Module 2: Dynamics

NSW HSC Physics Year 11

Table of contents

Module Overview

Dynamics extends kinematics by examining the forces that cause motion. This module covers Newton's Laws of Motion, momentum, energy, and their applications to real-world situations.

Indicative Hours: 30 hours

Related Outcomes:

- **PH11-8** describes and analyses motion in terms of scalar and vector quantities
- **PH11-9** describes and explains events in terms of Newton's Laws of Motion, conservation of momentum and conservation of energy

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Inquiry Questions

1. **How are forces produced between objects and what effects do forces produce?**
2. **How can the motion of objects be explained and analysed?**

Key Concepts

2.1 Forces

> **i** Learning Focus
>
> Understand the nature of forces and apply Newton's Laws to analyse motion.

Content:

- Identify forces acting on objects using free-body diagrams
- Apply Newton's three laws of motion to solve problems
- Analyse equilibrium conditions for objects at rest and in motion
- Calculate friction forces and understand their role in motion

Newton's Laws:

Law	Statement	Formula
First Law	An object remains at rest or in uniform motion unless acted upon by a net force	If $\Sigma F = 0$, then $a = 0$
Second Law	Acceleration is proportional to net force and inversely proportional to mass	$\Sigma F = ma$
Third Law	For every action there is an equal and opposite reaction	$F_{AB} = -F_{BA}$

2.2 Momentum

> **i** Learning Focus
>
> Apply the law of conservation of momentum to collision and explosion problems.

Content:

- Define momentum and impulse
- Apply the law of conservation of momentum
- Analyse elastic and inelastic collisions
- Solve problems involving explosions and recoil

Key Formulas:

Quantity	Formula
Momentum	$p = mv$
Impulse	$J = F\Delta t = \Delta p$
Conservation of momentum	$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

2.3 Energy

> **Learning Focus**
>
> Apply energy concepts and the law of conservation of energy to mechanical systems.

Content:

- Calculate kinetic energy and gravitational potential energy
- Apply the law of conservation of mechanical energy
- Analyse energy transformations in mechanical systems
- Calculate work done by constant and variable forces

Key Formulas:

Quantity	Formula
Kinetic energy	$E_k = \frac{1}{2}mv^2$
Gravitational PE	$E_p = mgh$
Work	$W = Fs\cos\theta$
Power	$P = \frac{W}{t} = Fv$

Working Scientifically

Practical Investigations

1. **Newton's Second Law**

- Investigate the relationship between force, mass, and acceleration
- Use dynamics trolleys and motion sensors to collect data

2. **Conservation of Momentum**

   - Analyse collisions between objects of different masses
   - Compare elastic and inelastic collisions

3. **Energy Transformations**

   - Investigate energy changes in pendulum motion
   - Analyse efficiency of energy transformations

Key Definitions

Force A push or pull that can change the motion of an object; measured in newtons (N).
Net Force The vector sum of all forces acting on an object.
Momentum The product of mass and velocity; a vector quantity measured in $\text{kg} \cdot \text{m/s}$.
Impulse The product of force and time; equal to the change in momentum.
Kinetic Energy The energy an object possesses due to its motion.
Potential Energy Stored energy due to position or configuration.
Work The energy transferred when a force moves an object; measured in joules (J).