

MEI Mechanics 1 General motion

Section 2: Motion in two and three dimensions

Exercise

Take $g = 9.8 \text{ ms}^{-2}$ unless instructed otherwise.

- In this question take g to be 10 ms^{-2} .**

A ball is fired from a point on level ground with velocity $\mathbf{u} = 15\mathbf{i} + 20\mathbf{j}$.

 - Write in terms of \mathbf{i} and \mathbf{j} the velocity vector and the position vector of the ball after t seconds.
 - Find the time at which the ball will be moving in a direction of 45° to the horizontal.
 - Find the time at which the ball returns to the ground
- In this question take g to be 10 ms^{-2} .**

A boy fires a stone from the top of a tower 10 m high using a catapult. The initial velocity of the ball is $12\mathbf{i}$.

 - Write in terms of \mathbf{i} and \mathbf{j} expressions for the velocity and displacement of the stone at time t seconds after projection.
 - How far horizontally from the base of the tower does the stone land?
- Particle P is moving in the x - y plane with the origin at O. The position vector of P with respect to O is $\mathbf{r} = 2t^3\mathbf{i} + 3t^2\mathbf{j}$. Find the velocity vector and the acceleration vector for P and hence the magnitudes of the velocity and acceleration when $t = 3$.
- A force $\mathbf{F} = 4t\mathbf{i} + 6\mathbf{j}$ acts on a particle of mass 2 kg. Given that the particle has an initial velocity of $5\mathbf{j}$ at the origin find the velocity and displacement when $t = 3$.
- At time t the position vector of particle P of mass 4 kg is $\mathbf{r} = 6t\mathbf{i} - 4t^2\mathbf{j}$. Force \mathbf{F} acts on P. Find the magnitude of \mathbf{F} .
- The position vector of a radio controlled car is $\mathbf{r} = (2t - 1)\mathbf{i} - t^2\mathbf{j}$
 - Find the velocity at time t .
 - Find the initial direction of motion.
 - Show that the acceleration is constant.
 - Explain why the car can never move in a direction at right angles to the original direction.
- Two forces $\mathbf{F} = 12\mathbf{i} - 2\mathbf{j}$ and $\mathbf{T} = 10\mathbf{i} + 12\mathbf{j}$ act on an object of mass 20 kg.
 - Find the resultant force on the object.
 - Find the acceleration of the object.
 - Given that the object is initially at rest at a point with position vector $3\mathbf{j}$ find its position vector after t seconds.