

# Advanced Mechanics

## 5.1 Projectile Motion

- Analyse projectile motion by resolving horizontal and vertical components
  - Constant vertical acceleration due to gravity
  - Zero air resistance
- Apply projectile motion modelling to derive relationships
  - Initial velocity
  - Launch angle
  - Maximum height
  - Time of flight
  - Final velocity
  - Launch height
  - Horizontal range
- Conduct a practical investigation to validate projectile motion relationships
- Solve problems using equations of motion
  - Uniformly accelerated motion
  - Constant rectilinear motion

## 5.2 Circular Motion

- Conduct investigations into uniform circular motion relationships
  - Centripetal force
  - Mass
  - Speed
  - Radius
- Analyse forces acting on objects in uniform circular motion
  - Cars on horizontal bends
  - Mass on a string
  - Objects on banked tracks
- Solve problems involving circular motion relationships
  - Centripetal acceleration
  - Centripetal force equations
- Investigate total energy and work in circular motion
- Investigate rotation of mechanical systems and torque

## 5.3 Motion in Gravitational Fields

- Apply Newton's Law of Universal Gravitation
  - Force of gravity between objects
  - Factors affecting gravitational field strength
  - Predict gravitational field strength
- Investigate orbital motion of planets and satellites
  - Gravitational force
  - Centripetal force
  - Centripetal acceleration
  - Mass
  - Orbital radius
  - Orbital velocity
  - Orbital period
- Predict orbital properties of planets and satellites
  - Near-Earth orbits
  - Geostationary orbits
- Investigate Kepler's Laws of Planetary Motion
  - Circular orbits
  - Non-circular orbits
- Derive and apply gravitational force and potential energy concepts
  - Escape velocity
  - Total potential energy
  - Total orbital energy
  - Energy changes between orbits

# Electromagnetism

## 6.1 Charged Particles, Conductors and Electric and Magnetic Fields

- Investigate charged particles in uniform electric fields
  - Electric field between parallel plates
  - Acceleration of charged particles
  - Work done on the charge
- Model trajectories of charged particles in electric fields
  - Comparison with projectile motion
- Analyse charged particles in magnetic fields
  - Perpendicular acceleration
  - Force on the charge
- Compare magnetic field interactions
  - Electric fields
  - Uniform circular motion

## 6.2 The Motor Effect

- Investigate current-carrying conductors in magnetic fields
  - Maximum force conditions
  - Direction of force
  - No force conditions
- Conduct investigation into parallel current-carrying wires
- Analyse interaction of parallel current-carrying wires
  - SI definition of ampere
  - Newton's Third Law

## 6.3 Electromagnetic Induction

- Describe changes in magnetic flux
- Analyse Faraday's Law and Lenz's Law
  - Relative movement with magnets and conductors
  - Relative movement between solenoids
- Analyse ideal transformers
  - Transformer equations
- Evaluate limitations of ideal transformers
  - Incomplete flux linkage
  - Heat losses and eddy currents
- Analyse applications of transformers
  - High-voltage transmission

## 6.4 Applications of the Motor Effect

- Investigate operation of a simple DC motor
  - Functions of components
  - Production of torque
  - Back emf
- Analyse DC and AC generators and induction motors
- Relate Lenz's Law to conservation of energy
  - DC motors
  - Magnetic braking

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# The Nature of Light

## 7.1 Electromagnetic Spectrum

- Investigate Maxwell's contribution to electromagnetism
  - Unification of electricity and magnetism
  - Prediction of electromagnetic waves
  - Prediction of velocity
- Describe production and propagation of electromagnetic waves
- Investigate methods used to determine speed of light
- Conduct investigation into spectra
- Investigate spectroscopy applications
  - Identification of elements
- Investigate stellar spectra
  - Surface temperature
  - Rotational velocity
  - Translational velocity
  - Density
  - Chemical composition

## 7.2 Light: Wave Model

- Conduct investigations into diffraction of light
- Conduct investigations into interference of light
  - Double slit apparatus
  - Diffraction gratings
- Analyse evidence supporting historical wave models
  - Newton
  - Huygens
- Conduct investigations using Malus' Law
  - Plane polarisation

## 7.3 Light: Quantum Model

- Analyse black body radiation evidence
  - Wien's Law
  - Planck's contribution
- Investigate photoelectric effect evidence
- Analyse photoelectric effect using conservation of energy
  - Photon model of light

## 7.4 Light and Special Relativity

- Analyse Einstein's two postulates
  - Constant speed of light
  - Equivalent inertial frames
- Investigate evidence for time dilation and length contraction
  - Cosmic muons
  - Atomic clocks
  - Particle accelerators
  - Cosmological studies
- Describe relativistic momentum
  - Maximum velocity limitation
- Apply mass-energy equivalence
  - Solar energy production
  - Particle-antiparticle annihilation
  - Combustion

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# From the Universe to the Atom

## 8.1 Origins of the Elements

- Investigate transformation of radiation into matter after the Big Bang
- Investigate evidence for expansion of the Universe
  - Hubble's discovery
- Analyse mass-energy equivalence in stellar nuclear reactions
- Account for emission and absorption spectra
- Investigate stellar spectra classification
- Investigate Hertzsprung-Russell diagram
  - Characteristics and evolutionary stage
  - Surface temperature
  - Colour
  - Luminosity
- Investigate nucleosynthesis reactions
  - Proton-proton chain
  - CNO cycle

## 8.2 Structure of the Atom

- Investigate evidence supporting the electron
  - Cathode rays
  - Thomson's experiment
  - Millikan's oil drop experiment
- Investigate evidence supporting nuclear atomic model
  - Geiger-Marsden experiment
  - Rutherford's model
  - Chadwick's neutron discovery

## 8.3 Quantum Mechanical Nature of the Atom

- Assess limitations of Rutherford and Bohr models
- Investigate Balmer series
- Relate quantised energy levels to hydrogen line emission spectrum
- Investigate de Broglie matter waves
- Analyse Schrödinger's contribution

## 8.4 Properties of the Nucleus

- Analyse spontaneous decay of unstable nuclei
  - Alpha radiation
  - Beta radiation
  - Gamma radiation
- Examine half-life model
- Model and explain nuclear fission
  - Controlled chain reactions
  - Uncontrolled chain reactions
- Analyse conservation of mass-energy in nuclear transmutations
- Account for energy release in nuclear fusion
- Predict energy released in nuclear reactions
  - Mass defect
  - Binding energy
  - Mass-energy equivalence

## 8.5 Deep inside the Atom

- Analyse evidence for substructure of protons and neutrons
- Investigate Standard Model of matter
  - Quarks
  - Hadrons
  - Leptons
  - Fundamental forces
- Investigate particle accelerators
  - Testing theories
  - Validating Standard Model