**8A Movement on a Plane**

1. A particle starts from the point with position vector $\left(3i+7j\right)m$ and moves with constant velocity $\left(2i-j\right) ms^{-1}$.
2. Find the position vector of the particle after 4 seconds
3. Find the time at which the particle is due east of the origin
4. A particle $P$ has velocity $\left(-3i+j\right) ms^{-1}$ at time $t=0$. The particle moves with constant acceleration $a=\left(2i+3j\right) ms^{-2}$. Find the speed of the particle and the bearing on which it is travelling at time 3 seconds.
5. An ice skater is skating on a large flat ice rink. At time $t=0 $the skater is at a fixed point $O$ and is skating with velocity $\left(2.4i-0.6j\right) ms^{-1}$.

At time $t=20$ the skater is travelling with velocity $\left(-5.6i+3.4j\right) ms^{-1}$.

Relative to $O$, the skater has position vector $s$ at time $t$ seconds.

Modelling the skater as having constant acceleration, find:

1. The acceleration of the ice skater
2. An expression for $s$ in terms of $t$
3. Find the time at which the skater is directly north-east of O
4. A second skater travels such that she has position vector $r=\left(1.1t-6\right)j m$ relative to the same point $O$ at time $t$.

**8B Projectiles with Vectors**

1. A ball is struck by a racket from a point $A$ which has position vector $20j m$ relative to a fixed origin O. Immediately after being struck, the ball has velocity $\left(5i+8j\right) ms^{-1}$, where $i$ and $j$ are unit vectors horizontally and vertically respectively. After being struck, the ball travels freely under gravity until it strikes the ground at point $B$.
2. Find the speed of the ball 1.5 seconds after being struck
3. Find an expression for the position vector, $r$ of the ball relative to $O$ at time $t$ seconds
4. Hence determine the distance $OB$

**8C Calculus in Mechanics**

1. A particle is moving in a straight line with acceleration at time t seconds given by:

$a=cos2πt ms^{-2}$, $   t\geq 0$

The velocity of the particle at time $t=0$ is $\frac{1}{2π} ms^{-1}$. Find:

1. An expression for the velocity at time $t$ seconds
2. The maximum speed of the particle
3. The distance travelled in the first 3 seconds
4. A particle of mass 6kg is moving on the positive x-axis. At time $t$ seconds the displacement, $s$, of the particle from the origin is given by:

$s=\left(2t^{\frac{3}{2}}+\frac{e^{-2t}}{3}\right)m$, where $t\geq 0$

1. Find the velocity of the particle when $t=1.5$
2. Given that the particle is acted on by a single force of variable magnitude $F N$ which acts in the direction of the positive x-axis, find the value of $F$ when $t=2$

**8D Differentiating Vectors**

1. A particle $P$ of mass 0.8kg is acted on by a single force $F N$. Relative to a fixed origin $O$, the position vector of $P$ at time $t$ seconds is $r$ metres, where:

$r=2t^{3}i+50t^{-\frac{1}{2}}j$, $t\geq 0$

Find:

1. The speed of $P$ when $t=4$
2. The acceleration of $P$ as a vector when $t=2$
3. The value of $F$ when $t=2$

**8E Integrating Vectors**

1. A particle $P$ is moving in a plane. At time $t$ seconds, its velocity, $vms^{-1}$, is given by:

$$v=3ti+\frac{1}{2}t^{2}j$$

When $t=0$, the position vector of $P$ with respect to a fixed origin $O$ is $(2i – 3j) m$. Find the position vector of $P$ at time $t$ seconds

1. A particle $P$ is moving in a plane so that, at time $t$ seconds, its acceleration is:

$$a=\left(4i-2tj\right)ms^{-2}$$

At $t=3$, the velocity of $P$ is $6i ms^{-1}$ and the position vector of $P$ is $\left(20i+3j\right) m $with respect to a fixed origin $O$. Find:

1. The angle between the direction of motion of $P$, and $i$, when $t=2$
2. The distance of $P$ from $O$ when $t=0$
3. The velocity of a particle at time $t$ seconds is given by:

$$v=\left(3t^{2}-8\right)i+5j$$

When $t=0$, the position vector of $P$ with respect to a fixed origin is $\left(2i – 4j\right) m$

1. Find the position vector of $P$ after $t$ seconds

A second particle $Q$ moves with constant velocity $\left(8i + 4j\right) ms^{-1}$. When $t = 0$, the position vector of Q with respect to the origin $O$ is $2i$ $m$.

b) Prove that $P$ and $Q$ collide