Question			Answer	Marks	Guidance
1	(a)		At C: $s = ut + \frac{1}{2}at^2$ $500 = 5 \times 20 + 0.5 \times a \times 20^2$ $a = 2$ (ms^{-2})	 M1 A1 **[2]**	 M1 for a method which if correctly applied would give a. Cao **Special case** If 800 is used for s instead of 500, giving $a = 3.5$, treat this as a misread. Annotate it as SC SC and give M1 A0 in this part
1	(b)		At B: $v^2 - u^2 = 2as$ $v^2 - 5^2 = 2 \times 2 \times 300$ $v = 35$ Speed is 35 m s^{-1} At B: $v = u + at$ $35 = 5 + 2 \times t$ $t = 15$ Time is 15 s	M1 A1 A1 **[3]**	M1 for a method which if correctly applied would give either v or t Apply FT from incorrect a from part (i) for the M mark only Cao. No FT from part (i) except for SC1 for 46.2 following $a = 3.5$ after the use of $s = 800$. Cao. No FT from part (i) except for SC1 for 11.7 following $a = 3.5$ after the use of $s = 800$.

Follow through between parts of Question 1 should be allowed for the value of *a* found in part (i) into parts (ii) and (iii).						
2	**(a)**		$v^2 - u^2 = 2as$ $31^2 - 12^2 = 2 \times 215 \times a$ $a = 1.9$ so $1.9\ \text{m s}^{-2}$	**M1** **A1** **[2]**	Selection and use of appropriate equation(s)	
	(b)		$v = u + at$ $31 = 12 + 1.9t$ $t = 10$ so 10 s	**M1** **A1** **[2]**	Selection and use of appropriate equation(s) FT from their value of *a* from part (i).	

	(c)		$s = ut + \frac{1}{2}at^2$ $\frac{215}{2} = 12t + \frac{1}{2} \times 1.9 \times t^2$ $\left(t = \frac{-12 \pm \sqrt{12^2 + 4 \times 0.95 \times 107.5}}{1.9} \right)$ $t = 6.055$ (or -18.69)	**M1** **M1** **A1** **[3]**	Selection and use of $s = ut + \frac{1}{2}at^2$, oe. Correct elements but condone minor arithmetic errors. Use of quadratic formula (may be implied by answer), oe. FT their *a* only.	
			Alternative: Finding a 2-stage method $v^2 - u^2 = 2as$ and $s = \frac{(u+v)}{2}t$ $v = \pm\sqrt{12^2 + 2 \times 1.9 \times 107.5} = (\pm)23.505...$ $s = \frac{(u+v)}{2}t \Rightarrow t = \frac{2 \times 107.5}{(12 + 23.505...)}$ $\left(\text{or } t = \frac{2 \times 107.5}{(12 - 23.505...)} \right)$ $t = 6.055$ (or 18.69)	 **M1** **M1** **A1**	 Selection and use of a complete valid 2-stage method Using the output from the first stage to find *t* FT their *a* only.	

	(d)		Because it is accelerating, it travels less fast in the first half of the distance and so takes more time.	**B1** **[1]**	The answer must refer to the two parts of the distance (or "the same distance") so no credit is given to answers like "Because it is accelerating" and "Because its speed is not uniform". Most successful answers will refer to the times to cover AM and MB but this may be implicit. So B1 should be given for an answer like "It is travelling faster between M and B than it is between A and M" Notice that the fact that the acceleration is uniform is irrelevant.	

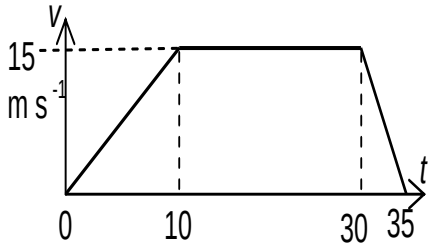
		mark	comment	sub
3(a)	The distance travelled by P is $0.5\times0.5\times t^2$ The distance travelled by Q is 10*t*	B1 B1	Accept 10*t* + 125 if used correctly below.	2
(b)	Meet when $0.25t^2 = 125+10t$ so $t^2 - 40t - 500 = 0$ Solving *t* = 50 (or -10) Distance is $0.25\times50^2 = 625$ m	M1 F1 A1 A1	All **their** wrong expressions for P and Q distances Allow ± 125 or 125 omitted Award for **their** expressions as long as one is quadratic and one linear. Must have 125 with correct sign. Accept any method that yields (smaller) + ve root of their 3 term quadratic cao Allow –ve root not mentioned cao [SC2 400 m seen]	5
		7		

Question			Answer	Marks	Guidance
4	(a)		**Either** $s = \frac{1}{2}(u+v)t$ Take O as the origin.	M1	Use of one relevant equation, including substitution
			$30 = \frac{1}{2} \times (u+9) \times 10$		
			$u = -3$	A1	
			$v = u + at$	M1	Use of a second relevant equation including substitution
			$9 = -3 + 10a$		
			$a = 1.2$	A1	
			or $v = u + at \Rightarrow u + 10a = 9$	M1	Use of one relevant equation, including substitution
			$s = ut + \frac{1}{2}at^2 \Rightarrow u + 5a = 3$	M1	Use of a second relevant equation including substitution
			Solving simultaneously: $a = 1.2$	A1	
			$u = -3$	A1	
			or $s = vt - \frac{1}{2}at^2$	M1	Use of one relevant equation, including substitution
			$\Rightarrow a = 1.2$	A1	
			$v = u + at$	M1	Use of a second relevant equation including substitution
			$\Rightarrow u = -3$	A1	
				[4]	
	(b)		**Either** $s = ut + \frac{1}{2}at^2$		
			Solving for P: $-5 = -3t + \frac{1}{2} \times 1.2t^2$	M1	Quadratic equation with $s = -5$
			$0.6t^2 - 3t + 5 = 0$		
			Discriminant $= 3^2 - 4 \times 0.6 \times 5 = -3$	M1	Considering the discriminant or equivalent
			No real roots for t ($\Rightarrow$ Particle is never at P)	E1	Cao without wrong working in the whole question.

Question	Answer	Marks	Guidance
	Or Find when $v = 0$	M1	
	$v = u + at$, $v = 0 \Rightarrow t = 2.5$		
	$s = ut + \frac{1}{2}at^2$ and $t = 2.5$	M1	Or use $v^2 = u^2 + 2as$
	$\Rightarrow s = -3.75 > -5$	E1	Cao without wrong working in the whole question. Comparison necessary
	Special cases when their $u > 0$ and their $a > 0$	SC1 SC1	"It is always going to the right" Demonstration that it is at –5 for two negative times.
		[3]	

		mark		Sub
5(a)	$14 = 2u + 0.5a \times 4$ $19 = u + 5a$ Solving gives u = 4 and a = 3	M1 A1 A1 M1 F1	U of appropriate *uvast* for either equn Any form y form Attempt at solution of 2 equns in 2 unknowns. At least one value found . Must have complete correct solution to **their** equns. .	5
(b)	$19^2 = 4^2 + 2 \times 3 \times s$ or $s = 4 \times 5 + 0.5 \times 3 \times 25$ s = 57.5 so 57.5 m	M1 A1	Use of appropriate *uvast* and **their** u, a & t = 5. cao [Accept 50 if t = 7 instead of t = 5 in (i) for 2/2]	2
				7

		mark	comment	sub
6(a)	$0.5\times8\times10=40$ m	M1	Attempt to find whole area or … If *suvat* used in 2 parts, accept any *t* value $0\le t\le 8$ for max.	2
(b)		A1	cao	
	$0.5\times5(T-8)=10$	M1	$0.5\times5\times k=10$ seen. Accept ±5 and ±10 only. If *suvat* used need whole area; if in 2 parts, accept any *t* value $8\le t\le T$ for min.	
		B1	Attempt to use $k = T - 8$.	
	$T = 12$	A1	cao. [Award 3 if $T = 12$ seen]	3
(c)	40 – 10 = 30 m	B1	FT **their** 40.	1
		6		

		Mark	Comment	
7(a)		B1 B1 B1	Acc and dec shown as straight lines Horizontal straight section All correct with *v* and times marked and at least one axis labelled. Accept (*t*, *v*) or (*v*, *t*) used.	
(b)	Distance is found from the area area is $\frac{1}{2}\times10\times15+20\times15+\frac{1}{2}\times5\times15$ (or $\frac{1}{2}\times(20+35)\times15$) = 412.5 so distance is 412.5 m	M1 A1 A1	At least one area attempted or equivalent *uvast* attempted over one appropriate interval. Award for at least two areas (or equivalent) correct Allow if a trapezium used and only 1 substitution error. FT **their** diagram. cao (Accept 410 or better accuracy)	
		6		

8 **(a)**		M1		For using $0 = u^2 + 2as$, **or** $0 = u + at$ and $s = ut + \frac{1}{2} at^2$, **or** $0 = u + at$ and $s = (u + 0)t/2$
	$0 = 5.2^2 - 2x10.4s_1$ or $s_1 = 5.2x0.5 - \frac{1}{2} 10.4x0.5^2$			
	or $s_1 = (5.2 + 0)x0.5/2$	A1		
	Greatest height is 7.5m	A1	[3]	
	(b) [$v^2 = 2x9.6x7.5$, $v = 9.6x1.25$, $v = 2x7.5/1.25$]	M1		For using $v^2 = 0 + 2as$, **or** $s = \frac{1}{2} at^2$ and $v = at$, **or** $s = \frac{1}{2} at^2$ and $0 + v = 2s/t$
	Speed is $12ms^-$	A1	[2]	

9	(a)	$25 = 30t - 5t^2 \rightarrow t^2 - 6t + 5 = 0 \rightarrow$ $(t - 1)(t - 5) = 0$ or $v^2 = 30^2 - 500$; $t_{up} = (20 - 0)/10$ $t = 1$, 5 or $t_{up} = 2$ Time = 5 – 1 = 4 s or Time = 2×2 = 4s or $1 < t < 5$	M1 A1 A1 3	For using $25 = ut - ½ gt^2$ and attempting to solve for t or for using $v^2 = u^2 - 2g(25)$ and $t_{up} = (v - 0)/g$
	(b)	$s_1 = 30t - 5t^2$ and $s_2 = 10t - 5t^2$ $30t - 10t = 25$ $t = 1.25$ $v_1 = 30 - 10 \times 1.25$ or $v_2 = 10 - 10 \times 1.25$ or $v_1^2 = 30^2 - 2 \times 10(29.6875)$ or $v_2^2 = 10^2 - 2 \times 10(4.6875)$ Velocities 17.5ms^{-1} and – 2.5ms^{-1}	M1 M1 A1 M1 A1 5	For using $s = ut - ½ gt^2$ for P_1 and P_2 For using $s_1 = s_2 + 25$ and attempting to solve for t For using $v = u - gt$ (either case) or for calculating s_1 and substituting into $v_1^2 = 30^2 - 2 \times 10s_1$ or calculating s_2 and substituting into $v_2^2 = 10^2 - 2 \times 10s_2$
			OR	
	(b)	$v_1 = 30 - 10t$, $v_2 = 10 - 10t$ $\rightarrow v_1 - v_2 = 20$ $(30^2 - v_1^2) \div 20 =$ $(10^2 - v_2^2) \div 20 + 25$ $v_1 - v_2 = 20$, $v_1^2 - v_2^2 = 300$ Velocities are 17.5 ms^{-1} and – 2.5 ms^{-1}	M1 M1 A1 M1 A1 5	For using $v = u - gt$ for P_1 and P_2 and eliminating t For using $v^2 = u^2 - 2gs$ for P_1 and P_2 and then $s_1 = s_2 + 25$ For solving simultaneous equations in v_1 and v_2
	(c)	$t_{up} = 3$ 3 – 1.25 Time is 1.75 s or $1.25 < t < 3$	B1 M1 A1 3	For using $t_{up \text{ and above}} = t_{up} - t_{equal}$
			OR	
	(c)	0 = 17.5 - 10t Time is 1.75 s or $1.25 < t < 3$	M2 A1	For using $0 = u - gt$ with u equal to the answer found for v_1 in **(ii)** SR (max 1 out of 3 marks) $0 = 17.5 + 10t$ B1 ft