



Vectors in Mechanics

Questions

Suitable for:
Pearson Edexcel International A-Level (iAL) — Mechanics 1



Question 1

The vectors **a** and **b** are given by

$$\mathbf{a} = 3\mathbf{i} + 4\mathbf{j} \quad \mathbf{b} = \mathbf{i} - 2\mathbf{j}$$

Find

(a) $\mathbf{a} + \mathbf{b}$,

(1 marks)

(b) $\mathbf{a} - \mathbf{b}$,

(1 marks)

(c) $2\mathbf{a} + 3\mathbf{b}$.

(2 marks)

Total for question = 4 marks





Question 2

A velocity vector is given by

$$\mathbf{v} = (5\mathbf{i} - 12\mathbf{j}) \text{ m s}^{-1}$$

(a) Find the magnitude of $\mathbf{v}$.

(2 marks)

(b) Find the bearing on which the particle is moving, giving your answer to one decimal place.

(3 marks)

Total for question = 5 marks



Question 3

Two forces act on a particle:

$$\mathbf{F}_1 = (2\mathbf{i} + 5\mathbf{j}) \text{ N} \quad \mathbf{F}_2 = (4\mathbf{i} - \mathbf{j}) \text{ N}$$

(a) Find the resultant force $\mathbf{R}$.

(2 marks)

(b) Find the magnitude of $\mathbf{R}$, giving your answer in the form $k\sqrt{13}$ where k is an integer.

(2 marks)

Total for question = 4 marks





Question 4

Three forces act on a particle. The resultant of the three forces is $(5\mathbf{i} + 7\mathbf{j})$ N.

$$\mathbf{F}_1 = (3\mathbf{i} - 2\mathbf{j}) \text{ N} \quad \mathbf{F}_2 = (-\mathbf{i} + 4\mathbf{j}) \text{ N}$$

Find the force $\mathbf{F}_3$.

(3 marks)

Total for question = 3 marks





Question 5

A force acts in the direction of the vector $(8\mathbf{i} - 6\mathbf{j})$ N.

(a) Find the unit vector in the direction of $(8\mathbf{i} - 6\mathbf{j})$.

(2 marks)

(b) Hence find the force vector $\mathbf{F}$ that has magnitude 15 N and acts in this direction.

(2 marks)

Total for question = 4 marks





Question 6

Three forces act on a particle which is in equilibrium.

$$\mathbf{F}_1 = (5\mathbf{i} + 2\mathbf{j}) \text{ N} \quad \mathbf{F}_2 = (-3\mathbf{i} + \mathbf{j}) \text{ N}$$

Find the force $\mathbf{F}_3$.

(3 marks)

Total for question = 3 marks



Question 7

A particle moves with constant velocity $(2\mathbf{i} + 5\mathbf{j}) \text{ m s}^{-1}$. At time $t = 0$ its position vector is $(3\mathbf{i} - \mathbf{j}) \text{ m}$.

Find the position vector of the particle at time $t = 4 \text{ s}$.

(3 marks)

Total for question = 3 marks





Question 8

A particle moves with constant velocity. At time $t = 0$ s its position vector is $(-i + 3j)$ m. At time $t = 5$ s its position vector is $(9i - 2j)$ m.

(a) Find the velocity of the particle.

(2 marks)

(b) Find the speed of the particle.

(2 marks)

(c) Find the bearing on which the particle is moving, to the nearest degree.

(2 marks)

Total for question = 6 marks





Question 9

At time $t = 0$, particle A has position vector $(2\mathbf{i} + \mathbf{j})$ m and moves with constant velocity $(3\mathbf{i} + 2\mathbf{j})$ m s^{-1} .

At time $t = 0$, particle B has position vector $(8\mathbf{i} - 5\mathbf{j})$ m and moves with constant velocity $(\mathbf{i} + 4\mathbf{j})$ m s^{-1} .

(a) Show that the particles meet, and find the time at which they meet.

(4 marks)

(b) Find the position vector of the point where they meet.

(2 marks)

Total for question = 6 marks



Question 10

A particle of mass 3 kg is acted on by two forces:

$$\mathbf{F}_1 = (6\mathbf{i} + 9\mathbf{j}) \text{ N} \quad \mathbf{F}_2 = (-2\mathbf{i} + 3\mathbf{j}) \text{ N}$$

(a) Find the resultant force acting on the particle and its magnitude, giving the magnitude in the form $k\sqrt{10}$ where k is an integer.

(4 marks)

(b) Find the acceleration of the particle, giving your answer as a vector.

(2 marks)

Total for question = 6 marks



Question 11

At time $t = 0$, ship A has position vector $(10\mathbf{i} + 5\mathbf{j})$ km and moves with constant velocity $(3\mathbf{i} + 4\mathbf{j})$ km h^{-1} .

At time $t = 0$, ship B has position vector $(25\mathbf{i} - 3\mathbf{j})$ km and moves with constant velocity $(\mathbf{i} + 6\mathbf{j})$ km h^{-1} .

Find the distance between the two ships after 2 hours, giving your answer in the form $k\sqrt{137}$ km where k is an integer.

(5 marks)

Total for question = 5 marks



Question 12

A particle P of mass 2 kg moves under a single constant force. At time $t = 0$ s, the velocity of P is $(-3\mathbf{i} + \mathbf{j}) \text{ m s}^{-1}$. At time $t = 4$ s, the velocity of P is $(5\mathbf{i} + 9\mathbf{j}) \text{ m s}^{-1}$.

(a) Find the acceleration of P.

(2 marks)

(b) Find the magnitude of the force acting on P.

(2 marks)

At time $t = 0$ s, particle P is at the origin.

(c) Find the position vector of P at time $t = 4$ s.

(3 marks)

Total for question = 7 marks



Question 13

At time $t = 0$, particle A is at the origin and moves with velocity $(p\mathbf{i} + 6\mathbf{j}) \text{ m s}^{-1}$, where p is a constant.

At time $t = 0$, particle B is at position $(14\mathbf{i}) \text{ m}$ and moves with velocity $(-2\mathbf{i} + q\mathbf{j}) \text{ m s}^{-1}$, where q is a constant.

Given that A and B collide,

(a) find the value of q ,

(3 marks)

(b) given that the collision occurs at $t = 2 \text{ s}$, find the value of p ,

(2 marks)

(c) find the position vector of the point of collision.

(2 marks)

Total for question = 7 marks



Question 14

A particle of mass 4 kg is initially at rest at a point with position vector $(2\mathbf{i} - 3\mathbf{j})$ m. A constant force $\mathbf{F} = (8\mathbf{i} + 8\mathbf{j})$ N acts on the particle.

(a) Find the acceleration of the particle.

(2 marks)

(b) Find the speed of the particle after 5 s.

(3 marks)

(c) Find the position vector of the particle after 5 s.

(3 marks)

Total for question = 8 marks





Question 15

A particle starts from the origin and moves with constant velocity $(4\mathbf{i} + 3\mathbf{j}) \text{ m s}^{-1}$ for 10 s. It then immediately changes velocity and moves with constant velocity $(-2\mathbf{i} + 6\mathbf{j}) \text{ m s}^{-1}$ for 6 s.

(a) Find the total displacement of the particle from its starting point.

(3 marks)

(b) Find the distance of the particle from its starting point at the end of the 16 s, giving your answer to 3 significant figures.

(2 marks)

(c) Find the average velocity of the particle over the 16 s.

(2 marks)

Total for question = 7 marks

