Constant Acceleration

SUVAT in 2 Dimensions

6 In this question, **i** and **j** are unit vectors east and north respectively. Position vectors are with respect to an origin O. Time t is in seconds.

A skater has a constant acceleration of $-2\mathbf{j}\,\mathrm{m\,s^{-2}}$. At $t = 0$, his velocity is $4\mathbf{i}\,\mathrm{m\,s^{-1}}$ and his position vector is $3\mathbf{j}$ m.

(i) Find expressions in terms of t for the velocity and the position vector of the skater at time t. **[5]**

(ii) Calculate as a bearing the direction of motion of the skater when $t = 2.5$. **[3]**

$\underline{a} = \begin{pmatrix} 0 \\ -2 \end{pmatrix} \quad \underline{u} = \begin{pmatrix} 4 \\ 0 \end{pmatrix} \quad \underline{r}_0 = \begin{pmatrix} 0 \\ 3 \end{pmatrix}$

$\underline{v} = \underline{u} + \underline{a}t$

$\underline{v} = \begin{pmatrix} 4 \\ 0 \end{pmatrix} + \begin{pmatrix} 0 \\ -2 \end{pmatrix} t$

$\underline{v} = 4\underline{i} - 2t\underline{j}$

$$\underline{r} - \underline{r}_0 = \underline{u}t + \frac{1}{2}\underline{a}t^2$$

$$\underline{r} - \begin{pmatrix} 0 \\ 3 \end{pmatrix} = \begin{pmatrix} 4 \\ 0 \end{pmatrix} t + \frac{1}{2}\begin{pmatrix} 0 \\ -2 \end{pmatrix} t^2$$

$$\underline{r} = \begin{pmatrix} 4 \\ 0 \end{pmatrix} t + \begin{pmatrix} 0 \\ -1 \end{pmatrix} t^2 + \begin{pmatrix} 0 \\ 3 \end{pmatrix}$$

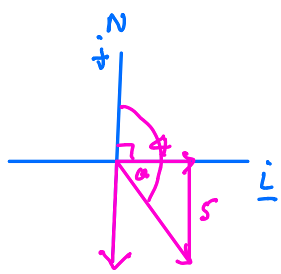
$$\underline{r} = 4t\,\underline{i} + (3 - t^2)\,\underline{j}$$

ii)

$$\underline{v} = 4\underline{i} - 2t\,\underline{j}$$

When $t = 2.5$

$$\underline{v} = 4\underline{i} - 5\underline{j}$$



$$\theta = \tan^{-1}\left(\frac{5}{4}\right) = 51.3^\circ$$

Bearing $= 90 + 51.3$

$= 141^\circ$