Question			Answer	Marks	AO	Guidance	
13	(a)		$\mathbf{F} = (4t-8)\mathbf{i} + 6\left((2t-1)^2 - 9\right)\mathbf{j}$	**M1**	**3.1b**	Combines given forces and considers either component equal to zero – allow **M1** for either $4t-8=0$ **or** for $6(2t-1)^2 - 54 = 0$	
			When $t = 2$, the forces are in equilibrium	**A1** **[2]**	**1.1**	$t = 2$ only – need only consider **i** or **j** component but any contradictory working/answers scores **A0**	
13	(b)		$m = 2 \Rightarrow \mathbf{a} = (2t-4)\mathbf{i} + 3\left((2t-1)^2 - 9\right)\mathbf{j}$	**B1**	**3.3**	Using **F** = 2**a** correctly	Allow 2**a** = …
				M1*	**3.1b**	Attempt to integrate **a** (or **F**) wrt t – two of their terms integrated correctly	**M0** if only considering one force or one component for **a** or **F**
			$\mathbf{v} = \left(t^2 - 4t\right)\mathbf{i} + 3\left(\frac{1}{6}(2t-1)^3 - 9t\right)\mathbf{j}(+\mathbf{c})$	**A1**	**1.1**	Condone no +**c** for this mark $\mathbf{v} = (t^2 - 4t)\mathbf{i} + (4t^3 - 6t^2 - 24t)\mathbf{j}$ (oe)	Allow 2**v** =…
			$t = 0, \mathbf{v} = \mathbf{0} \Rightarrow \mathbf{c} = \frac{1}{2}\mathbf{j}$	**M1dep***	**3.4**	Uses correct initial conditions to find **c** (or **c** = **0** if expanded version used)	
			Moving parallel to $\mathbf{j} \Rightarrow \mathbf{i} = \mathbf{0}$ therefore $t(t-4) = 0$	**M1**	**3.1a**	Sets **i**-component of **v** equal to 0 to obtain a quadratic equation in t	Dependent on first **M** mark
			$t = 4 \Rightarrow \lvert\mathbf{v}\rvert = 64\ (\text{ms}^{-1})$	**A1** **[6]**	**2.2a**	Must have found +**c** for this mark	

Question			Answer	Marks	AO	Guidance	
13	(c)			M1*	1.1	Attempt to integrate **v** wrt t – two of their terms integrated correctly – dependent on first M mark in **(b)**	no vector constant of integration required in **(c)**
			$\mathbf{r} = \left(\frac{1}{3}t^3 - 2t^2\right)\mathbf{i} + 3\left(\frac{1}{48}(2t-1)^4 - \frac{9}{2}t^2 + \frac{1}{6}t\right)\mathbf{j}$	A1	1.1	$\mathbf{r} = (\frac{1}{3}t^3 - 2t^2)\mathbf{i} + (t^4 - 2t^3 - 12t^2)\mathbf{j}$	
			$t = 0 \Rightarrow \mathbf{r} = \frac{1}{16}\mathbf{j}$, $t = 3 \Rightarrow \mathbf{r} = -9\mathbf{i} - \frac{1295}{16}\mathbf{j}$	M1dep*	1.1	Attempt to find **r** at both $t = 0$ and $t = 3$	
			Dist. = $\sqrt{(-9)^2 + \left(-\frac{1295}{16} - \frac{1}{16}\right)^2}$	M1	1.1	Correct expression for the distance between given times (dependent on both previous **M** marks)	
			81.5 (m)	A1	2.2a	(For reference: 81.49846624…)	$\sqrt{6642} = 9\sqrt{82}$
				[5]			