**8A Movement on a Plane**

1. A particle starts from the point with position vector and moves with constant velocity .
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 has velocity at time . The particle moves with constant acceleration . 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 the skater is at a fixed point and is skating with velocity .

At time the skater is travelling with velocity .

Relative to , the skater has position vector at time seconds.

Modelling the skater as having constant acceleration, find:

1. The acceleration of the ice skater
2. An expression for in terms of
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 relative to the same point at time .

**8B Projectiles with Vectors**

1. A ball is struck by a racket from a point which has position vector relative to a fixed origin O. Immediately after being struck, the ball has velocity , where and are unit vectors horizontally and vertically respectively. After being struck, the ball travels freely under gravity until it strikes the ground at point .
2. Find the speed of the ball 1.5 seconds after being struck
3. Find an expression for the position vector, of the ball relative to at time seconds
4. Hence determine the distance

**8C Calculus in Mechanics**

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

,

The velocity of the particle at time is . Find:

1. An expression for the velocity at time 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 seconds the displacement, , of the particle from the origin is given by:

, where

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

**8D Differentiating Vectors**

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

,

Find:

1. The speed of when
2. The acceleration of as a vector when
3. The value of when

**8E Integrating Vectors**

1. A particle is moving in a plane. At time seconds, its velocity, , is given by:

When , the position vector of with respect to a fixed origin is . Find the position vector of at time seconds

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

At , the velocity of is and the position vector of is with respect to a fixed origin . Find:

1. The angle between the direction of motion of , and , when
2. The distance of from when
3. The velocity of a particle at time seconds is given by:

When , the position vector of with respect to a fixed origin is

1. Find the position vector of after seconds

A second particle moves with constant velocity . When , the position vector of Q with respect to the origin is .

b) Prove that and collide