1. A particle P of mass 3 kg moves under the action of a force $\begin{pmatrix} 9 \\ -3 \end{pmatrix}$ N. Initially P has velocity $\begin{pmatrix} 1 \\ -2 \end{pmatrix}$ m s^{-1} and is at the point with position vector $\begin{pmatrix} 2 \\ 3 \end{pmatrix}$ m. At time t seconds later, P has velocity $\mathbf{v}$ ms^{-1}.

(a) Express $\mathbf{v}$ in terms of t. [2]

(b) Find the value of t when the speed of P reaches 5 ms^{-1}. [3]

(c) Find the position vector of P when $t = 2$. [2]

2. A particle P moves with constant acceleration $(3\mathbf{i} - 5\mathbf{j})$ms^{-2}. At time $t = 0$ seconds P is at the origin. At time $t = 4$ seconds P has velocity $(2\mathbf{i} + 4\mathbf{j})$ms^{-1}.

(a) Find the displacement vector of P at time $t = 4$ seconds. [2]

(b) Find the speed of P at time $t = 0$ seconds. [4]

END OF QUESTION paper

Mark scheme

Question			Answer/Indicative content	Marks	Guidance	
1		a	Use **F** = *m***a** to obtain $\mathbf{a} = \begin{pmatrix} 3 \\ -1 \end{pmatrix}$ $\mathbf{v} = \begin{pmatrix} 1+3t \\ -2-t \end{pmatrix}$	B1(AO3.3) B1ft(AO3.4) [2]	For use of **v** = **u** + **a***t* with their a (allow ft for this mark even if **F** used for **a**)	Or integrate and use initial conditions
		b	$(1 + 3t)^2 + (-2 - t)^2 = 25$ $t^2 + t - 2 = 0 \Rightarrow t = \ldots$ As *t* cannot be negative, *t* = 1 only	M1(AO1.1) M1(AO1.1) A1(AO2.3) [2]	Use of Pythagoras using their vector for **v** Forming and attempting solution of 3-term quadratic for *t* BC; must explicitly reject *t* = – 2	
		c	$\mathbf{s} = \begin{pmatrix} 2+t+\frac{3}{2}t^2 \\ 3-2t-\frac{1}{2}t^2 \end{pmatrix}$ When *t* = 2, $\mathbf{s} = \begin{pmatrix} 10 \\ -3 \end{pmatrix}$ m	M1(AO3.4) M1(AO1.1) [2]	For use of $\mathbf{s} = \mathbf{u}t + \frac{1}{2}\mathbf{a}t^2$ with their **a**	Or integration of their **v** and use of initial conditions
			Total	7		
2		a	$\mathbf{s} = 4(2\mathbf{i} + 4\mathbf{j}) - \frac{1}{2}(4)^2(3\mathbf{i} - 5\mathbf{j})$ **s** = (–16**i** + 56**j**)m	M1 (AO 3.3) A1 (AO 1.1) [2]	Attempt use of $\mathbf{s} = \mathbf{v}t - \frac{1}{2}\mathbf{a}t^2$	Accept equivalent full methods using *suvat* equations e.g. first using **v** = **u** + **a***t* to find **u** and then

					using $\mathbf{s} = \mathbf{u}t + \frac{1}{2}\mathbf{a}t^2$
		b	$2\mathbf{i} + 4\mathbf{j} = \mathbf{u} + 4(3\mathbf{i} - 5\mathbf{j})$ $\mathbf{u} = -10\mathbf{i} + 24\mathbf{j}$ $\lvert\mathbf{u}\rvert = \sqrt{(-10)^2 + 24^2}$ $= 26\ \text{ms}^{-1}$	M1* (AO 3.3) A1 (AO 1.1) M1dep* (AO 1.1) A1 (AO 2.2a) [4]	Attempt use of $\mathbf{v} = \mathbf{u} + \mathbf{a}t$ Attempt magnitude of their $\mathbf{u}$	
			Total	6	