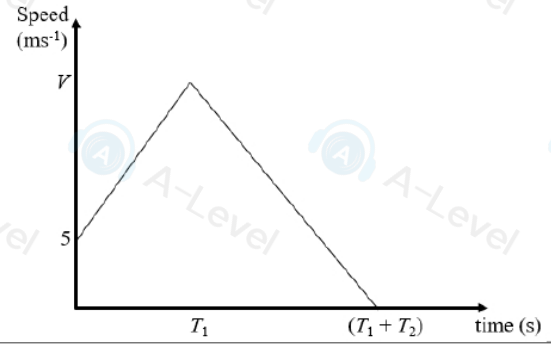
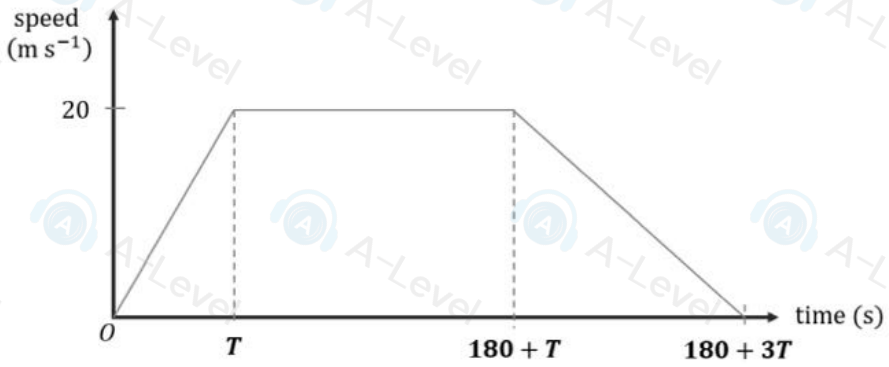
Question Number	Scheme	Marks
8(a)	R$(\perp$ plane$)$: $R = 0.5g\cos 30^\circ + 5\sin 30°$	M1A1A1
	$R = 6.743... = 6.7$ or 6.74 N	A1 (4)
(b)	R$(\|\|$ plane$)$: $F = 5\cos 30° - 0.5g\sin 30°$ $(= 1.880...)$	M1A1A1
	$\mu = \dfrac{F}{R} = \dfrac{1.880}{6.743}$, $= 0.27880... = 0.28$ or 0.279	M1A1 (5)
(c)	NL2: $0.5g\sin 30° - F' = 0.5a$	M1A1
	R$(\perp$ plane$)$: $R' = 0.5g\cos 30^\circ$ $(= 4.2435...)$	M1A1
	Use of $F' = \mu R' = 0.2787... \times R'$ $(= 1.18345...)$ and solve for a	**DM**1
	$a = 2.53...$ m s^{-2}	A1
	$v^2 = 2as = 2 \times 2.533 \times 3$	M1
	$v = 3.9$ or 3.90 ms^{-1}	A1 (8) **[17]**
	Notes for qu 8	
8a	M1 for resolution perp to the plane, with usual rules	
	First and second A1 for a correct equation, -1 each error	
	Third A1 for 6.7 or 6.74 (N) must be positive	
8b	First M1 for resolution parallel to the plane, with usual rules	
	First and second A1 for a correct equation, -1 each error	
	Second M1 for *use* of $\mu = \dfrac{F}{R}$	
	Third A1 for 0.28 or 0.279	
8c	**SC: If 5N force is not removed, can score max: M1A0M1A0DM1A0M0A0** with usual rules applying for M marks assuming that 5N force still acting.	
	First M1 for equation of motion parallel to plane, with usual rules	
	First A1 for a correct equation (F' does not need to be substituted and allow if they use the value of F from part (b))	
	Second M1 for resolution perp to the plane, with usual rules	
	Second A1 for a correct equation	
	Third DM1, dependent on both previous M marks, for use of $F' = \mu R'$ and	

QUESTION NUMBER	SCHEME	MARKS
2(a)		B1 shape B1 time labels B1 speed labels
		(3)
2(b)(i)	$132 = \frac{(5+V)T_1}{2}$ **OR** $132 = 5T_1 + \frac{1}{2}T_1(V-5)$	M1
	$T_1 = \frac{264}{5+V}$ oe	A1
2(b)(ii)	$136 = \frac{VT_2}{2}$	M1
	$T_2 = \frac{272}{V}$ oe	A1
		(4)
2(c)	$\frac{264}{5+V} + \frac{272}{V} = 28$	M1
	$(28V^2 - 396V - 1360 = 0$ **OR** $7V^2 - 96V - 340 = 0)$	
	$V = 17$ only	A1
		(2)
2(d)	Deceleration $= \frac{their\ V}{their\ T_2}$ **OR** $\frac{(their\ V)^2}{272}$	M1
	$\frac{17}{16}$ oe $= 1.0625$ Accept 1.1 or better (m s^{-2})	A1
		(2)
		(11)
	Notes for Question 2	
	N.B. If you think a candidate has misread the question and consistently uses T_2 as the time from A to C, send to Review.	
	Allow use of t_1 and t_2 instead of T_1 and T_2 throughout.	
2(a)		
B1	Correct graph shape. Must start on the vertical axis and not at the origin and finish on the t-axis. B0 if they have any extra **continuous** lines.	
B1	Correct time labels. Accept delineators (B0 if delineators missing)	

Question Number	Scheme	Marks
	First A1 for TWO correct equations (allow 4.12 or better) Second M1, independent, for solving a 'correct sine formula' for θ or ϕ **OR** independent for solving two equations, with correct structure, for α Second A1 for $\theta =$ **AWRT** 29° or $\phi =$ **AWRT** 121° **OR** $\alpha =$ **AWRT** 59°	
	Third A1 for Bearing is 149° (nearest degree)	
	N.B. First M1A1 Could use cos rule to find an angle	
	N.B. If the resolving method is used and there are no (i) or (ii) labels, only award M1A1 in both cases when an answer is reached.	
5a	$0 = 14.7^2 - 2 \times 9.8h$	M1A1
	$h = 11.025$	A1
	max ht $= 13.5$ or 14 (m)	A1 (4)
5b	$-1.5 = 14.7t - 4.9t^2$	M1A1
	$4.9t^2 - 14.7t - 1.5 = 0$	
	$t = \dfrac{14.7 \pm \sqrt{14.7^2 + 6 \times 4.9}}{9.8}$	**DM1**
	$t = 3.1$ or 3.10 (s)	A1 (4)
5c	$v^2 = 14.7^2 + 2 \times (-9.8) \times (-2.5)$	M1 A1
	$v = 16.3$ or 16 (m s^{-1})	A1 (3)
		11
	Notes	
5a	**N.B.** If they use $g = 9.81$, lose first A mark (once for whole question) but all other A marks can be scored. First M1 for a complete method to find the height (Could involve two *suvat* equations) condone sign errors. First A1 for a correct equation (or equations) Second A1 for $h = 11$ (may be unsimplified) or better (For other methods, give this A1 for any correct (may be unsimplified) intermediate answer) Third A1 for 13.5 or 14 (m)	
5b	First M1 for a complete method to find the required time (they may find the time up (1.5 s) and then add on the time down. Condone sign errors First A1 for a correct equation or equations Second DM1, dependent, for solving to find required time Second A1 for 3.1 or 3.10 (s)	

Question Number	Scheme	Marks
5c	First M1 for a complete method to find the speed / velocity(Could involve two *suvat* equations) Condone sign errors but must have correct numbers in their equation(s) First A1 for a correct equation (or equations) Second A1 for 16 or 16.3 (m s^{-1}) Must be *positive (speed)*	
6a		B1 shape B1 270, V (2)
6b	$\frac{V}{0.6}=\frac{5V}{3}$ **Given answer**	M1A1 (2)
6c	Time decelerating is $5V$	B1
	$\frac{1}{2}V\frac{5V}{3}+(270-5V-\frac{5V}{3})V+\frac{1}{2}V.5V=1500$ **OR:** $\frac{1}{2}(270+270-5V-\frac{5V}{3})V=1500$	M1 A2
	$V^2-81V+450=0$ **Given answer**	**DM1**A1 (6)
6d	$V^2-81V+450=0$ $(V-6)(V-75)=0$ or $V=\frac{81\pm\sqrt{81^2-4\times450}}{2}$	M1 solving
	$V=6$ or 75	A1 A1
	$V=6$ since $(5\times75)>270$ or $V=75$ unrealistic	**B**1 (4)
		14
	Notes	
6a	First B1 for a trapezium with line starting at the origin Second B1 for 270 and V correctly marked	
6b	M1 for $(t=)\frac{V}{0.6}$; **N.B.** M1A0 for V=0.6t then answer Must see division or intermediate step from V=0.6t e.g. Changing 0.6 into 3/5. A1 for $t=\frac{5V}{3}$ **Given answer**	

Question Number	Scheme	Marks
1(a)		B1 shape B1 20 B1 T, T+180, $3T$+180
		(3)
1(b)	T and $2T$ seen or implied, for acceleration and deceleration in that order	B1
	Any of: $4800 = \left(\frac{20\times T}{2}\right) + (180\times 20) + \left(\frac{20\times 2T}{2}\right)$ $4800 = \left(\frac{20\times T}{2}\right) + \frac{1}{2}\times 20(180 + (180 + 2T))$ $4800 = \frac{1}{2}\times 20(180 + T + 180) + \left(\frac{20\times 2T}{2}\right)$ $4800 = \frac{1}{2}\times 20(180 + 3T + 180)$ $4800 = 20\times(180 + 3T) - \left(\frac{20\times T}{2}\right) - \left(\frac{20\times 2T}{2}\right)$	M1 A1 A1
	$T = 40$ (allow t)	A1
		(5)
1(c)	$20 = a$ x their T oe	M1
	Acceleration $= \frac{1}{2}\left(\text{m s}^{-2}\right)$	A1 **ft**
		(2)
		(10)

NOTES

(a)	
B1	Correct shape with acceleration steeper than deceleration (**ignore** entries on the axes).
B1	Correct vertical label.
B1	Correct horizontal labels. Accept use of their T or appropriately labelled delineators.

(b)		
B1	Correct relationship seen or implied between the time accelerating and the time decelerating.	
M1	**A clear attempt** to use the total area under the graph (or use *suvat* formulae) and equate to 4800 (or 4.8) to form an equation in T only or their unknown only (e.g. replace T by $\frac{20}{a}$). Must involve a triangle or a trapezium (M0 if they use a *single suvat* formula for the whole motion)	
A1	An equation with at most one error. (use of 3 instead of 180 is one error) Having T and $2T$ round the wrong way, treat as one error	
A1	A fully correct equation	
A1	cao **N.B.** If attempting to use a single trapezium, and '180' appears in the bracket i.e. $\frac{1}{2}\times 20(\text{'}T\text{ terms'} + 180)$, allow at least M1A1 for one correct parallel side. **N.B.** $\frac{1}{2}\times 20(x+180) = 4800$ => $x = 300$ ONLY scores B0M1A1A0A0	
(c)		
M1	Correct equation in a, using their T	
A1 ft	Correct answer, follow through on their '40'	

QUESTION NUMBER	SCHEME	MARKS
5		
5(a)	$F = 10\cos\theta - 0.2g$ **or** $F = 0.2g - 10\cos\theta$	M1 A1
	$\lvert F \rvert = 1.9$ or 1.89 (N)	A1
		(3)
5(b)	Friction acts downwards or down.	A1
	A0 for anything else.	
		(1)
5(c)	$R = T\sin\theta$ $\left(R = \frac{12T}{13}\right)$	M1 A1
	$F = \frac{1}{4}R$	B1
	Resolve vertically For min value $T\cos\theta = 0.2g - F$ For max value $T\cos\theta = 0.2g + F$	M1 A1 A1
(i)	Min T 3.2 or 3.19 (N)	A1
(ii)	Max T 13 or 12.7 (N)	A1
	N.B. Penalise over accuracy once for the whole question and penalise the FIRST time it is seen.	
	N.B. If 2 instead of 0.2 is used throughout the WHOLE question, treat as a MR.	
		(8)
		(12)
	Notes for question 5	
(a) M1	Resolve vertically, dimensionally correct, condone sin/cos confusion and sign errors.	
A1	Correct unsimplified equation.	
A1	Correct value for Friction, must be positive **N.B**. If they use μR as their notation for F and never separate μ and R, allow M1A1A1. If, however, they do separate them, give M1A1A0.	
(b) A1	Correct direction from **a correct, but possibly unrounded, answer to part (a).**	
(c) M1	Resolve perpendicular to the rod. Must be dimensionally correct and have correct no of terms. Condone sin/cos confusion. **N.B.** M0 if they use $T = 10$	
A1	Correct unsimplified equation	
B1	$F = \frac{1}{4}R$ seen or implied	
M1	Resolve parallel to the rod for either case. Must be dimensionally correct and have correct no of terms. Condone sin/cos confusion. **N.B.** M0 if they use $T = 10$ or if they use F from part (a).	
A1	Correct minimum case equation	
A1	Correct maximum case equation	
(i)A1	cao for min T. Allow 0.325g	
(ii)A1	cao for max T Allow 1.3g	
	N.B. If only one found and no labels, allow the A mark for the equation but must state which one it is to score the A mark for the answer. **N.B.** If both correctly found and no labels, allow all the marks. **N.B.** If both correctly found but the answers are labelled wrongly, lose the final two A marks.	