Question 1 (**)

The position vector $\mathbf{r}$ m of a particle, t seconds after a given instant is given by

$$\mathbf{r} = \left(2t^2 - 1\right)\mathbf{i} + \left(6t - 5t^2\right)\mathbf{j}, \ t \geq 0,$$

where $\mathbf{i}$ and $\mathbf{j}$ are unit vectors pointing due east and due north, respectively.

Given that the mass of the particle is 0.5 kg, determine the magnitude of the resultant force acting on the particle.

Question 2 (**)

The position vector $\mathbf{r}$ m of a particle P, t s after a given instant is given by

$$\mathbf{r} = \left(t^3 - 2t\right)\mathbf{i} + \left(4t^2 + t\right)\mathbf{j}, \ t \geq 0,$$

where $\mathbf{i}$ and $\mathbf{j}$ are unit vectors pointing due east and due north, respectively.

a) Find the magnitude of the acceleration of the particle, when $t = 1$.

b) Determine the value of t when P is moving parallel to the vector $\mathbf{i} + \mathbf{j}$.

Question 3 (**+)

The velocity $\mathbf{v}$ ms^{-1} of a particle P, t seconds after a given instant is given by

$$\mathbf{v} = (4t - 3)\mathbf{i} + (2t + 3)\mathbf{j}, \ t \geq 0,$$

where $\mathbf{i}$ and $\mathbf{j}$ are unit vectors pointing due east and due north, respectively.

a) Find the magnitude of the acceleration of the particle.

When $t = 1$, the position vector of P is $8\mathbf{j}$ m.

b) Determine the **initial distance** of P from the origin O.

Question 4 (+)**

The velocity $\mathbf{v}$ ms^{-1} of a particle of mass 2 kg, t s after a given instant is given by

$$\mathbf{v} = 6t^2\mathbf{i} - 6t^{\frac{3}{2}}\mathbf{j},\ t \geq 0,$$

where $\mathbf{i}$ and $\mathbf{j}$ are unit vectors pointing due east and due north, respectively.

a) Find the magnitude of the resultant force acting on the particle, when $t = 1$.

When $t = 0$, the particle is at the point A with position vector $(2\mathbf{i} + \mathbf{j})$ m and when $t = 1$, the particle is at the point B.

b) Determine the distance AB.

Question 5 (+)**

The position vector $\mathbf{r}$ m of a particle of mass 0.5 kg, t s after a given instant satisfies

$$\mathbf{r} = \left(3t^2 - 7t + 2\right)\mathbf{i} + \left(2t^2 - 5t + 2\right)\mathbf{j},\ t \geq 0,$$

where $\mathbf{i}$ and $\mathbf{j}$ are unit vectors pointing due east and due north, respectively.

a) Find the value of t when the particle is at the origin.

b) Determine the magnitude of the resultant force acting on the particle.

c) Find the value of t when the particle is moving parallel to the vector $2\mathbf{i} + \mathbf{j}$.

Question 6 (+)**

The velocity $\mathbf{v}$ ms^{-1} of a particle of mass 5 kg, t s after a given instant is given by

$$\mathbf{v} = \left(12t^2 - 2\right)\mathbf{i} + \left(2t - 3t^2\right)\mathbf{j},\ t \geq 0,$$

where $\mathbf{i}$ and $\mathbf{j}$ are unit vectors pointing due east and due north, respectively.

a) Find the magnitude of the resultant force acting on the particle, when $t = 2$.

b) Find the value of t when the particle's acceleration is parallel to the x axis.

When $t = 0$, the particle is at the point A with position vector $(\mathbf{i} + 6\mathbf{j})$ m and when $t = 1$, the particle is at the point B.

c) Determine the distance AB.

Question 7 (***+)

The acceleration $\mathbf{a}$ ms^{-2} of a particle P of mass 0.2 kg, t s after a given instant is given by

$$\mathbf{a}=(2t-4)\mathbf{i}+3\mathbf{j},\ t\geq 0,$$

where $\mathbf{i}$ and $\mathbf{j}$ are unit vectors pointing along the positive x axis and along the positive y axis, respectively.

a) Find the magnitude of the resultant force acting on P, when $t=4$.

It is further given that when $t=0$, P is at the point A with position vector $(-18\mathbf{i}-24\mathbf{j})$ m and has velocity $(3\mathbf{i}-9\mathbf{j})$ ms^{-1}.

b) Find the value of t when the particle is at rest.

c) Show that when $t=6$, P is on the y axis and state its distance from A.

d) Determine the value of t when the particle is on the x axis.

Question 8 (****)

The position vector, velocity and acceleration of a particle P, t s after a given instant are denoted by $\mathbf{r}$ m, $\mathbf{v}$ ms^{-1} and $\mathbf{a}$ ms^{-2}.

When $t=1$, $\mathbf{r}=9\mathbf{i}+2\mathbf{j}$ and $\mathbf{v}=13\mathbf{i}+\mathbf{j}$, where $\mathbf{i}$ and $\mathbf{j}$ are unit vectors pointing due east and due north, respectively.

It is further given that P has a constant acceleration of $6\mathbf{i}$ ms^{-2}.

a) Determine the distance of P from the origin O, when $t=3$.

b) Show that P is moving on the curve with equation

$$x=3y^2+y-\rho \qquad \text{State } \rho$$

1) $\boxed{F = \sqrt{29} \approx 5.39\,\text{N}}$

2) $\boxed{a = 10\,\text{ms}^{-2}}$, $\boxed{t = 3}$

3) $\boxed{a = \sqrt{20} \approx 4.47\,\text{ms}^{-2}}$, $\boxed{d = \sqrt{17} \approx 4.12\,\text{m}}$

4) $\boxed{F = 30\,\text{N}}$, $\boxed{|AB| \approx 3.12\,\text{m}}$

5) $\boxed{t = 2}$, $\boxed{F = \sqrt{13} \approx 3.61\,\text{N}}$, $\boxed{t = 1.5}$

6) $\boxed{F \approx 245\,\text{N}}$, $\boxed{t = \frac{1}{3}}$, $\boxed{|AB| = 2\ \text{m}}$

7) $\boxed{F = 1\,\text{N}}$, $\boxed{t = 3}$, $\boxed{18\ \text{m}}$, $\boxed{t = 8}$

8) $\boxed{\approx 47.17\,\text{m}}$ $p = 5$