4.	$h=\frac{1}{2}gt^2$	B1
	$h=7.35(t-\frac{1}{2})+\frac{1}{2}g(t-\frac{1}{2})^2$	M1 A1
	$\frac{1}{2}gt^2=7.35(t-\frac{1}{2})+\frac{1}{2}g(t-\frac{1}{2})^2$	**DM1**
	$t=1$	M1 A1
	$h=4.9$	A1 7

NOTES

Question 4

B1 for $h=\frac{1}{2}gt^2$ or $h=\frac{1}{2}g(t+\frac{1}{2})^2$

First M1 for $h=7.35(t-\frac{1}{2})+\frac{1}{2}g(t-\frac{1}{2})^2$ or $h=7.35t+\frac{1}{2}gt^2$

M0 if different t used in the two terms and M0 if two terms have opposite signs.

First A1 for appropriate t value used

Second M1, dependent, for equating their two expressions for h, but must have different t's in the two expressions

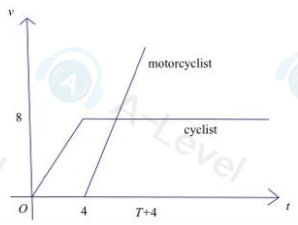
Third M1, independent, for solving for their t (must have used two expressions etc.)

Second A1 for $t = 1$ (or $t = ½$)

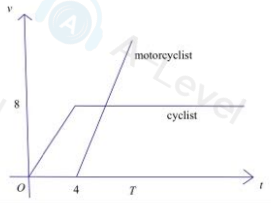
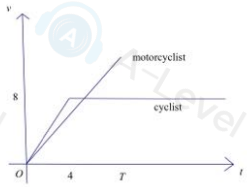
Third A1 for $h = 4.9$

N.B. See alternative below where t is eliminated:

$h=\frac{1}{2}gt^2$	B1
$h=7.35(t-\frac{1}{2})+\frac{1}{2}g(t-\frac{1}{2})^2$	M1A1
$h=7.35(\sqrt{\frac{2h}{g}}-\frac{1}{2})+\frac{1}{2}g(\sqrt{\frac{2h}{g}}-\frac{1}{2})^2$	**DM1**
$h=7.35\sqrt{\frac{2h}{g}}-3.675+4.9(\frac{2h}{g}-\sqrt{\frac{2h}{g}}+0.25)$	A1
$h=4.9$	M1 A1

Question Number	Scheme	Marks	Notes
3a		B1 shape B1 figs B1 shape B1 figs (4)	Correct shape graph for cyclist 4 marked Motorcyclist graph in relatively correct position Must start at $t = 4$ and must continue beyond point of intersection of the graphs $T+4$ marked Treat two separate graphs as two attempts and award the marks for the better attempt
3b	$\frac{1}{2}T.4T = \left(\frac{T+T+4}{2}\right)8$	M1	Equate distances to form equation in T
		A1	One distance correct
		A1	Both distances correct
	$T^2 - 4T - 8 = 0$	A1	Simplify to 3 term quadratic
	$T = 2 \pm \sqrt{12}$	M1	Solve a 3 term quadratic for T
	$T = 5.5$	A1	Q asks for answer to 1 dp. Must reject negative solution if seen.
		(6)	
		[10]	
			See over

1

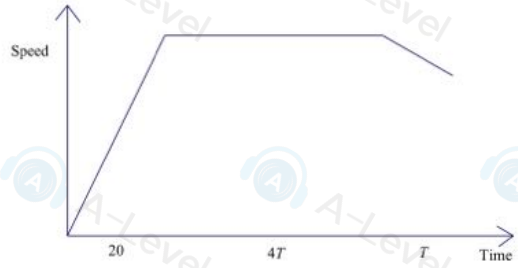
Question Number	Scheme	Marks	Notes
SC1			B1B1 B1B0 $16 + 8(T-4) = \frac{1}{2} \times 4(T-4)^2$ M1A1A1 $T^2 - 12T + 24 = 0$ (or equivalent) A1 $T = 6 + 2\sqrt{3} = 9.5$ M1A0 (marking the T as a misread)
SC2			B1B1 B0B0 $16 + 8(T-4) = \frac{1}{2} \times 4T^2$ M1A1A1 $2T^2 - 8T + 16 = 0$ A0M0A0 (completely changed the question but some evidence of correct thinking)

1

	Allow column vectors throughout apart from in the answers to (b) and (c).		
7a	$\lvert\mathbf{a}\rvert = \sqrt{1^2+(-4)^2}$ or $\sqrt{1^2+4^2}$	M1	Complete method to find the magnitude using the correct vector or the correct vector with just a sign error. They may use $\mathbf{a} = \frac{\mathbf{v}_p - \mathbf{v}_q}{p-q}$ for two specific times p and q, allow subtraction either way round and slips in arithmetic
	$= \sqrt{17}$. Accept $4.1\left(\text{km h}^{-2}\right)$ or better	A1	$= 4.123105\ldots\ \left(\text{km h}^{-2}\right)$ Must come from a correct **a** (if seen.)
		(2)	
7b	$\frac{(\mathbf{i}-5\mathbf{j})-(4\mathbf{i}+\mathbf{j})}{3}$	M1	Condone subtraction the wrong way round
	$= -\mathbf{i}-2\mathbf{j}\quad\left(\text{km h}^{-2}\right)$	A1	Must be in **i** and **j**
		(2)	
7c	$4\mathbf{i}+\mathbf{j}-2(-\mathbf{i}-2\mathbf{j})$ **OR** $\mathbf{i}-5\mathbf{j}-5(-\mathbf{i}-2\mathbf{j})$	M1	Or equivalent for their **a**
	$= 6\mathbf{i}+5\mathbf{j}\quad\left(\text{km h}^{-1}\right)$	A1	Must be in **i** and **j**. Isw if they find the speed.
			N.B. In (b) and (c), penalise the use of column vectors in the answers ONCE.
		(2)	
7d	Express both velocities in component form, with **i**'s and **j**'s collected, using their answers to (b) and (c) for $\mathbf{v}_B$.	M1	$\mathbf{v}_A = (2+t)\mathbf{i}+(3-4t)\mathbf{j}$ $\mathbf{v}_B = (6-t)\mathbf{i}+(5-2t)\mathbf{j}$ Seen or implied. Allow slips. **N.B.** This mark can be earned in part (e).
	Correct use of Pythagoras to form an equation in T_1 (or t) only, with or without square roots.	M1	For given $\mathbf{v}_A$ and their $\mathbf{v}_B$
	$(6-T_1)^2+(5-2T_1)^2 = (2+T_1)^2+(3-4T_1)^2$ $\left(T_1^2+T_1-4=0\right)$	A1**ft**	Correct unsimplified equation in T_1 (or t), without square roots. Follow their answers from (b) and (c)
	$\frac{-1+\sqrt{17}}{2}$ only	A1	cao accept exact equivalent
		(4)	
7e	Use ratios to form an equation in T_2 (or t) only	M1	Allow reciprocal on one side **N.B**. Allow if **i**'s and **j**'s are left in

	$\Rightarrow \frac{5-2T_2}{6-T_2} = \frac{3-4T_2}{2+T_2}$ (allow t at this stage)	A1**ft**	Or equivalent ft on their $\mathbf{v_B}$
	$\Rightarrow 3T_2^2 - 14T_2 + 4 = 0$ *	A1*	Obtain **correct answer** from full and correct working with no errors. Must see at least $10 + 5T_2 - 4T_2 - 2T_2^2 = 18 - 24T_2 - 3T_2 + 4T_2^2$ **OR** $10 + T_2 - 2T_2^2 = 18 - 27T_2 + 4T_2^2$ (Allow t at this stage but must be T_2 in final answer) $\Rightarrow 3T_2^2 - 14T_2 + 4 = 0$ *
		(3)	
		(13)	

Question Number	Scheme	Marks
6.	$s_A = 35t + \frac{1}{2}0.4t^2 ; s_B = 44t + \frac{1}{2}0.5t^2$ $44t + \frac{1}{2}0.5t^2 = 200 + 35t + \frac{1}{2}0.4t^2$ $\frac{1}{20}t^2 + 9t - 200 = 0$ $(t-20)(t+200) = 0$ $t = 20$ $v = 44 + \frac{1}{2}.20 = 54 \text{ ms}^{-1}$	M1 A1 A1 M1 A1 M1 A1 **DM1** A1 **9**
	Notes	
	First M1 for use of $s = ut + \frac{1}{2}at^2$ for either *A* or *B* First A1 for a correct equation for *A* Second A1 for a correct equation for *B* Second M1 for producing a quadratic in *t* only from their s_A = their $s_B \pm 200$ Third A1 for a correct '3 term = 0' equation Third M1 (can be implied by one correct answer) for attempt to solve their quadratic (M0 if linear). Must include 200, must be 3 terms and must have come from using both distance expressions. Fourth A1 for $t = 20$ Fourth M1 dependent on third M1 for correctly using their *t* value to find *v* Fifth A1 for 54 **N.B. SC for trial and error to find *t* ; can score max M1A1A1M1A0M0A0M1A1 6/9**	

Question Number	Scheme	Marks
5a		
	Basic shape 20, $4T$ and T placed correctly	B1 **DB**1
		(2)
5b	Use of $v=u+at$: constant speed $=0.6\times 20=12$ (ms^{-1})	M1A1
	(Speed at end $=12-0.3T$)	
	Using v-t graph: Distance: $705=\frac{12}{2}\left(4T+\left(20+4T\right)\right)+\frac{T}{2}\left(12+\left(12-0.3T\right)\right)$	M1A2
	$=48T+120+12T-0.15T^2=60T+120-0.15T^2$	
	Form 3 term quadratic and solve for T: $\Rightarrow 3T^2-1200T+11700=0 \quad \left(T^2-400T+3900=0\right)$	M1
	$\Rightarrow \left(T-10\right)\left(T-390\right)=0 \qquad T=10$ only	A1
		(7)
	Alternative:	
	Use of $v=u+at$: constant speed $=0.6\times 20=12$ (ms^{-1}) M1A1	
	Using $s=ut+\frac{1}{2}at^2$: $705=\left(0.3\times 400\right)+\left(4T\times 12\right)+\left(12T-0.15T^2\right)$ M1A2	
	$\Rightarrow 0.15T^2-60T+585=0 \quad \left(T^2-400T+3900=0\right)$	
	$\Rightarrow \left(T-10\right)\left(T-390\right)=0 \qquad T=10$ only M1A1	
	(7)	
5c	Extra time: $(2\times 20)-$*their T* **OR** $\frac{12-0.3\times \textit{their}T}{0.3}$	B1
	Total time: $20+5T+40-T$ (*their T*)	M1
	$=100$ (s)	A1
		(3)
	Alternative: Total time to decelerate to rest = 12/0.3 = 40 B1	
	Total time A to $C=20+4T+40=100$ M1A1	
		[12]

Question Number	Scheme	Marks
	Notes for question 5	
5a	First B1 for basic shape. Allow if 'extra triangle' on end included, provided *B* clearly marked	
	Second **DB**1 : may use, 20, 20 + 4*T*, 20 + 5*T*	
5b	First M1 for attempt to find constant speed ($v = u + at$ or a = gradient) 20 x 0.6	
	First A1 for 12	
	Second (generous) M1 for clear attempt to use 705 = *total* area under the graph to give an equation in T only but must see ½ used somewhere **N.B.** M0 if just a trapezium oe is used	
	Second A1 and Third A1: for any correct equation, -1 e.e.o.o.	
	Third M1 for forming and attempt to solve a 3 term quadratic (need *evidence* of solving e.g. formula or factorising, if T values are incorrect) otherwise this M mark can be implied if they state that $T = 10$ with no working. ($T = 390$ NOT needed)	
	Fourth A1 for $T = 10$.	
	N.B. For total area, could see: Trapezium + Rectangle + Triangle $705 = \frac{12}{2}\left(4T + \left(20 + 4T\right)\right) + T(12 - 0.3T) + \frac{1}{2}T \times 0.3T$ Triangle + Rectangle + Trapezium $705 = \frac{1}{2}.20.12 + (4T \times 12) + \frac{1}{2}T\left(12 + 12 - 0.3T\right)$ Triangle + Rectangle + Rectangle + Triangle $705 = \frac{1}{2}.20.12 + (4T \times 12) + T(12 - 0.3T) + \frac{1}{2}T \times 0.3T$ Triangle + Rectangle + Trapezium (at top) $705 = \frac{1}{2}.20.12 + 5T(12 - 0.3T) + \frac{1}{2}0.3T(5T + 4T)$ Rectangle – triangle– triangle $705 = 12(20 + 5T) - \frac{1}{2}.20.12 - \frac{1}{2}T \times 0.3T$	
5c	B1 for either additional time is $\frac{12}{0.3} - T$ **or** time to decelerate is $\frac{12}{0.3}$	
	M1 for a correct method to find the total time, using *their T* $= 20 + 4T + T + \frac{12}{0.3} - T$ **or** $20 + 4T + \frac{12}{0.3}$	
	A1 for 100 cao	