10.4) Motion in 2 dimensions

Worked example

Let $\boldsymbol{i}$ represent East and $\boldsymbol{j}$ North. A resultant force of $(2\boldsymbol{i} + 7\boldsymbol{j})\ N$ acts upon a particle of mass 0.25 kg.

(a) Find the acceleration of the particle in the form $(p\boldsymbol{i} + q\boldsymbol{j})$ ms^{-2}.

(b) Find the magnitude and bearing of the acceleration of the particle.

Your turn

Let $\boldsymbol{i}$ represent East and $\boldsymbol{j}$ North. A resultant force of $(3\boldsymbol{i} + 8\boldsymbol{j})\ N$ acts upon a particle of mass 0.5 kg.

(a) Find the acceleration of the particle in the form $(p\boldsymbol{i} + q\boldsymbol{j})\ ms^{-2}$.

(b) Find the magnitude and bearing of the acceleration of the particle.

a) $(6\boldsymbol{i} + 16\boldsymbol{j})\ ms^{-2}$

b) Magnitude $= 17.1\ ms^{-2}$ (3 sf)

Bearing $= 020.6°$ (1 dp)

Worked example

A boat is modelled as a particle of mass 30 kg being acted on by three forces.

$$F_1 = \begin{pmatrix} 25 \\ 40 \end{pmatrix} N,$$

$$F_2 = \begin{pmatrix} 5q \\ 10q \end{pmatrix} N,$$

$$F_3 = \begin{pmatrix} 50 \\ -37.5 \end{pmatrix} N$$

Given that the boat is accelerating at a rate of $\begin{pmatrix} -0.75 \\ 0.4 \end{pmatrix}$ ms^{-2}, find the values of p and q.

Your turn

A boat is modelled as a particle of mass 60 kg being acted on by three forces.

$$F_1 = \begin{pmatrix} 80 \\ 50 \end{pmatrix} N,$$

$$F_2 = \begin{pmatrix} 10q \\ 20q \end{pmatrix} N,$$

$$F_3 = \begin{pmatrix} -75 \\ 100 \end{pmatrix} N$$

Given that the boat is accelerating at a rate of $\begin{pmatrix} 0.8 \\ -1.5 \end{pmatrix}$ ms^{-2}, find the values of p and q.

$$p = 4.3\,, q = -12$$

Worked example

A particle of mass $5\ kg$ start from rest and is acted upon by a force R of $(4\boldsymbol{i} + k\boldsymbol{j})\ N$. R acts on a bearing of $45°$. Find the value of k

Your turn

A particle of mass $4\ kg$ start from rest and is acted upon by a force R of $(5\boldsymbol{i} + k\boldsymbol{j})\ N$. R acts on a bearing of $135°$. Find the value of k

$$k = -5$$

Worked example

Two forces, $\begin{pmatrix}5\\2\end{pmatrix}$ N and $\begin{pmatrix}p\\q\end{pmatrix}$ N act on a particle of mass m kg. The resultant of the two forces is R.

a) Given that R acts in a direction which is parallel to the vector $\begin{pmatrix}-1\\2\end{pmatrix}$, show that $2p + q + 12 = 0$

b) Given also that $p = 1$ and that P moves with an acceleration of magnitude $10\sqrt{5}\ ms^{-2}$, find the value of m

Your turn

Two forces, $\begin{pmatrix}3\\4\end{pmatrix}$ N and $\begin{pmatrix}p\\q\end{pmatrix}$ N act on a particle of mass m kg. The resultant of the two forces is R.

a) Given that R acts in a direction which is parallel to the vector $\begin{pmatrix}-2\\1\end{pmatrix}$, show that $2q + p + 11 = 0$

b) Given also that $p = 5$ and that P moves with an acceleration of magnitude $40\sqrt{5}\ ms^{-2}$, find the value of m

a) Shown

b) $m = 0.1\ kg$