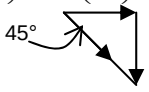
1		mark		sub
(i)	$t = 2.5 \Rightarrow \mathbf{v} = \begin{pmatrix} -5 \\ 10 \end{pmatrix} + 2.5\begin{pmatrix} 6 \\ -8 \end{pmatrix} = \begin{pmatrix} 10 \\ -10 \end{pmatrix}$	B1	Need not be in vector form	
		E1	Accept diag and/or correct derivation of just $\pm 45°$	
	speed is $\sqrt{10^2 + 10^2} = 14.14...$ so 14.1 m s^{-1} (3 s. f.)	F1	FT **their v**	3
(ii)	$\mathbf{s} = 2.5\begin{pmatrix} -5 \\ 10 \end{pmatrix} + \frac{1}{2} \times 2.5^2 \times \begin{pmatrix} 6 \\ -8 \end{pmatrix}$	M1	Consideration of **s** (const accn or integration)	
		A1	Correct sub into *uvast* with **u** and **a.** (If integration used it must be correct but allow no arb constant)	
	$= \begin{pmatrix} 6.25 \\ 0 \end{pmatrix}$	A1		
	so 090°	A1	cao. CWO.	4
				7

2		mark		**Sub**
(i)	$9\mathbf{i}$ m s^{-2}; $(9\mathbf{i} - 12\mathbf{j})$ m s^{-2}	B1	Award for either. Accept no units. (isw e.g. finding magnitudes)	1
(ii)	2L $\mathbf{F} = 4(9\mathbf{i} - 12\mathbf{j}) = (36\mathbf{i} - 48\mathbf{j})$ N	B1	Accept factored form. isw. FT **a**(3). Accept 60 N or **their** $4\lvert\mathbf{a}\rvert$	1
(iii)	$\mathbf{v} = \int \begin{pmatrix} 9 \\ -4t \end{pmatrix} dt = \begin{pmatrix} 9t + C \\ -2t^2 + D \end{pmatrix}$ Using $\mathbf{v} = 4\mathbf{i} + 2\mathbf{j}$ when $t = 1$ $\begin{pmatrix} 4 \\ 2 \end{pmatrix} = \begin{pmatrix} 9 + C \\ -2 + D \end{pmatrix}$ $\Rightarrow C = -5, D = 4$ so $\mathbf{v} = (9t - 5)\mathbf{i} + (4 - 2t^2)\mathbf{j}$	M1 A1 M1 A1	Integration. At least one term correct. Neglect arbitrary constant(s) Sub at $t = 1$ to find arb const(s) y form	4
				6

3		mark		
(i)	Differentiate $\mathbf{v} = 2t\,\mathbf{i} + (5 - 4t)\,\mathbf{j}$ Differentiate $\mathbf{a} = 2\,\mathbf{i} - 4\,\mathbf{j}$	M1 A1 M1 F1	At least 1 cpt correct Award for RHS seen Do not award if **i** and **j** lost in **v.** At least 1 cpt correct. FT FT from **their** 2 component **v**	4
(ii)	$\mathbf{F} + 12\,\mathbf{j} = 4(2\,\mathbf{i} - 4\,\mathbf{j})$ $\mathbf{F} = 8\,\mathbf{i} - 28\,\mathbf{j}$	M1 A1 A1	N2L. Allow $\mathbf{F} = m\mathbf{a}$. No extra forces. Allow 12**j** omitted Allow wrong signs otherwise correct with **their** vector **a**. cao	3
	total	7		

4		mark	notes
(i)	$\frac{-20}{2} = -10$ -10 m s^{-2}	M1 A1 2	Use of a suitable triangle to attempt at $\Delta v / \Delta t$ for suitable interval. Accept wrong sign. cao. Allow both marks if correct answer seen.
(ii) (A) **(B)**	Signed area under graph $\frac{1}{2} \times 2 \times 20 = 20$	M1 A1	Using the relevant area or other complete method
	either using areas Signed area $2 \le t \le 5$ is $\frac{1}{2} \times ((5-2) + (4.5-2.4)) \times (-4) = -10.2$ Signed area $5 \le t \le 6$ is $\frac{1}{2} \times 1 \times 8 = 4$ Total displacement is 13.8 m	 B1 B1 B1	 Allow + 10.2. cao but FT from their 20 in part (A)
	or using *suvat* From $t = 0$ to $t = 2.4$: 19.2 From $t = 4.5$ to $t = 6$: 3.0 From $t = 2.4$ to $t = 4.5$: -8.4 Total : 13.8	 B1 B1 B1	 Both required and both must be correct.
		5	
(iii)	$a = 4t - 14$ $a(0.5) = -12$ so -12 m s^{-2}	M1 A1 A1 3	Differentiate. Do not award for division by t.
(iv)	Model A gives -4 m s^{-1} For model B we need v when $a = 0$ $v\left(\frac{7}{2}\right) = -4.5$ so model B is 0.5 m s^{-1} less	B1 M1 A1 F1 4	May be implied by other working Using (iii) or an argument based on symmetry or sketch graph that $a = 0$ when $t = 3.5$ Accept values without more or less

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