Module 1: Kinematics

NSW HSC Physics Year 11

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Module Overview

Kinematics is the study of motion without reference to the forces causing that motion. This module introduces fundamental concepts of describing and analysing motion in one and two dimensions.

Indicative Hours: 30 hours

Related Outcomes:

- **PH11-8** describes and analyses motion in terms of scalar and vector quantities in two dimensions
- **PH11-9** describes and explains events in terms of Newton's Laws of Motion

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Inquiry Questions

1. **How is the motion of an object moving in a straight line described and predicted?**
2. **How can the motion of objects be explained and analysed?**

Key Concepts

1.1 Motion in a Straight Line

> **Learning Focus**
>
> Describe and analyse motion using scalar and vector quantities.

Content:

- Distinguish between scalar and vector quantities
- Define and calculate distance, displacement, speed, velocity, and acceleration
- Interpret and construct displacement-time, velocity-time, and acceleration-time graphs
- Use kinematic equations to solve problems involving uniformly accelerated motion

Key Formulas:

Quantity	Formula
Average velocity	$\bar{v} = \frac{\Delta x}{\Delta t}$
Average acceleration	$\bar{a} = \frac{\Delta v}{\Delta t}$
Kinematic equation 1	$v = u + at$
Kinematic equation 2	$s = ut + \frac{1}{2}at^2$
Kinematic equation 3	$v^2 = u^2 + 2as$
Kinematic equation 4	$s = \frac{(u+v)}{2}t$

1.2 Motion on a Plane

> **Learning Focus**
>
> Analyse two-dimensional motion by resolving into perpendicular components.

Content:

- Resolve vectors into perpendicular components
- Add vectors using graphical and algebraic methods
- Apply vector analysis to motion problems
- Calculate relative velocity in two dimensions

Key Concepts:

- Vector components: $v_x = v\cos\theta$, $v_y = v\sin\theta$
- Vector magnitude: $|v| = \sqrt{v_x^2 + v_y^2}$
- Vector direction: $\theta = \tan^{-1}\left(\frac{v_y}{v_x}\right)$

Working Scientifically

Practical Investigations

1. **Motion Analysis**
    - Use ticker timers or motion sensors to collect position-time data
    - Calculate velocity and acceleration from experimental data
    - Compare experimental results with theoretical predictions
2. **Relative Motion**
    - Investigate relative velocity using practical demonstrations
    - Apply vector addition to analyse relative motion scenarios

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Key Definitions

Scalar A quantity that has magnitude only (e.g., speed, distance, time, mass).
Vector A quantity that has both magnitude and direction (e.g., velocity, displacement, acceleration, force).
Displacement The change in position of an object; a vector quantity measured in metres (m).
Velocity The rate of change of displacement; a vector quantity measured in metres per second (m/s).
Acceleration The rate of change of velocity; a vector quantity measured in metres per second squared (m/s^2).
Uniform Motion Motion with constant velocity (zero acceleration).
Uniformly Accelerated Motion Motion with constant acceleration.