FP008-30 Foundations of Physics

24/25

Department
Warwick Foundation Studies
Level
Foundation
Module leader
Felix Mayeya
Credit value
30
Module duration
25 weeks
Assessment
40% coursework, 60% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

FP008-30 Foundations of Physics

Module web page

Module aims

The module focuses on developing students' skills and confidence in building, applying and reviewing models and techniques in physics to analyse practical scientific and engineering problems.
Students will be aware which models to use in a variety of relevant topics and the limitations of models in the context of the real world. The module will enable students to develop the academic competency to proceed to undergraduate studies in physics and engineering programmes.

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

Physical Quantities and Measurements
SI system of units; base units; derivation of SI units; use of the SI prefixes and standard form;

random and systematic errors; precision, repeatability, reproducibility, resolution and accuracy; absolute, fractional and percentage uncertainties; combination of absolute and percentage uncertainties; represent uncertainty in a data point using error bars; orders of magnitude; estimation of approximate physical quantities.

Scalar and vector quantities

Nature of scalars and vectors; velocity/speed, mass, force/weight, acceleration, displacement/distance; addition of vectors by calculation or scale drawing; resolution of vectors.

Linear motion

Displacement, speed, velocity, acceleration; $v = \Delta s/\Delta t$; $a = \Delta v/\Delta t$; average and instantaneous speeds and velocities; representation of motion by graphical methods; significance of areas of velocity–time and gradients of displacement–time and velocity–time graphs for uniform and non-uniform acceleration; equations for uniform acceleration; acceleration due to gravity, g.

Projectile motion

Independent effect of motion in horizontal and vertical directions of a uniform gravitational field; solution of problems using the equations of uniform acceleration; qualitative understanding of the effect of air resistance on the trajectory of a projectile.

Newton’s laws of motion

Application of the three laws of motion in appropriate situations; Newton's laws to describe, explain and analyze the motion of objects in two dimensions; friction and drag forces; terminal speed.

Work, energy and power

Energy transferred, $W = Fs \cos \theta$; rate of doing work = rate of energy transfer, $P = \Delta W/\Delta t = Fv$; significance of the area under a force–displacement graph; efficiency; principle of conservation of energy: $\Delta E_p=mg\Delta h$ and $E_k=1/2\ mv^2$

Momentum and its applications

Momentum = mass × velocity; conservation of linear momentum; force as the rate of change of momentum, $F = \Delta mv/\Delta t$; Impulse = change in momentum, $F\Delta t = \Delta mv$; significance of the area under a force–time graph; elastic and inelastic collisions.

Moments

Moment of a force about a point; moment defined as force × perpendicular distance from the point to the line of action of the force; moment of couple; principle of moments; centre of mass of uniform regular solid is at its centre.

Circular motion

Periodic motion; angular speed; radian measure of angle; centripetal acceleration; centripetal force; Motion in a vertical circle; conical pendulum and banked tracks.

Materials

Hooke’s law; elastic limit; spring constant; elastic strain energy; tensile strain, tensile stress and Young’s modulus; elastic and plastic deformation; ductile and brittle behaviour; Interpretation of simple stress–strain curves; properties of materials.

Electricity

Electric current, potential difference and resistance; energy and electric power equations; current-voltage curves; Ohm’s law; resistivity; drift velocity; electric circuits: series and parallel connections; potential divider circuits; use of potentiometer; Kirchorff’s circuit laws; electromotive

force and internal resistance.

Simple harmonic motion
Defining equation; amplitude, time period and frequency; x-t, v-t and a-t graphs; maximum speeds and acceleration; mass spring system; simple pendulum; energy of oscillating systems; resonance and the effects of damping.

Waves: Wave properties
Oscillation of the particles of the medium; amplitude, frequency, wavelength, wave speed: $c=f\lambda$; nature of longitudinal and transverse waves, examples to include: sound, electromagnetic waves, and waves on a string; polarisation as evidence for the nature of transverse waves; applications of polarisers; refractive index of a substance, Snell's law of refraction for a boundary $n1 \sin\theta1=n2 \sin \theta2$; total internal reflection, $\sin \theta c =n2/n1$
Waves: Diffraction and interference
Phase difference; path difference; coherence; interference and diffraction using a laser as a source of monochromatic light; Young's double-slit experiment: the use of two coherent sources or the use of a single source with double slits to produce an interference pattern; fringe spacing, $w=\lambda D/s$; production of interference pattern using white light; plane transmission diffraction grating at normal incidence; derivation of $d\sin\theta=n\lambda$
Waves: Stationary waves
The formation of stationary waves by two waves of the same frequency travelling in opposite directions; nodes and antinodes on strings; harmonics; $f=1/2l \sqrt{(T/\mu)}$ for first harmonic.

Thermal energy transfer
Internal energy of a system; specific heat capacity; specific latent heat.
Ideal gases
Gas laws; concept of absolute zero; Ideal gas equation, $pV = nRT$, $pV = NkT$; Avogadro constant, molar mass and molecular mass; kinetic theory; root mean square speed and average kinetic energy.

Thermodynamics
First and second laws of thermodynamics; adiabatic and isothermal changes; p-V diagrams; Engine cycles and efficiency.

Electric field
Electric force; Coulombs law; electric fields; electric field strength; electric potential; motion of charged particles in electric field; the electron volt.

Capacitors
Charge, potential difference and capacitance; permittivity of free space; relative permittivity and dielectric constant; energy stored by a capacitor; series and parallel connections; capacitor charge and discharge; exponential decay; time constant.

Magnetic fields
Magnetic field around bar magnet, current-carrying wire and solenoid; force on a current-carrying conductor, $F = BIl \sin \theta$; magnetic flux density B and the Tesla; force on a charged particle moving in a magnetic field, $F = Bqv \sin \theta$; applications of motion of charged particles in magnetic fields.

Electromagnetic induction

Magnetic flux, $\Phi = BA \cos \theta$ and magnetic flux linkage $N\Phi$; electromagnetic induction, factors affecting the induced emf; Faraday's and Lenz's laws of e.m. induction; $\varepsilon = - d(N\Phi)/dt$; applications: straight conductor moving in magnetic field, ac generator; alternating currents and voltages.

Transformers
Operation of transformers; step up and step down transformers; efficiency of transformer; energy losses in transformer; power transmission.

Quantum phenomena
Photoelectric effect; photon model of electromagnetic radiation, the Planck constant; photon energy, $E = h f = hc/\lambda$; photoelectric equation: $h f = \varphi + Ek(max)$; energy levels; ionisation and excitation; applications in the fluorescent tube.

Wave-particle duality
Electron diffraction suggests that particles possess wave properties and the photoelectric effect suggests that electromagnetic waves have a particulate nature; de Broglie wavelength $\lambda=h/mv$.

Atomic, Nuclear and Particle Physics
Alpha-particle scattering experiment; Nuclear model of the atom; Strong nuclear force; Size of nuclei; Classification of particles; Beta decays; Radioactivity; Binding energy; Nuclear fission and fusion.

Learning outcomes

By the end of the module, students should be able to:

- Apply fundamental principles of physics in the analysis and solution of real-world problems in the sciences and engineering.
- Construct and present arguments through appropriate use of logical deduction of the fundamental principles of physics and experimentation.
- Solve problems systematically using the scientific method.
- Exhibit a range of key competences including time management, team-work, communication skills and presentation skills, research skills (including information retrieval, interpretation and citation) and critical analysis.

Indicative reading list

- S. Adams, J. Allday, P. (2013) Advanced Physics. Oxford University Press (ISBN 978-0-19-839292-7)
- Peter Warren, P.(2003) Advanced Physics Laboratory Book
- T. Lowe, J. Rounce, P. (2002) Calculations for A-level Physics. Nelson Thornes Ltd (ISBN 978-0748767489)
- T. Akrill, C. Millar, P. (2011) Practice in Physics. Hodder Education (ISBN 978-0340758137)

Subject specific skills

Students will develop the fundamental principles of physics in the analysis and solution of real-world problems in the sciences and engineering.

Transferable skills

Students will exhibit a range of key competences including time management, teamwork, communication skills and presentation skills, research skills (including information retrieval, interpretation and citation) and critical analysis.

Study

Study time

Type	Required
Seminars	100 sessions of 1 hour (33%)
Online learning (independent)	(0%)
Private study	140 hours (47%)
Assessment	60 hours (20%)
Total	300 hours

Private study description

Additional reading to consolidate the understanding of topics covered during lectures and seminars.
Practice past examination questions
Review articles for case study

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Assessment group D6

	Weighting	Study time
Lab Investigation Lab report on practical investigation	20%	12 hours
Theory Test In-person	20%	12 hours

	Weighting	Study time
Examination In-person	60%	36 hours

- Answerbook Gold (24 page)
- Students may use a calculator

Feedback on assessment

Tabula and individual discussion.

Past exam papers for FP008

Availability

Courses

This module is Core for:

- FIOE Warwick International Foundation Programme
  - Year 1 of FP19 Warwick International Foundation Programme - Engineering
  - Year 1 of FP20 Warwick International Foundation Programme - Physical Sciences

This module is Core option list A for:

- Year 1 of FIOE Warwick International Foundation Programme