\right)$
	$0^2 = 1.4gh - 2 \text{ x } 0.5g \text{ x } d$	A1	Correctly substituted equation. Follow their $a \neq 0.7g$, $a \neq g$.
	$d = 1.4h$	A1	
	Hence, length of string is greater than $1.4h + h = 2.4h$	A1	Obtain **given answer** with no errors seen. Their statement needs to reflect the inequality.
		(6)	
		16	

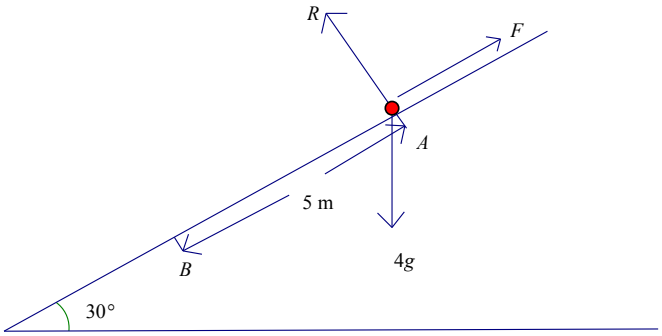
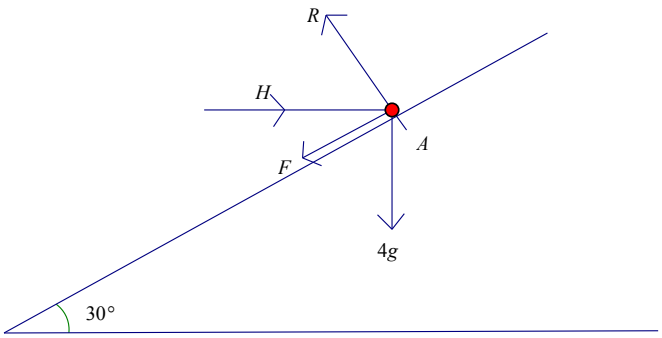
Question Number	Scheme	Marks	Notes
3			
(a)			For resolution of forces parallel or perpendicular to the plane. Weight must be resolved. Condone sin/cos confusion.
	For equilibrium	M1	
	$\mathrm{R}(\perp \text{ plane})\ N = 1.5g\cos 30$	A1	Correct equation for N (12.7)
	$\mathrm{R}(\parallel \text{ plane})\ F = 1.5g\cos 60$	A1	Correct equation for F (7.35). Condone μR
	$\frac{F}{N} = \frac{\cos 60}{\cos 30} = 0.577... < 0.6$	M1	Use of $F_{\max} = \mu N$ and compare with F, or find the value of their $\frac{F}{N}$ and compare with μ
	$\therefore$ equilibrium	A1 (5)	Reach **given conclusion** correctly. They must make some comment, however brief.
	ALT for first 3 marks:		
	Resolve vertically $N\cos 30 + F\cos 60 = 1.5g$	M1A1	
	Resolve horizontally $N\cos 60 = F\cos 30$	A1	
	ALT for last 2 marks:		
	$F_{\max} = 0.6\times 12.73 = 7.63 > 7.35$	M1	
	$\therefore$ P is at rest	A1	
	Candidates who think that the diagram applies to (a) will score nothing in (a) but if they carry their results forward in to (b) then their work can score the marks available in (b).		If the candidate has given the equation of motion for the particle moving down the plane then A1 for $1.5g\sin 30 - \mu R = \pm 1.5a$ To score more they need to comment correctly on their answer: a = -0.19 impossible M1 Conclude that the particle cannot be moving. A1

Question Number	Scheme	Marks	Notes
(b)			
	R(⊥ plane) $N = 1.5g\cos 30 + X\cos 60$	M1	Requires all 3 terms. Condone sin/cos confusion and sign errors.
	R(∥ plane) $X\cos 30 = 1.5g\cos 60 + F$	M1	Requires all 3 terms. Condone sin/cos confusion and sign errors.
		A1	Both equations correct unsimplified.
	$N = 1.5g\cos 30 + \dfrac{\cos 60}{\cos 30}(1.5g\cos 60 + 0.6N)$	DM1	Use $F = 0.6N$ to form an equation in N or in X. Dependent on the two previous M marks
	$N\left(1 - \dfrac{\cos 60}{\cos 30}\times 0.6\right) = 1.5g\cos 30 + \dfrac{\cos 60}{\cos 30}\times 1.5g\cos 60$		OR: $0.6(X\cos 60 + 1.5g\cos 30) + 1.5g\sin 30 = X\cos 30$
	(i) $N = 26$ or 26.0 (N)	A1	First value found correctly. (N or X)
	(ii) $X = (N - 1.5g\cos 30) \div \cos 60$	DM1	Substitute their N (or X) to find X (or N) Dependent on the previous M mark.
	$X = 26$ or 26.5	A1 (7) **[12]**	Second value found correctly.
Alt:	$N\cos 30 - F\cos 60 = 1.5g, \quad N\cos 30 - 0.6N\cos 60 = 1.5g$	M1, DM1 A1	Resolve vertically. Condone sin/cos confusion. Must have all terms. Use $F = 0.6N$ Correct unsimplified equation
	$N = \dfrac{1.5g}{\cos 30 - 0.6\cos 60} = 26$ or 26.0	A1	
	$X = F\cos 30 + N\cos 60, = N(0.6\cos 30 + \cos 60)$	M1, DM1	Resolve horizontally. Follow their N. Must have all terms. Condone sin/cos confusion. Substitute for F and N
	$X = 26$ or 26.5	A1	

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
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**: $v^2 = u^2 + 2as$: $s = \frac{their\ (\text{b})^2}{2 \times a} = 4.23$ (m)	M1A1
	New $a = -g\sin 40$ (-ve sign not needed)	B1
	Distance up plane : $v^2 = u^2 + 2as$, $s = \frac{their\ (\text{b})^2}{2 \times \text{ new } a}$ (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
6a		
	Resolve perpendicular to plane: $R = 4g\cos 30$	B1
	$F = 0.3R$ seen	B1
	Use of $F = ma$ parallel to plane: $4a = 4g\sin 30 - F$	M1A1
	$4a = 4g\sin 30 - 0.3\times 4g\cos 30$	A1
	Use of $v^2 = (u^2 +)2as$: $v = \sqrt{(10a)}$	M1
	v = 4.9 or 4.85(m s^{-1})	A1
		(7)
6b		
	Resolve perpendicular to the plane: $R = 4g\cos 30 + H\cos 60$	M1A1
	Resolve parallel to the plane: $H\cos 30 = F + 4g\sin 30$	M1A1
	Use of $F = 0.3R$	M1
	Solve for H: $H = \dfrac{g(1.2\cos 30 + 4\sin 30)}{\cos 30 - 0.3\cos 60}$	**DM**1
	= 42 or 41.6	A1
		(7)
6b alt	Resolve vertically: $R\cos 30 = 4g + F\cos 60$	M1A1
	Resolve horizontally: $H = R\cos 60 + F\cos 30$	M1A1
	Use of $F = 0.3R$	M1
	Solve for H:	**DM**1
	H = 42 or 41.6	A1 (7)
	N.B. Enter marks on ePen for equations as they appear.	[14]

1

8 (a)	For B: $1 = \frac{1}{2}a.2^2 \quad \Rightarrow \quad a = \frac{1}{2}$ m s^{-2}	M1 A1 (2)
(b)	$R = 3mg$; F=μR	B1 ; B1
	$T - F = 3m \times 0.5$	M1 A1**ft**
	$2mg - T = 2m \times 0.5$	M1 A1 **ft**
	Solving for μ	**DM**1
	$\mu = 0.58$ or 0.582	A1 (8)
(c)	$v = \frac{1}{2} \times 2 = 1$	B1 **ft**
	$-\mu\ 3mg = 3ma$	M1
	$0 = 1^2 - 2\mu gs$	M1
	$s = 0.0877\ldots$(.0.09 or better)	A1
	$s < 0.3$ **correct conclusion**,	**DM**1A1 cso (6)
		16

NOTES

Question 8(a)
First M1 for a complete method to find *a*. M0 if s =1.3 is used
First A1 for *a* =0.5

Question 8(b)
First B1 for $R = 3mg$
Second B1 for $F = \mu R$ seen (could be on diagram)
First M1 for resolving horizontally for *A* (this M mark can be scored if they just use *m* for mass but M0 if no mass used)
First A1ft on their *a,* for correct equation. (allow *F*)
Second M1 for resolving vertically for *B* (this M mark can be scored if they just use *m* for mass but M0 if no mass used)
Second A1ft on their *a,* for correct equation.
(Allow M2A2 for 'whole system' equation but M0 if not using 5*m*)
Third M1 dependent on both previous M marks for solving for μ
N.B. If *m* omitted consistently throughout (b), can score max B0B1M1A0M1A0M1A0

Question 8(c)
B1 **ft** for (their *a* x 2) oe to find *v*
First M1 for resolving horizontally for *A* with $T = 0$
Second M1 for a complete method (must have found a new '*a*') to find distance moved by *A*.
First A1 for 0.09 or better (0.087719..)
Third M1, dependent on first and second M marks, for comparison with 0.3 or 1.3 (Must explicitly refer to either 0.3 or 1.3 or an appropriate equivalent)
Second A1 **cso** for does not reach pulley.