



Name: _____ **Date:** _____ **Score:** _____ / 86

1 [In this question **i** and **j** are perpendicular horizontal unit vectors and position vectors are given relative to a fixed origin *O*.]

A particle *P* moves with constant acceleration $(2\mathbf{i} - 3\mathbf{j}) \text{ m s}^{-2}$. At time $t = 0$ its velocity is $(4\mathbf{i} + \mathbf{j}) \text{ m s}^{-1}$.

- Find the velocity of *P* when $t = 3$
- Find the speed of *P* when $t = 3$, giving your answer as an exact surd.

(4 marks)

Answer _____

2 [In this question **i** and **j** are perpendicular horizontal unit vectors and position vectors are given relative to a fixed origin *O*.]

A particle moves with constant acceleration $(0.5\mathbf{i} + \mathbf{j}) \text{ m s}^{-2}$. At time $t = 0$ it is at the point with position vector $(2\mathbf{i} + 5\mathbf{j}) \text{ m}$ and has velocity $(3\mathbf{i} - 2\mathbf{j}) \text{ m s}^{-1}$.

- Find the position vector of the particle when $t = 4$
- Find the distance of the particle from *O* when $t = 4$

(4 marks)

Answer _____

- 3 [In this question $\mathbf{i}$ and $\mathbf{j}$ are perpendicular horizontal unit vectors and position vectors are given relative to a fixed origin O .]

At time t seconds, the position vector of a particle P is $\mathbf{r}$ metres, where

$$\mathbf{r} = (t^3 - 4t)\mathbf{i} + (2t^2 + 1)\mathbf{j}$$

- Find the speed of P when $t = 2$
- Find the acceleration of P when $t = 2$

(5 marks)

Answer _____

- 4 [In this question $\mathbf{i}$ and $\mathbf{j}$ are horizontal unit vectors due east and due north respectively, and position vectors are given relative to a fixed origin O .]

A particle P moves with constant acceleration. At time $t = 0$ the velocity of P is $(-3\mathbf{i} + 6\mathbf{j}) \text{ m s}^{-1}$ and at time $t = 4$ seconds its velocity is $(5\mathbf{i} - 2\mathbf{j}) \text{ m s}^{-1}$.

- Find the acceleration of P .
- Find the value of t when P is moving parallel to $\mathbf{i}$.
- Find the value of t when P is moving north-east.

(7 marks)

Answer _____

5

[In this question $\mathbf{i}$ and $\mathbf{j}$ are horizontal unit vectors due east and due north respectively, and position vectors are given relative to a fixed origin O .]

A particle P moves with constant acceleration $(-2\mathbf{i} + \mathbf{j}) \text{ m s}^{-2}$. At time $t = 0$, P is at the point with position vector $(-10\mathbf{i} + 4\mathbf{j}) \text{ m}$ and is moving with velocity $(7\mathbf{i} - 2\mathbf{j}) \text{ m s}^{-1}$.

- Find the position vector of P at time t seconds.
- Find the two values of t for which P is due north of O .
- Show that at the first of these times P is moving due east.

(7 marks)

Answer _____

6

[In this question $\mathbf{i}$ and $\mathbf{j}$ are perpendicular horizontal unit vectors and position vectors are given relative to a fixed origin O .]

At time t seconds, where $t \geq 0$, a particle P has velocity $\mathbf{v} \text{ m s}^{-1}$, where

$$\mathbf{v} = (t^2 - 4t + 3)\mathbf{i} + (2t + 1)\mathbf{j}$$

- Find the values of t when P is moving parallel to $\mathbf{j}$.
- Find the magnitude of the acceleration of P when $t = 4$
- Find the displacement of P from $t = 0$ to $t = 3$

(8 marks)

Answer _____

7

[In this question $\mathbf{i}$ and $\mathbf{j}$ are perpendicular horizontal unit vectors and position vectors are given relative to a fixed origin O .]

At time t seconds, where $t \geq 0$, a particle P has acceleration $\mathbf{a} \text{ m s}^{-2}$, where

$$\mathbf{a} = 3t^{\frac{1}{2}}\mathbf{i} - 2\mathbf{j}$$

When $t = 0$, P is at O and is moving with velocity $(4\mathbf{i} + 5\mathbf{j}) \text{ m s}^{-1}$.

- Find the speed of P when $t = 4$
- Find the position vector of P when $t = 4$

(8 marks)

Answer _____

8

[In this question $\mathbf{i}$ and $\mathbf{j}$ are perpendicular horizontal unit vectors and position vectors are given relative to a fixed origin O .]

Two particles A and B move on a smooth horizontal surface with constant velocities. At time $t = 0$, A is at the point with position vector $(2\mathbf{i} + \mathbf{j}) \text{ m}$ and B is at the point with position vector $(10\mathbf{i} - 3\mathbf{j}) \text{ m}$. The velocity of A is $(3\mathbf{i} + \mathbf{j}) \text{ m s}^{-1}$ and the velocity of B is $(-\mathbf{i} + 3\mathbf{j}) \text{ m s}^{-1}$.

- Find the vector $\overrightarrow{AB}$ in terms of t .
- Show that A and B collide, and find the position vector of the point where they collide.
- Find the exact distance between A and B when $t = 0.5$

(7 marks)

Answer _____

9

[In this question $\mathbf{i}$ and $\mathbf{j}$ are perpendicular horizontal unit vectors and position vectors are given relative to a fixed origin O .]

A particle P moves with constant acceleration $(2\mathbf{i} - \mathbf{j}) \text{ m s}^{-2}$. At time $t = 0$, P passes through O with velocity $(-4\mathbf{i} + 2\mathbf{j}) \text{ m s}^{-1}$. At time T seconds, where $T > 0$, P passes through the point C with position vector $(\lambda\mathbf{i} - 6\mathbf{j}) \text{ m}$, where λ is a constant.

- Find the value of T .
- Find the value of λ .
- Find the exact speed of P as it passes through C .

(8 marks)

Answer _____

10

[In this question $\mathbf{i}$ and $\mathbf{j}$ are horizontal unit vectors due east and due north respectively, and position vectors are given relative to a fixed origin O .]

At time t seconds, where $t \geq 0$, the position vector of a particle P is $\mathbf{r}$ metres, where

$$\mathbf{r} = (t^3 - 3t)\mathbf{i} + (5t - t^2)\mathbf{j}$$

- Find the velocity of P at time t .
- Find the value of t when P is moving north-east.
- Find the distance of P from O when P is due east of O .
- Find the magnitude of the acceleration of P at this time.

(9 marks)

Answer

11

[In this question $\mathbf{i}$ and $\mathbf{j}$ are horizontal unit vectors due east and due north respectively, and position vectors are given relative to a fixed origin O .]

At noon, ship A is at O and ship B is at the point with position vector $(20\mathbf{i} + 4\mathbf{j})$ km. Ship A moves with constant velocity $(6\mathbf{i} + 8\mathbf{j})$ km h^{-1} and ship B moves with constant velocity $(2\mathbf{i} + 10\mathbf{j})$ km h^{-1} . At time t hours after noon the position vectors of A and B are $\mathbf{r}_A$ km and $\mathbf{r}_B$ km.

- Show that the position vector of B relative to A is $(20 - 4t)\mathbf{i} + (4 + 2t)\mathbf{j}$
- Find the time at which B is due north of A , and the distance between the ships at that time.
- Find, using calculus, the time at which the ships are closest together and the least distance between them.

(9 marks)

Answer

12

[In this question $\mathbf{i}$ and $\mathbf{j}$ are horizontal unit vectors due east and due north respectively, and position vectors are given relative to a fixed origin O .]

At time t seconds, where $t > 0$, a particle P has velocity $\mathbf{v} \text{ m s}^{-1}$, where

$$\mathbf{v} = 6t\frac{1}{2}\mathbf{i} + (2t - 5)\mathbf{j}$$

- Find the magnitude of the acceleration of P when $t = 4$
- P is at the point A when $t = 1$ and at the point B when $t = 4$. Find the exact distance AB .
- When $t = 1$, the position vector of P is $(-2\mathbf{i} + 3\mathbf{j}) \text{ m}$. Find the position vector of P at time t .
- Show that P is never due east of O .

(10 marks)

Answer

End of questions | Total 86 marks