Kickstart Physics

Our physics workshops cover many points of the HSC syllabus overseen by your own dynamic tutor, all in a real physics lab in the historic Physics Building at the University of Sydney.

Get hands-on experience of superconductors, generators, cathode ray tubes and the Wilson cloud chamber. See the experiments of Hertz, Lenz, Michelson-Morley, Einstein and more as your class spends the session completing five experiments.

Modules offered

Ideas to implementations

Dotpoints addressed from the Physics Stage 6 Syllabus Core:
11.3b, 13.1f, 12.1a, 12.2a, 12.3e 14.1f, 14.1h

The Meissner effect

- Hertz's experiment
  - Describe Hertz's observation of the effect of a radio wave on a receiver and the photoelectric effect he produced but failed to investigate
  - Outline qualitatively Hertz's experiments in measuring the speed of radio waves and how they relate to light waves
  - Identify the relationships between, frequency, speed of light and wavelength: $c = f \lambda$
  - Solve problems and analyse information using: $c = f \lambda$ Photoelectric effect
  - Identify Einstein's contribution to quantum theory.
  - Explain the particle model of light in terms of photons with particular energy and frequency
  - Solve problems and analyse information using: $E = hf$
  - Selecting and using appropriate media to present data and information

- Cathode rays
  - Identify that moving charged particles in a magnetic field experience a force
  - Outline Thomson's experiment to measure the charge : mass ratio of an electron

- Photo Electric Effect
  - Identify data sources gather, process and present information to summarise the use of the photoelectric effect in: – solar cells
  - Identify data sources, gather, process and analyse information and use available evidence to assess Einstein's contribution to quantum theory

- Semiconductors
  - Describe the difference between conductors, insulators and semiconductors in terms of band structures and relative electrical resistance
  - Identify absences of electrons in a nearly full band as holes, and recognise that both electrons and holes help to carry current
  - Compare qualitatively the relative number of free electrons that can drift from atom to atom in conductors, semiconductors and insulators

- Superconductors and the Meissner effect
    - Discuss the BCS theory
    - Gather and process information to describe how superconductors and the effects of magnetic fields have been applied to develop a maglev train
    - Process information to identify some of the metals, metal alloys and compounds that have been identified as exhibiting the property of superconductivity and their critical temperatures
    - Perform an investigation to demonstrate magnetic levitation
    - Analyse information to explain why a magnet is able to hover above a superconducting material that has reached the temperature at which it is superconducting
    - Discuss the advantages of using superconductors and identify limitations to their use
    - Describe the occurrence in superconductors below their critical temperature of a population of electron pairs unaffected by electrical resistance

Motors and generators

Dotpoints addressed from the Physics Stage 6 Syllabus Core:
11.2d, 11.3b 13.1b, 13.1d, 13.1f, 14.1d, 14.1f

Motor Effect

- Identify that the motor effect is due to the force acting on a current carrying conductor in a magnetic field
- Identify data sources, gather and process information to qualitatively describe the application of the motor effect in: the galvanometer and the loudspeaker
- Describe the main features of a DC electric motor and the role of each feature

Electromagnetic Induction and Lenz's Law

- Account for Lenz's Law in terms of conservation of energy and relate it to the production of back emf in motors
- Explain that, in electric motors, back emf opposes the supply emf
- Explain the production of eddy currents in terms of Lenz's Law
- Gather secondary information to identify how eddy currents have been utilised in electromagnetic braking

AC Induction Motors

- Describe the main features of an AC electric motor

Generators

- Describe the differences between AC and DC generators

Transformers

- Describe the purpose of transformers in electrical circuits
- Perform an investigation to model the structure of a transformer to demonstrate how secondary voltage is produced
- Solve problems and analyse information about transformers using: $V_p/V_s = n_p/n_s$

Qanta to Quarks

Dotpoints addressed from the Physics Stage 6 Syllabus Core:
11.3b, 13.1e, 11.2a, 11.2b, 12.1a, 12.2a, 13.b, 13.1f, H15

The standard model of Physics

- Atomic emission spectra (including Hydrogen)
  - Solve problems and analyse information using: $1/\lambda = R(1/nf2 - 1/ni2)$
  - Perform a first-hand investigation to observe the visible components of the hydrogen spectrum

- Wilson Cloud Chamber
  - Perform a first-hand investigation or gather secondary information to observe radiation emitted from a nucleus using a Wilson cloud chamber or similar detection device

Penetration of radioactive emission

- Tracking fundamental particles:
  - Identify ways by which physicists continue to develop their understanding of matter, using accelerators as a probe to investigate the structure of matter

- Mass defect in radioactive decay
  - Explain the concept of a mass defect using Einstein's equivalence between mass and energy
  - Solve problems and analyse information to calculate the mass defect and energy released in natural transmutation and fission reactions

Space

Dotpoints addressed from the Physics Stage 6 Syllabus Core:
12.2a, 13.1f, 14.1f, 14.1h

Speed and velocity

- Account for the orbital decay of satellites in low Earth orbit
- Compare qualitatively low Earth and geo-stationary orbits
- Outline Newton's concept of escape velocity

Projectile motion

- Describe the trajectory of an object undergoing projectile motion within the Earth's gravitational field in terms of horizontal and vertical components
- Describe Galileo's analysis of projectile motion $\Delta y = ut + at2$

c and relativity

- Discuss the role of the Michelson-Morley experiments in making determinations about competing theories
- Discuss the principle of relativity
- Describe the significance of Einstein's assumption of the constancy of the speed of light
- Identify that if c is constant then space and time become relative

- Discuss the concept that length standards gather and process information to interpret the results of the Michelson-Morley experiment
- Explain qualitatively and quantitatively the consequence of special relativity in relation to: length contraction and time dilation
- Discuss the implications of mass increase, time dilation and length contraction for space travel

Energy and rocket science

- Analyse the changing acceleration of a rocket during launch in terms of the: forces experienced by astronauts
- Identify why the term 'g forces' is used to explain the forces acting on an astronaut during launch
- Analyse the changing acceleration of a rocket during launch in terms of the: Law of conservation of momentum and the forces experienced by astronauts

Medical physics

Dotpoints addressed from the Physics Stage 6 Syllabus Core:
12.1b, 12.2b, 11.3b, 13.1f, 14.1f

- Describe how radioactive isotopes may be metabolised by the body to bind or accumulate in the target organ
- Gather secondary information to observe at least two ultrasound images of body organs
- Identify that the greater the difference in acoustic impedance between two materials, the greater is the reflected proportion of the incident pulse
- Explain how a computed axial tomography (CAT) scan is produced
- Describe circumstances where a CAT scan would be a superior diagnostic tool compared to either X-rays or ultrasound
- Explain that large differences would occur in the relaxation time between tissue containing hydrogen bound water molecules and tissues containing other molecules
- Gather and process secondary information to identify the function of the electromagnet, radio frequency oscillator, radio receiver and computer in the MRI equipment
- Outline properties of radioactive isotopes and their half-lives that are used to obtain scans of organs

Preliminary physics

Dotpoints addressed from the Physics Stage 6 Syllabus Core:
11.2a, 11.3b, 13.1f, 12.1a, 12.2, 12.3c, 12.4b, 14.1a, 14.1f

- Present information graphically of:
    - displacement vs time
    - velocity vs time for objects with uniform and non-uniform linear velocity

- Outline how the modulation of amplitude or frequency of visible light, microwaves and/or radio waves can be used to transmit information

- Identify the conditions necessary for total internal reflection with reference to the critical angle

- Identify data sources, gather, process and present information from secondary sources to identify areas of current research and use the available evidence to discuss some of the underlying physical principles used in one application of physics related to waves, such as:
    - Global Positioning System
    - CD technology
    - The internet (digital process)
    - DVD technology

- Describe sunspots as representing regions of strong magnetic activity and lower temperature

- Gather secondary information to relate brightness of an object to its luminosity and distance

- Solve problems to apply the inverse square law of intensity of light to relate the brightness of a star to its luminosity and distance from the observer

- Perform an investigation and gather first-hand information to observe the occurrence of different striation patterns for different pressures in discharge tubes

- Perform an investigation to demonstrate and identify properties of cathode rays using discharge tubes:
    - Containing a Maltese cross
    - Containing electric plates with a fluorescent display screen
    - Containing a glass wheel

- Analyse the information gathered to determine the sign of the charge on cathode rays

- Explain why the apparent inconsistent behaviour of cathode rays caused debate as to whether they were charged particles or electromagnetic waves