Chapter 6 - Mechanics

Projectiles

Chapter Overview

1. Horizontal Projection

2. Horizontal and Vertical Components

3. Projection at any Angle

4. Projectile Motion Formulae

Topics	What students need to learn:		
	Content		Guidance
	7.3	**Understand, use and derive the formulae for constant acceleration for motion in a straight line.** Extend to 2 dimensions using vectors.	**Derivation may use knowledge of sections 7.2 and/or 7.4** **Understand and use *suvat* formulae for constant acceleration in 2-D,** e.g. $\mathbf{v} = \mathbf{u} + \mathbf{a}t$, $\mathbf{r} = \mathbf{u}t + \frac{1}{2}at^2$ with vectors given in $\mathbf{i} - \mathbf{j}$ or column vector form. Use vectors to solve problems.
	7.4	**Use calculus in kinematics for motion in a straight line:** $v = \frac{dr}{dt}$, $a = \frac{dv}{dt} = \frac{d^2r}{dt^2}$ $\mathbf{r} = \int \mathbf{v}\ dt$, $\mathbf{v} = \int \mathbf{a}\ dt$ Extend to 2 dimensions using vectors.	**The level of calculus required will be consistent with that in Sections 7 and 8 in Paper 1** and Sections 6 and 7 in Paper 2. Differentiation and integration of a vector with respect to time. e.g. Given $\mathbf{r} = t^2\mathbf{i} + t^{\frac{3}{2}}\mathbf{j}$, find $\dot{\mathbf{r}}$ and $\ddot{\mathbf{r}}$ at a given time.
	7.5	Model motion under gravity in a vertical plane using vectors; projectiles.	Derivation of formulae for time of flight, range and greatest height and the derivation of the equation of the path of a projectile may be required.

A particle moving in a vertical plane under gravity is sometimes called a projectile. You can use projectile motion to model the flight of e.g. a golf ball.

1. Horizontal Motion

The horizontal motion of a projectile is modelled as having constant velocity ($a = 0$), so $s = vt$. Use u_x and v_x to denote horizontal velocity components.

The vertical motion of a projectile is modelled as having constant acceleration due to gravity ($a = g$). Use SUVAT - careful with directions! Use u_y and v_y to denote vertical velocity components.

Example

A ball is thrown horizontally with speed $20ms^{-1}$, from the top of a building, which is 30m high. Find:

a) The time the ball takes to reach the ground.

b) The distance between the bottom of the building and the point where the ball hits the ground.

Example

A particle is projected horizontally with a velocity of $39.2ms^{-1}$. Find the horizontal and vertical components of the velocity of the particle 3s after projection. Find also the speed and direction of the motion of the particle.

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