



# Fluids and Waves

*Roger Moore*

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This material was developed for the second term of the first year calculus-based, introductory physics course at the University of Alberta. It contains a richer, more in-depth mathematical treatment of the material than many standard texts for first year courses and starts with the assumption that the reader is already familiar with calculus of polynomials and trigonometric and exponential functions.

The book has the following chapters each of which has its own end of chapter problems:

**Mathematics** - Complex numbers, complex exponentials, partial derivatives, experimental uncertainties.

**Elasticity** - Stress, strain, moduli of elasticity, bulk stress, strain and modulus

**Fluid Statics** - pressure, Pascal's law, measuring pressures, Archimedes' principle

**Fluid Dynamics** - continuity equation, Bernoulli's equation, Torricelli's law, viscosity, Poiseuille's law, Stokes' law

**Oscillations** - simple harmonic motion, simple and compound pendulums, damped harmonic motion, driven oscillators

**Waves** - types of waves, mathematical description of a wave, waves on a string, acoustic waves, wave power and intensity

**Wave Interactions** - principle of superposition, reflection at a boundary, interference, beats, standing waves, the relativistic and non-relativistic doppler effect

**Light Waves** - basic geometric optics, Huyghens' principle, dispersion, polarization, thin film interference, diffraction

**Introduction to Quantum Mechanics** - atomic spectra, blackbody spectrum, photo-electric effect, Bohr atom, de Broglie wavelength, Schrodinger equation

In addition there are two appendices which cover some of the more mathematically challenging topics in detail:

**Wave Equations** - derivation and general solution of the partial differential wave equation, derivation of the pressure and displacement wave equation for acoustic waves

**Blackbody Spectrum** - 2D and 3D standing waves, density of states for a cavity, calculation of Planck's spectrum, derivation of Wien's displacement law

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