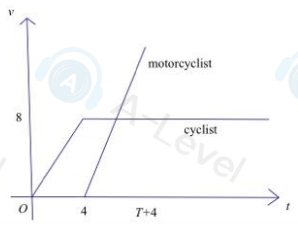
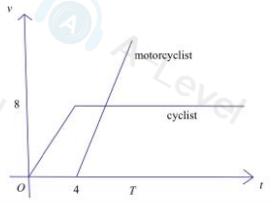
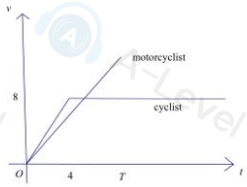
Question Number	Scheme	Marks
6.	$s_A = 35t + \frac{1}{2}0.4t^2 ; s_B = 44t + \frac{1}{2}0.5t^2$ $44t + \frac{1}{2}0.5t^2 = 200 + 35t + \frac{1}{2}0.4t^2$ $\frac{1}{20}t^2 + 9t - 200 = 0$ $(t-20)(t+200) = 0$ $t = 20$ $v = 44 + \frac{1}{2}.20 = 54 \text{ ms}^{-1}$	M1 A1 A1 M1 A1 M1 A1 **DM1** A1 **9**
	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	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

QUESTION NUMBER	SCHEME	MARKS
3(a)	A to B : $s=\left(\frac{u+v}{2}\right)t$: $400=\left(\frac{u+28}{2}\right)20$ Other possible equations: $28=u+20a$ $400=20u+\frac{1}{2}a\times 20^2$ $28^2=u^2+2\times 400a$ $400=(28\times 20)-\frac{1}{2}a\times 20^2$	M1
	$u=12$ *	A1* cso
		(2)
3(b)	A to B : Any of the above equations with $u=12$ e.g. $v=u+at$ $28=12+20a$ (leads to $a=0.8$)	M1 A1
	A to midpoint: $200=12t+\frac{1}{2}0.8t^2$ **OR:** find v and use it to find t e.g. $v^2=12^2+(2\times 0.8\times 200)$ => $v=\sqrt{464}$ and then one of : $\sqrt{464}=12+0.8t$ $200=\left(\frac{12+\sqrt{464}}{2}\right)t$ $200=\sqrt{464}t-\frac{1}{2}\times 0.8t^2$	M1 A1
	$t=12\,(s)$ or better $(11.9258..)$, $5\sqrt{29}-15$	A1
		(5)
3(c)	$D-260=1200(0.8)$	M1A1ft
	D=1220 (N)	A1
		(3)
		(10)
	Notes for question 3	
(a) **M1** **A1***	Complete method to find the value of u. (they may use two equations, eliminate a and solve for u) Correctly reaches the given answer. **N.B**. If they use 2 equations, we need to see a eliminated and u found correctly for this A mark. **N.B.** No marks if they use u =12 in (b) to find a and then use it in (a) to show that u = 12.	

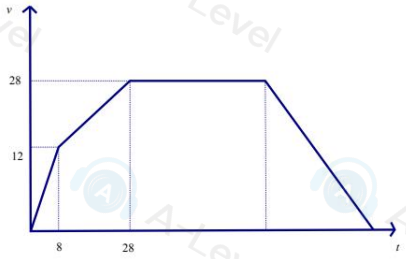
7 (a)	$108 \times 1000/3600 = 30 \text{ m s}^{-1}$	M1 A1 (2)
(b)		B1 shape **DB1 ft** figs (2)
(c)	$12000 = \frac{1}{2} \times 30(480 + 480 - 4T)$ $T = 40$ $a = 30/40 = 0.75 \text{ m s}^{-2}$	M1 A2 A1 M1 A1 (6) **10**

NOTES

Question 7(a)
M1 for 108 x 1000/3600 oe
A1 for 30

Question 7(b)
First B1 for trapezium (B0 for triangle), from the origin, finishing on the *t*-axis.
Second dependent B1 **ft** on their '30' and 480 or 108 and (8/60 oe).

Question 7(c)
First M1 for clear attempt at equating *total* area under a trapezium to distance travelled oe (equation must include at least one '1/2') to give equation in ONE unknown.
A2 for a correct equation , -1 each error. **N.B.** Repeated use of an incorrect v from part (a) is ONE error.
Third A1 for $T = 40$ (or 120)
N.B. (First M1 **only** for ½(480 + *x*).30 = 12000
First A1 for 480 – *x* = 160; Second A1 if they divide 160 in ratio 1:3)
(First M0 if they use *s* = the full distance in any single *suvat* equation)
Second M1 (independent) for a complete method to find *a*.
Fourth A1 for 0.75

Question Number	Scheme	Marks	Notes
6(a)	$v_1 = 8\times1.5\ (=12)$	M1	Use of $v = u + at$ or equivalent for $t = 8$
	$v_2 = 12 + 0.8\times20$	M1	Follow their 12
	$v_2 = 28$ m s^{-1}	A1 (3)	
(b)		B1 B1ft	shape nos: 8,28; 12,28 indicated. Follow their 12, 28
		(2)	
(c)	first 8 s: dist = $\frac{1}{2}\times8\times12\ \ (=48)$	M1 A1ft	Correct method for distance for the triangle (0-8) or the trapezium (8-28) Follow their 12
	next 20 s: dist = $\frac{1}{2}\times(12+28)\times20\ \ (=400)$	A1ft	Follow their 12, 28
	Total dist = 448 m	A1 (4)	Correct answer only (cao)
(d)	$0 = 28^2 - 2\times2.8s$	M1	Find area of right hand triangle or an expression in T for the trapezium (rectangle + triangle).
	$s = \frac{28^2}{2\times2.8}\ (=140)$	A1ft	Follow their 28
	$448 + 140 + 28T = 2000$	DM1	Form an equation in T for their 16, 448 and 140
	$T = \frac{2000-448-140}{28} = 50.4$	A1 (4)	Or better (50.42857...) Accept 50.
		[13]	

Question Number	Scheme	Marks	Notes
1.	$(2\mathbf{i}+3a\mathbf{j})+(2a\mathbf{i}+b\mathbf{j})+(b\mathbf{i}+4\mathbf{j})=\mathbf{0}$	M1	Use of resultant force = 0 (Seen or implied)
	$2a+b+2=0;\ 3a+b+4=0$	M1	In an equation involving all three forces once and once only, compare **i** or **j** components to form an equation in a and b. Allow with **i** or **j**. $\lambda\mathbf{i}=\mu\mathbf{j}$ is M0
		A1	Two correct scalar equations. No i/j
	$a=-2; b=2$	DM1	Solve simultaneous equations to find a or b. Dependent on the previous M1
		A1	a correct
		A1	b correct
		6	
2(a)	$2mu-km3u=-2m\frac{1}{2}u+kmv$	M1	Conservation of momentum. Must have all four terms but condone sign errors and consistent omission of m or g included in all terms
	$(3u=kv+3ku)$	A2,1,0	-1 for each error. All correct A1A1, one error A1A0, two or more errors A0A0
	$v=(1-k)\frac{3u}{k}$ or $k=\frac{3u}{v+3u}$	A1	Correct expression for v or for kv or for k
	$v>0 \Rightarrow$	M1	Correct inequality for their v
	$\Rightarrow k<1$ *	A1	Reach **given answer** correctly
		(6)	
(b)	$I=2m(\frac{1}{2}u--u)$	M1	Impulse = change in momentum for A or for B. Condone sign errors.
		A1	Correct unsimplified expression in terms of m and u. Allow +/-
	$=3mu$	A1	Correct answer only.
		(3)	
		9	

Question Number	Scheme	Marks
8(a)	$\mathbf{v}_B = (40\cos 60)\mathbf{i} + (-40\sin 60)\mathbf{j}$	M1A1
	$= 20\mathbf{i} - 20\sqrt{3}\mathbf{j}$	A1 (3)
8(b)	$\mathbf{r} = 60\mathbf{i} + t(-20\mathbf{i})$	M1 A1
	$\mathbf{s} = t(20\mathbf{i} - 20\sqrt{3}\mathbf{j})$	B1**ft** (3)
8(c)	$\overrightarrow{AB} = \mathbf{s} - \mathbf{r} = t(20\mathbf{i} - 20\sqrt{3}\mathbf{j}) - [60\mathbf{i} + t(-20\mathbf{i})]$	M1
	$\sqrt{(40t-60)^2 + (-20t\sqrt{3})^2} = 60$ **OR** $(40t-60)^2 + (-20t\sqrt{3})^2 = 60^2$	M1 A2**ft**
	$2800t^2 - 4800t = 0$	M1 A1
	$t = \frac{12}{7}$	A1
	13 43 OR 1 43 pm (nearest minute)	A1 **cso** (8)
		(14)
	Notes for qu 8	
	For (a) and (b) allow working in column vector form	
8(a)	M1 for 40 resolved in both components but allow sin/cos confusion and sign errors	
	First A1 for two correct unsimplified components	
	Second A1 for a correct vector, allow 2SF or better for the **j** component **N.B.** Need to see a complete velocity vector not just $p =$, $q =$	
8(b)	M1 for $\mathbf{r} = 60\mathbf{i} \pm 20t\mathbf{i}$	
	A1 for $\mathbf{r} = 60\mathbf{i} + t(-20\mathbf{i})$	
	B1 ft on their answer for (a)	
8(c)	M1 for finding either $\mathbf{s} - \mathbf{r}$ or $\mathbf{r} - \mathbf{s}$. Allow missing brackets if they recover.	
	Second M1 for obtaining an equation in t only by using the magnitude of their $\mathbf{s} - \mathbf{r}$ or $\mathbf{r} - \mathbf{s}$ and equating it to 60 (allow the square on both sides). Must be a clear attempt to use Pythagoras	
	First and Second A1 **ft** for a correct equation, **ft** on their $\mathbf{s} - \mathbf{r}$ or $\mathbf{r} - \mathbf{s}$	
	Third M1 for a simplified quadratic equation = 0 with at least a t^2 and a t term	
	Third A1 for a correct equation from correct working (**N.B.** Coefficient of t^2 must be in range $[2797, 2825]$)	
	Fourth A1 for a correct value of t (allow AWRT 1.7) from correct working	
	Fifth A1 for a correct time to the nearest minute **cso**	
	SC: If using $+20\sqrt{3}$ oe for the coefficient of j in part (a) , can score for (c) **max M1M1A2 M1A1A1A0**	

QUESTION NUMBER	SCHEME	MARKS
6(a)	$\frac{(20\mathbf{i}+34\mathbf{j})-(15\mathbf{i}+36\mathbf{j})}{0.5}$ oe	M1
	$(10\mathbf{i}-4\mathbf{j})$ *	A1*
		(2)
6(b)	$(15\mathbf{i}+36\mathbf{j})+t(10\mathbf{i}-4\mathbf{j})$	M1 A1
		(2)
6(c)(i)	Verify using $t=1.5$ in **p or q** $\mathbf{p}=(15\mathbf{i}+36\mathbf{j})+1.5(10\mathbf{i}-4\mathbf{j})=30\mathbf{i}+30\mathbf{j}$ $\mathbf{q}=(42-8\times1.5)\mathbf{i}+(9+14\times1.5)\mathbf{j}=30\mathbf{i}+30\mathbf{j}$	M1 A1 A1
(ii)	$30\mathbf{i}+30\mathbf{j}$	A1 (B1)
	N.B. The A mark for (ii) is now to be treated as a B mark.	
		(4)
ALT1 (i)	Find t by equating **i or j** components of **p** and **q** Equate **i**'s $\quad 15+10t=42-8t \rightarrow t=1.5$ **j**'s $\quad 36-4t=9+14t \rightarrow t=1.5$	M1 A1 A1
(ii)	$30\mathbf{i}+30\mathbf{j}$	A1 (B1)
ALT2 (i)	Uses ratio: $\frac{15+10t}{36-4t}=\frac{42-8t}{9+14t}$ $\rightarrow t=1.5$ or -8.5 verifies that components are both 30 at $t=1.5$	M1 A1 A1
(ii)	$30\mathbf{i}+30\mathbf{j}$	A1 (B1)
		(4)
6(d)	Position of P at 14:30 is $40\mathbf{i}+26\mathbf{j}$	B1
	Position of Q when $t=0.5$ $\mathbf{q}=(42-8\times0.5)\mathbf{i}+(9+14\times0.5)\mathbf{j}$ $(=(38\mathbf{i}+16\mathbf{j}))$	M1
	$15\mathbf{j}$ seen or implied	B1
	New position of Q at time 14:30 $\mathbf{q}=(38\mathbf{i}+16\mathbf{j})+2(15\mathbf{j})$ **N.B**. M0 if 2.5 is used.	M1
	$\mathbf{q}=38\mathbf{i}+46\mathbf{j}$	A1
	$\lvert PQ\rvert=\sqrt{(40-38)^2+(26-46)^2}$	**d**M1
	$=\sqrt{404}$ or $2\sqrt{101}$ (km)	A1
		(7)
		(15)