Question	Scheme	Marks	AOs
8(a)	Multiply out and differentiate *wrt* to time (or use of product rule i.e. must have two terms with correct structure)	M1	1.1a
	$v = 2t^3 - 3t^2 + t$	A1	1.1b
	$2t^3 - 3t^2 + t = 0$ and solve: $t(2t-1)(t-1) = 0$	**DM**1	1.1b
	$t = 0$ or $t = \frac{1}{2}$ or $t = 1$; any two	A1	1.1b
	All three	A1	1.1b
		(5)	
(b)	Find x when $t = 0, \frac{1}{2}$, 1 and 2 : $(0, \frac{1}{32}, 0, 2)$	M1	2.1
	Distance = $\frac{1}{32} + \frac{1}{32} + 2$	M1	2.1
	$2\frac{1}{16}$ (m) oe or 2.06 or better	A1	1.1b
		(3)	
(c)	$x = \frac{1}{2}t^2(t-1)^2$	M1	3.1a
	$\frac{1}{2}$ perfect square so $x \geq 0$ i.e. never negative	A1 cso	2.4
		(2)	
			(10 marks)

Notes:

(a)

M1: Must have 3 terms and at least two powers going down by 1

A1: A correct expression

DM1: Dependent on first M, for equating to zero and attempting to solve a <u>cubic</u>

A1: Any two of the three values (Two correct answers can imply a correct method)

A1: The third value

(b)

M1: For attempting to find the values of x (at least two) at their t values found in (a) or at t =2 or equivalent e.g. they may integrate their v and sub in at least two of their t values

M1: Using a correct strategy to combine their distances (must have at least 3 distances)

Question	Scheme	Marks	AOs	Notes
3(a)	$v = 12 + 4t - t^2 = 0$ and solving	M1	3.1a	Equating v to 0 and solving the quadratic If no evidence of solving, and at least one answer wrong, M0
	$t = 6$ (or -2)	A1	1.1b	6 but allow -2 as well at this stage
	Differentiate v wrt t	M1	1.1a	For differentiation (both powers decreasing by 1)
	$(a = \frac{\mathrm{d}v}{\mathrm{d}t} =)\ 4 - 2t$	A1	1.1b	Cao; only need RHS
	When $t = 6$, $a = -8$; Magnitude is 8 (m s^{-2})	A1	1.1b	Substitute in $t = 6$ and get 8 (m s^{-2}) as the answer . Must be **positive.** (A0 if two answers given)
		(5)		
(b)	Integrate v wrt t	M1	3.1a	For integration (at least two powers increasing by 1)
	$(s =)12t + 2t^2 - \frac{1}{3}t^3 (+C)$	A1	1.1b	Correct expression (ignore C) only need RHS Must be used in part (b)
	$t = 3$ => distance = 45 (m)	A1	1.1b	Correct distance. Ignore units
		(3)		
			(8 marks)	

Question	Scheme	Marks	AOs
3(a)	$v = 3t - 2t^2 + 14$ and differentiate	M1	3.1a
	$a = \dfrac{\mathrm{d}v}{\mathrm{d}t} = 3 - 4t$ or $(7-2t) - 2(t+2)$ using product rule	A1	1.1b
	$3 - 4t = 0$ and solve for t	M1	1.1b
	$t = \dfrac{3}{4}$ oe	A1	1.1b
		(4)	
3(b)	Solve problem using $v = 0$ to find a value of t $\left(t = \dfrac{7}{2}\right)$	M1	3.1a
	$v = 3t - 2t^2 + 14$ and integrate	M1	1.1b
	$s = \dfrac{3t^2}{2} - \dfrac{2t^3}{3} + 14t$	A1	1.1b
	Substitute $t = \dfrac{7}{2}$ into their s expression (M0 if using *suvat*)	M1	1.1b
	$s = \dfrac{931}{24} = 38\dfrac{19}{24} = 38.79166..(\mathrm{m})$ Accept 39 or better	A1	1.1b
		(5)	
			(9 marks)

Notes:

(a)	M1	Multiply out and attempt to differentiate, with at least one power decreasing
	A1	Correct expression
	M1	Equate their a to 0 and solve for t
	A1	cao
(b)	M1	Uses $v = 0$ to obtain a value of t
	M1	Attempt to integrate, with at least one power increasing
	A1	Correct expression
	M1	Substitute in their value of t ,which must have come from using $v = 0$, into their s (must have integrated)
	A1	39 or better

Question	Scheme	Marks	AOs
8(a)	Substitution of both $t = 0$ and $t = 10$	M1	2.1
	$s = 0$ for both $t = 0$ and $t = 10$	A1	1.1b
	Explanation ($s > 0$ for $0 < t < 10$) since $s = \frac{1}{10}t^2(t-10)^2$	A1	2.4
		(3)	
(b)	Differentiate displacement s w.r.t. t to give velocity, v	M1	1.1a
	$v = \frac{1}{10}(4t^3 - 60t^2 + 200t)$	A1	1.1b
	Interpretation of 'rest' to give $v = \frac{1}{10}(4t^3 - 60t^2 + 200t) = \frac{2}{5}t(t-5)(t-10) = 0$	M1	1.1b
	$t = 0, 5, 10$	A1	1.1b
	Select $t = 5$ and substitute their $t = 5$ into s	M1	1.1a
	Distance $= 62.5$ m	A1ft	1.1b
		(6)	
			(9 marks)

Notes:

(a)

M1: For substituting $t = 0$ and $t = 10$ into s expression

A1: For noting that $s = 0$ at both times

A1: Since s is a perfect square, $s > 0$ for all other t- values

(b)

M1: For differentiating s w.r.t. t to give v (powers of t reducing by 1)

A1: For a correct v expression in any form

M1: For equating v to 0 and factorising

A1: For correct t values

M1: For substituting their intermediate t value into s

A1: ft following an incorrect t-value