A Level Mathematics

Chapter 8 - Mechanics

Further Kinematics

Chapter Overview

1. Vectors in Kinematics

2. Vector Methods with Projectiles

3. Variable Acceleration in One Dimension

4. Differentiating Vectors

5. Integrating Vectors





1. **Vectors in Kinematics**

If a particle starts from the point with position vector ***r***0, and moves with constant velocity ***v***, its displacement from its initial position at time t is given by ***v***t and it position vector ***r*** is given by:

**Example**

At time $t = 0$, where $t$ is the time (in seconds), a particle is at the point with position vector $(4i - j) $m and travels with velocity $(-2i + 2j) $ms-1. Find:

a) The position vector of the particle after $t$ seconds

b) The distance the particle is from the origin, O, after 3 seconds.

**Example**

A particle starts at a point 8m from O at an angle of 45O anti-clockwise from east and travels with a velocity $(-2i - 3j)$ ms-1, where $i$ and $j$ are unit vectors due east and north respectively.

Find the position vector of the particle after t seconds in the form $r = r\_{0} + tv$.

**Example – Using SUVAT with Vectors**

A particle is initially travelling with velocity $(-2i - 9j)$ ms-1 and 2 seconds later it has a velocity of$ (6i - 11j)$ ms-1, where $i$ and $j$ are unit vectors in the directions of the positive x- and y- axes respectively. Given that the acceleration of the particle is constant, find:

a) The acceleration

b) The magnitude of the acceleration

c) The angle that the acceleration makes with the vector $j$

**Example** *(Textbook p161 Example 3)*

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 travelling with velocity $\left(2.4i-0.6j\right)$ ms-1.

At time $t=20$ s 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 ice skater as a particle with constant acceleration, find:

1. The acceleration of the ice skater
2. An expression for $s$ in terms of $t$
3. The time at which the skater is directly north-east of $O$.

A second skater travels so that she has position vector$r=\left(1.1t-6\right)j$ m relative to $O$ at time $t$.

1. Show that the two skaters will meet.

**Test Your Understanding** *(EdExcel M1 May 2013(R) Q6)*



Exercise 7A Page 162