Question	Scheme	Marks	AOs
9(a)	Equation of motion for P	M1	3.3
	$2mg - T = 2m \times \frac{5g}{7}$	A1	1.1b
	$T = \frac{4mg}{7}$	A1	1.1b
		(3)	
(b)	Since the string is modelled as being inextensible	B1	3.4
		(1)	
(c)	Equation of motion for Q **OR** for whole system	M1	3.3
	$T - kmg = km \times \frac{5g}{7}$ **OR** $2mg - kmg = (km + 2m)\frac{5g}{7}$	A1	1.1b
	$\frac{4mg}{7} - kmg = km \times \frac{5g}{7}$ oe and solve for k	DM1	1.1b
	$k = \frac{1}{3}$ or 0.333 or better	A1	1.1b
		(4)	
(d)	e.g The model does not take account of the mass of the string (see notes below for alternatives)	B1	3.5b
		(1)	
			(9 marks)

Notes: Condone both equations of motion appearing in (a) if used in (c)

(a)

M1: Resolving vertically for P with usual rules, correct no. of terms but condone sign errors and a does not need to be substituted (N.B. inconsistent omission of m is M0). Allow ma on RHS for M1

A1: A correct equation (allow if they use 7 instead of $\frac{5g}{7}$)

A1: A correct answer of form cmg, where $c = \frac{4}{7}$ oe or 0.57 or better

(b)

B1: String is inextensible. N.B. B0 if any extras (wrong or irrelevant) given

(c)

M1: Resolving vertically for Q or for a whole system equation, with usual rules, correct no. of terms but condone sign errors and neither T nor a does need to be substituted

N.B. Omission or extra g in a resolution is an accuracy error not a method error

In 2(a), use the mass which appears in the '*ma*' term of an equation of motion, to identify which particle that equation of motion applies to.

Question	Scheme	Marks	AOs	Notes
2(a)	Equation of motion for Q	M1	3.3	Equation of motion for Q with correct no. of terms, condone sign errors.
	$0.6g - T = 0.6a$	A1	1.1b	A correct equation
	Equation of motion for P	M1	3.3	Equation of motion for Q with correct no. of terms, condone sign errors.
	$T = 0.8a$	A1	1.1b	A correct equation
	$a = 4.2$ (m s^{-2}) *	A1*	2.2a	Given acceleration obtained correctly. **You must see an equation in a only before reaching $a = 4.2$**
		(5)		**N.B.** if they just use the whole system equation: $0.6g = 1.4a$, can only score max M1A1M0A0A0 **N.B**. Use of $g = 9.81$ or 10 loses final A mark only. **N.B.** Complete verification, using both equations, can score full marks.

(b)	$0.4=\frac{1}{2}\times 4.2\times t_1^2$ or e.g. they may find v first and then use $v=4.2t_1$	M1	2.1	Complete method (they may use more than one *suvat* equation) to find time for Q to hit the floor (M0 if 0.4 **not** used as distance moved and/or if 4.2 is **not** used as acceleration and this applies to finding v as well if they use v to find t_1)
	$t_1=0.436\,(4357\ldots..)$ Allow 0.43, 0.44, 0.436, or better, or any surd form e.g. $\frac{2}{\sqrt{21}}$	A1	1.1b	See alternatives
	$v=4.2\times t_1$ or $v=\sqrt{2\times 4.2\times 0.4}$ or $0.4=\frac{(0+v)}{2}\times t_1$ $(v=1.8330\ldots)$	M1	3.4	Complete method to find speed of Q as it hits the floor (M0 if 0.4 **not** used as distance moved and/or if 4.2 is **not** used as acceleration and this applies to finding t_1 as well if they use t_1 to find v)
	$t_2=\frac{1.5-0.4}{v}$	M1	1.1b	Uses distance/speed to find time for P to hit the pulley after Q has hit the floor. N.B. This is independent of previous M mark.
	Complete strategy to solve the problem by finding the sum of the two times t_1+t_2	**DM**1	3.1b	Complete method to solve the problem by finding and adding the two required times, dependent on previous three M marks
	1.0 (s) or 1.04 (s)	A1	1.1b	
		(6)		
(c)	e.g. rope being light; rope being inextensible; pulley being smooth; pulley being small; balls being particles	B1	3.5b	Clear statement. Allow negatives of these i.e. the rope may not be light, the rope may not be inextensible etc Must be a limitation of the model stated in the question Penalise incorrect or irrelevant extras
		(1)		B0 for: Air resistance, table being smooth
		(12 marks)		

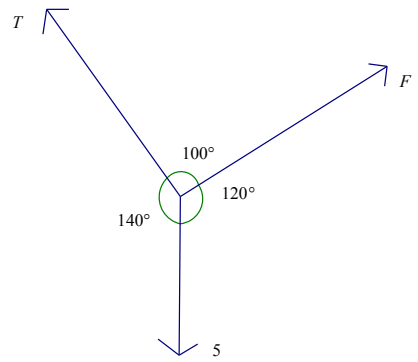
Question	Scheme	Marks	AOs
2(a)	Equation of motion for P with usual rules	M1	3.3
	$4mg - T = 4ma$	A1	1.1b
	Equation of motion for Q with usual rules	M1	3.3
	$T - 3mg = 3ma$	A1	1.1b
	Solve these equations for T (does not need to be in terms of mg)	M1	1.1b
	$T = \frac{24mg}{7}$ in any form (does not need to be a single term)	A1	1.1b
	Force on pulley = $2T$	M1	3.4
	$\frac{48mg}{7}$ Accept $6.9mg$ or better	A1	1.1b
		(8)	
2(b)	Weight of the rope or extensibility of rope Or: pulley may not be smooth	B1	3.5b
		(1)	
			(9 marks)

Notes:		
(a)	M1	Translate situation into the model and set up the equation of motion for P M0 if they omit m's i.e. $4g - T = 4a$
	A1	Correct equation
	M1	Translate situation into the model and set up the equation of motion for Q M0 if they omit m's i.e. $T - 3g = 3a$
	A1	Correct equation
		N.B. Condone either of the above equations being replaced by the 'whole system equation': $4mg - 3mg = 7ma$ (N.B. $a = g/7$) **N.B.** a replaced by $-a$ consistently can score all the marks
	M1	Solve equations for T
	A1	$T = \frac{24mg}{7}$ oe
	M1	T does not need to be substituted.
	A1	$\frac{48mg}{7}$ oe <u>Must be in terms of m and g</u> and be a single term
(b)	B1	B0 if any incorrect extras are given

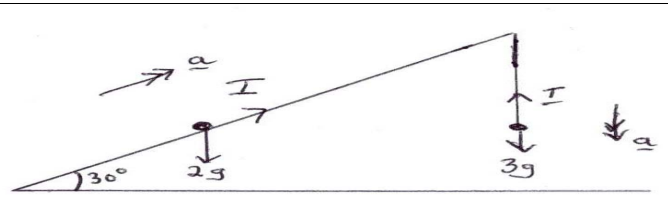
Question	Scheme	Marks	AOs
9(a)(i)	Equation of motion for A	M1	3.3
	$T - 12.7 = 2.5a$	A1	1.1b
(ii)	Equation of motion for B	M1	3.3
	$1.5g - T = 1.5a$	A1	1.1b
		(4)	
(b)	Solving two equations for a	M1	1.1b
	$a = 0.5$	A1	1.1b
		(2)	
(c)	$1 = \frac{1}{2} \leftarrow 0.5\, t^2$	M1	3.4
	$t = 2$ seconds	A1ft	1.1b
		(2)	
(d)	Valid improvement, see below in notes	B1	3.5c
	Valid improvement, see below in notes	B1	3.5c
		(2)	
			(10 marks)

Question Number	Scheme	Marks
2(a)	$(-10\mathbf{i}+a\mathbf{j})+(b\mathbf{i}-5\mathbf{j})+(2a\mathbf{i}+7\mathbf{j}) = 3(3\mathbf{i}+4\mathbf{j})$ $a-5+7=12 \Rightarrow a=10$ $-10+b+2a=9 \Rightarrow b=-1$	M1 M1 A1 M1 A1 (5)
(b)	$20\mathbf{i}+20\mathbf{j}=\mathbf{u}+4(3\mathbf{i}+4\mathbf{j})$ $\mathbf{u}=(8\mathbf{i}+4\mathbf{j})$ $u=\sqrt{8^2+4^2}=\sqrt{80}=8.9$ (or better)	M1 A1 M1 A1 (4) **9**
	Notes	
2(a)	First M1 for applying **F** = *m***a**; need all terms but allow slips and allow *m* instead of 3 Second M1 (independent but M0 if they have **0** instead of *m***a**) for equating *coefficients* of **j** First A1 for $a = 10$ Third M1 (independent but M0 if they have **0** instead of *m***a**) for equating *coefficients* of **i** Second A1 for $b = -1$	
(b)	First M1 for applying **v** = **u** + *t***a**; need all terms and must be vector **u** First A1 for 8**i** + 4**j** Second M1 (independent) for finding magnitude of their vector **u** Second A1 for √80 or 8.9 or better	

June 2017 Standardisation
WME01 Mechanics M1
Mark Scheme

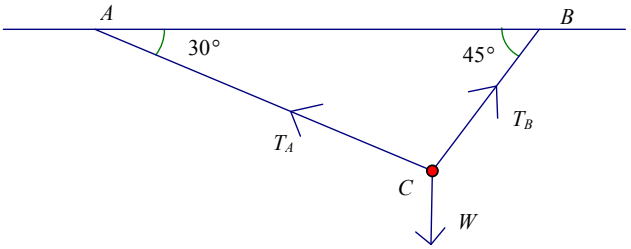
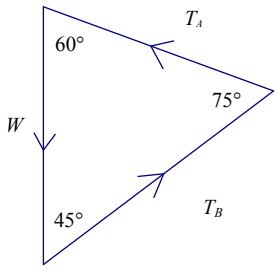
Question	Scheme	Marks	Notes
1.	Vertically: $T\cos 40 + F\cos 60 = 5$	M1	First equation seen for resolution of forces. No missing/additional terms Condone sin/cos confusion and sign error(s) $5g$ in place of 5 is an accuracy error T must link with 40 or 50 and F with 60 or 30
		A1	Correct equation
	Horizontally: $T\cos 50 = F\cos 30$	M1	Second equation seen for resolution of forces No missing/additional terms Condone sin/cos confusion and sign error(s) $5g$ in place of 5 is an accuracy error T must link with 40 or 50 and F with 60 or 30
		A1	Correct equation
	Perpendicular to line of F: $T\cos 10 = 5\cos 30$		
	Perpendicular to line of T: $F\cos 10 = 5\cos 50$		
	Solve for T or F	dM1	Dependent on using equation(s) that scored M mark(s)
	$T = 4.3969..$ N $= 4.4$ N (or better)	A1	One correct
	$F = 3.263....$ $= 3.3$ N(or better)	A1	Both correct
		[7]	
1 alt			Solution using Lami's theorem Or a triangle of forces
	$\frac{5}{\sin 100} = \frac{F}{\sin 140} = \frac{T}{\sin 120}$	M1	One pair including $\frac{5}{\sin 100}$ or $\frac{5}{\sin 80}$ Incorrect pairing of forces and angles is M0
		A1	Two fractions correct
		M1	Second pair of fractions
		A1	All correct
	Solve for T or F	dM1	Dependent on using equation(s) that scored M mark(s)
	$T = 4.3969..$ N $= 4.4$ N (or better)	A1	One correct
	$F = 3.263....$ $= 3.3$ N(or better)	A1	Both correct

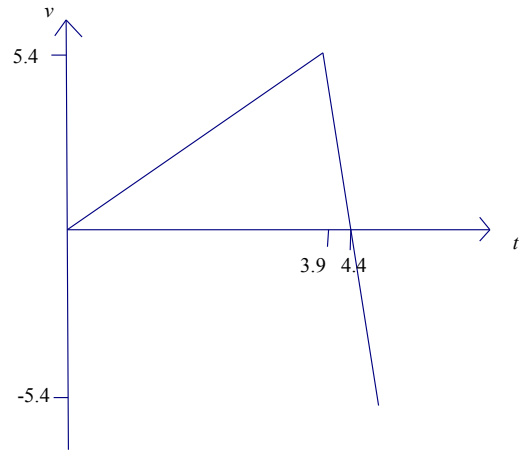
Question Number	Scheme	Marks	Notes
3.(a)	$7^2 = 2 \text{ x } 9.8h$	M1	Use of $v^2 = u^2 + 2as$ with $u = 0, v = 7$ or alternative complete method to find h.
	$h = 2.5$	A1	Condone $h = -2.5$ in the working but the final answer must be positive.
		(2)	
3.(b)	$9 \text{ x } 7 = 10.5\ u$	M1	Use CLM to find the speed of the blocks after the impact. Condone additional factor of g throughout.
	$u = 6$	A1	
	$0^2 = 6^2 - 2a \text{ x } 0.12$	M1	Use of $v^2 = u^2 + 2as$ with $u = 6, v = 0$ Allow for their u and $v = 0$ Allow for $u = 7, v = 0$ Accept alternative *suvat* method to form an equation in a. Condone use of 12 for 0.12
		A1	Correctly substituted equation in a with $u = 6, s = 0.12$ $(\text{implied by } a = 150)$
	$(\downarrow)\ 10.5g - R = 10.5 \text{ x } (-a)$	M1	Use of $F = ma$ with their $a \neq \pm g$. Must have all 3 terms and 10.5 Condone sign error(s)
	$(\downarrow)\ 10.5g - R = 10.5 \text{ x } (-150)$	A1	Unsimplified equation with a substituted and at most one error (their a with the wrong sign is 1 error)
		A1	Correct unsimplified equation with a substituted
	$R = 1680$ or 1700	A1	
		(8)	
	Alternative for the last 6 marks:		
	$\frac{1}{2} \times 10.5 \times 6^2 + 10.5 \times 9.8 \times 0.12 = R \times 0.12$	M2	Energy equation (needs all three terms)
		A3	-1 each error A1A1A0 for 1 error, A1A0A0 for 2 errors
	$R = 1680$ or 1700	A1	
		[10]	

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]	

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
7a	Motion of P: $T - 3g = 3a$	M1
	$33.6 - 3g = 3a$	A1
	$a = 1.4$ (m s^{-2}) ***Given Answer***	A1
		(3)
7b	Motion of Q: $mg - T = ma$	M1
	$mg - 33.6 = 1.4m$	A1
	$m = 4$	A1
		(3)
7c	Use of $s = (ut +)\frac{1}{2}at^2$: $10.5 = \frac{1}{2} \times 1.4 \times t^2$	M1A1
	$T_1 = \sqrt{15} = 3.9$ **or better**	A1
		(3)
7d	Use $v^2 = (u^2 +)2as$ to find speed of particles when Q hits ground: $v = \sqrt{2 \times 1.4 \times 10.5}$ $(= \sqrt{29.4})$	M1
	Use $v = u + at$ to find additional time for P to come to rest: $0 = \sqrt{29.4} - gt$	**DM**1
	Total time : $T_2 = \sqrt{15} + \frac{\sqrt{29.4}}{9.8} = 4.4$ **or** 4.43	A1
		(3)
7e		B1 Shape **DB**1 **ft** their values for 5.4, -5.4, 3.9, 4.4 (or T_1 T_2) (2)
		[14]

Question Number	Scheme	Marks
	Notes	
7a	M1 for equation of motion for P with T not substituted, condone sign errors First A1 for a correct equation in a only (allow $\pm a$) Second A1 for **given answer** (units not needed)	
7b	M1 for equation of motion for Q with neither T nor a substituted, condone sign errors First A1 for a correct equation in m only Second A1 for $m = 4$ **N.B.** Whole system equn: $mg - 3g = a(m + 3)$ may be used	
7c	M1 for a complete method to find T_1 (M0 if g used) First A1 for a correct equation (or equations) Second A1 for $\sqrt{15}$, 3.9 or better $v = \sqrt{29.4}$ (5.4) may be found in this part but only gets credit if it appears in part (d)	
7d	First M1 for a complete method to find the speed of particles when Q hits the ground (M0 if using g) Second M1 **dependent** on first M1for a complete method to find the additional time for P to come to rest (must be using g) A1 for 4.4 or 4.43	
7e	First B1 (generous) for shape. Graph does not need to go down as far as it goes up and ignore gradients. (B0 if it goes outside the range $0 \leq t \leq T_3$ or if a continuous vertical line is included) Second **B**1, **dependent** on first B1, **ft** on their $\sqrt{29.4}$, T_1 and T_2 Allow T_1 and T_2 entered on the graph (rather than their numerical values)	

Question Number	Scheme	Marks
1(a)	For truck: $D - 600 - 400 = 2400$ x 0.5 $D = 2200$N	M1 A1 A1 (3)
(b)	For both: $D - 600 = (M + 2400)$ x 0.5 (or trailer: 600 - 200 = M x0.5) $M = 800$ $M = 800$	M1 A1 A1 (3)
(c)	Truck and trailer have same acceleration.	B1 (1) **7**
	Notes **Can mark (a) and (b) 'together' if it helps the candidate, provided no wrong working seen.**	
1(a)	M1 for NL2 for truck only (or for a complete method if they find *M* first), with correct no. of terms, in *D* only. (M0 if 600 or 400 is replaced by 200) First A1 for a correct equation . Second A1 for 2200 (N). .	
1(b)	M1 for NL2 for whole system or trailer only, with correct no. of terms. First A1 for a correct equation. (Allow '*D*' or their *D*) Second A1 for 800. **N.B.** In both parts of this question use the mass which is being used in their equation to guide you as to which part of the system is being considered.	
1(c)	B0 if extras included. E.g if 'tension is same' is included. B1 Must include 'truck and trailer' or 'both particles' or 'accln is same throughout the system' B0 for 'accln is same'	