

Year 1 Chapter 10: Forces and Vectors

Q1.

A particle is acted upon by two forces $\mathbf{F}_1$ and $\mathbf{F}_2$, given by

$$\mathbf{F}_1 = (\mathbf{i} - 3\mathbf{j}) \text{ N},$$

$$\mathbf{F}_2 = (p\mathbf{i} + 2p\mathbf{j}) \text{ N}, \text{ where } p \text{ is a positive constant.}$$

(a) Find the angle between $\mathbf{F}_2$ and $\mathbf{j}$.

(2)

The resultant of $\mathbf{F}_1$ and $\mathbf{F}_2$ is $\mathbf{R}$. Given that $\mathbf{R}$ is parallel to $\mathbf{i}$,

(b) find the value of p .

(4)

(Total 6 marks)

Q2.

Two forces, $(4\mathbf{i} - 5\mathbf{j}) \text{ N}$ and $(p\mathbf{i} + q\mathbf{j}) \text{ N}$, act on a particle P of mass $m \text{ kg}$.

The resultant of the two forces is $\mathbf{R}$.

Given that $\mathbf{R}$ acts in a direction which is parallel to the vector $(\mathbf{i} - 2\mathbf{j})$,

(a) find the angle between $\mathbf{R}$ and the vector $\mathbf{j}$,

(3)

(b) show that $2p + q + 3 = 0$.

(4)

Given also that $q = 1$ and that P moves with an acceleration of magnitude $8\sqrt{5} \text{ m s}^{-2}$,

(c) find the value of m .

(7)

(Total 14 marks)

Q3.

Two forces $(4\mathbf{i} - 2\mathbf{j})$ N and $(2\mathbf{i} + q\mathbf{j})$ N act on a particle P of mass 1.5 kg.

The resultant of these two forces is parallel to the vector $(2\mathbf{i} + \mathbf{j})$.

(a) Find the value of q .

(4)

At time $t = 0$, P is moving with velocity $(-2\mathbf{i} + 4\mathbf{j})\text{m s}^{-1}$.

(b) Find the speed of P at time $t = 2$ seconds.

(6)

(Total 10 marks)

Q4.

Two forces $\mathbf{F}_1$ and $\mathbf{F}_2$ act on a particle P .

The force $\mathbf{F}_1$ is given by $\mathbf{F}_1 = (-\mathbf{i} + 2\mathbf{j})$ N and

$\mathbf{F}_2$ acts in the direction of the vector $(\mathbf{i} + \mathbf{j})$.

Given that the resultant of $\mathbf{F}_1$ and $\mathbf{F}_2$ acts in the direction of the vector $(\mathbf{i} + 3\mathbf{j})$,

(a) find $\mathbf{F}_2$

(7)

The acceleration of P is $(3\mathbf{i} + 9\mathbf{j})\text{ m s}^{-2}$.

At time $t = 0$, the velocity of P is $(3\mathbf{i} - 22\mathbf{j})\text{ m s}^{-1}$

(b) Find the speed of P when $t = 3$ seconds.

(4)

(Total for question = 11 marks)