Module 3: Waves and Thermodynamics

NSW HSC Physics Year 11

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Module Overview

This module explores wave phenomena and thermodynamic principles, covering mechanical waves, sound, and the behaviour of thermal energy in systems.

Indicative Hours: 30 hours

Related Outcomes:

- **PH11-10** explains and analyses waves and the transfer of energy by sound, light and thermodynamic principles

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Inquiry Questions

1. **What are the properties of all waves and wave motion?**
2. **How do thermodynamic principles apply to systems?**

Key Concepts

3.1 Wave Properties

> **i** Learning Focus
>
> Understand the properties of mechanical waves and wave behaviour.

Content:

- Distinguish between transverse and longitudinal waves
- Define wavelength, frequency, period, amplitude, and wave speed
- Apply the wave equation to solve problems
- Analyse reflection, refraction, diffraction, and superposition

Key Formulas:

Quantity	Formula
Wave equation	$v = f\lambda$
Period-frequency	$T = \frac{1}{f}$
Wave speed (string)	$v = \sqrt{\frac{T}{\mu}}$

3.2 Sound Waves

> **i** Learning Focus
>
> Analyse sound as a longitudinal wave and understand resonance phenomena.

Content:

- Describe sound as a longitudinal mechanical wave
- Calculate the speed of sound in different media
- Explain resonance in air columns and strings
- Analyse beats and the Doppler effect

Key Formulas:

Quantity	Formula
Speed of sound in air	$v \approx 331 + 0.6T$ m/s
Beat frequency	$f_{beat} = \lvert f_1 - f_2 \rvert$
Doppler effect	$f' = f\frac{v \pm v_o}{v \mp v_s}$

Quantity	Formula

3.3 Thermodynamics

> **Learning Focus**
>
> Apply thermodynamic principles to energy transfer and transformations.

Content:

- Define temperature, thermal energy, and heat
- Apply the specific heat capacity formula
- Explain conduction, convection, and radiation
- Analyse the first and second laws of thermodynamics

Key Formulas:

Quantity	Formula
Heat energy	$Q = mc\Delta T$
Latent heat	$Q = mL$
Thermal expansion	$\Delta L = L_0 \alpha \Delta T$

Key Definitions

Wave A disturbance that transfers energy through a medium or space without transferring matter.

Transverse Wave A wave where particles oscillate perpendicular to the direction of energy transfer.

Longitudinal Wave A wave where particles oscillate parallel to the direction of energy transfer.

Wavelength The distance between successive corresponding points on a wave.

Frequency The number of complete waves passing a point per second; measured in hertz (Hz).

Amplitude The maximum displacement of a particle from its equilibrium position.

Temperature A measure of the average kinetic energy of particles in a substance.

Specific Heat Capacity The amount of heat required to raise the temperature of 1 kg of a substance by 1°C.