IBS Physics – U6

Curriculum Intent

Physics is the most fundamental science which aims to understand everything from tiny particles to vast galaxies. The aim of all IB programmes is to develop internationally minded people who strive to create a better society.

The course aims for all students to: ·

- Understand that science is only one of eight ways of knowing
- Understand how science is an international pursuit and the benefits and impacts of international collaborations in science.
- Become critically aware, as global citizens, of the ethical implications of the use of science and technology
- To recognise the contributions of all civilisations that led us to our current understanding of the physics
- develop experimental and investigative scientific skills using up to date technology
- develop and demonstrate a deep appreciation of the skills, knowledge and understanding of scientific methods
- promote students' interest in and enthusiasm for the subject, including an interest in further study and careers associated with the subject.

"Everything is theoretically impossible, until it is done" **– Robert A. Heinlein**

Students will learn: - Term 1: -

Topic D - Fields

- D1 Gravitational Fields
- D2 Electric Fields
- D3 Motion in Electromagnetic fields

Students will learn: - Term 2: -

Topic E - Nuclear and Quantum Physics

- E1 Structure of the Atom
- E3 Radioactive decay
- E4 Fission
- E5 Fusion

What does excellence look like?

Students should understand:

- Kepler's three laws of orbital motion
- Newton's universal law of gravitation for bodies treated as point masses
- conditions under which extended bodies can be treated as point masses
- that gravitational field strength g at a point is the force per unit mass experienced by a small point mass at that point
- gravitational field lines.
- the direction of forces between the two types of electric charge
- Coulomb's law for charged bodies treated as point charges
- the conservation of electric charge
- Millikan's experiment as evidence for quantization of electric charge
- that the electric charge can be transferred between bodies using friction, electrostatic induction and by contact, including the role of grounding (earthing)
- the electric field strength as given
- electric field lines

Knowledge, understanding & Skills

For calculations involving orbital motion the orbits will be assumed to be circular.
Newton's universal law of gravitation should be extended to spherical masses of uniform density by assuming that their mass is concentrated at their centre.
Determination of the resultant gravitational field strength will be restricted to points along a line joining two bodies.
Sketching and interpretation of gravitational field lines is required.
Gravitational potential is defined as being zero at infinity.
Problems may include, but are not limited to, determining the:
speed to maintain orbit
changes in energy when a satellite changes orbit
energetics of a satellite going into orbit
around a non-rotating planet starting from rest on its surface
energy conditions for an orbiting satellite to escape the gravitational influence of a planet.
Gravitational fields will include the radial fields around point or spherical masses and the (assumed) uniform field close to the surface of massive celestial bodies and planetary bodies.
The orbital motion of a satellite around a planet is restricted to a consideration of circular orbits.
An ability to map fields using potential is required.

The radial field around single point charge
inside and outside a single spherical conducting body
The field between two point charges and two oppositely charged parallel plates, including edge effects.
Sketching and interpretation of electric field lines is required.
Magnetic field patterns will be restricted to a bar magnet, a current-carrying straight wire, a current- carrying circular coil and an air-core solenoid.
Sketching and interpretation of magnetic field lines is required.
The determination of the direction of the magnetic field based in the current direction in a current-carrying straight wire is required.
Work done in electric fields can be expressed in both joules and electronvolts.
A range of permittivity values for Coulomb's law are required.

What does excellence look like?

Students should understand:

- the relationship between field line density and field strength
- the uniform electric field strength between parallel plates as given
- magnetic field lines.
- the motion of a charged particle in a uniform electric field
- the motion of a charged particle in a uniform magnetic field
- the motion of a charged particle in perpendicularly orientated uniform electric and magnetic fields
- the magnitude and direction of the force on a charge moving in a magnetic field as given by $F = qvB \sin \theta$
- the magnitude and direction of the force on a current-carrying conductor in a magnetic field as given by $F = BIL \sin \theta$
- the force per unit length between parallel wires where r is the separation between the two wires.
- the Geiger–Marsden–Rutherford experiment and the discovery of the nucleus
- Nuclear notation where A is the nucleon number Z is the proton number and X is the chemical
- that emission and absorption spectra provide evidence for discrete atomic energy levels
- that photons are emitted and absorbed during atomic transitions
- that the frequency of the photon released during an atomic transition depends on the difference in energy level as given by $E = hf$
- that emission and absorption spectra provide information on the chemical composition.
- isotopes
- nuclear binding energy and mass defect
- the variation of the binding energy per nucleon with nucleon number
- the existence of the strong nuclear force, a short-range, attractive force between nucleons
- the random and spontaneous nature of radioactive decay
- the changes in the state of the nucleus following alpha, beta and gamma radioactive decay
- the mass-energy equivalence as given by $E = mc^2$ in nuclear reactions
- the radioactive decay equations involving α, $\beta-$, $\beta+$, γ
- the existence of neutrinos and antineutrinos
- the penetration and ionizing ability of alpha particles, beta particles and gamma rays
- the activity, count rate and half-life in radioactive decay
- the changes in activity and count rate during radioactive decay using integer values of half-life
- the effect of background radiation on count rate.
- that energy is released in spontaneous and neutron-induced fission
- the role of chain reactions in nuclear fission reactions
- the role of control rods, moderators, heat exchangers and shielding in a nuclear power plant
- the properties of the products of nuclear fission and their management.
- that the stability of stars relies on an equilibrium between outward radiation pressure and inward gravitational forces
- that fusion is a source of energy in stars
- the conditions leading to fusion in stars in terms of density and temperature
- the effect of stellar mass on the evolution of a star
- the main regions of the Hertzsprung–Russell (HR) diagram and how to describe the main properties of stars in these regions
- the use of stellar parallax as a method to determine the distance d to celestial bodies as given by $d(\text{parsec}) = 1/p(\text{arc-second})$
- how to determine stellar radii.

Knowledge, understanding & Skills - cont

Electric potential is defined as being zero at infinity.
No work is done in moving charge or mass on an equipotential surface.
Equipotential surfaces should be recognized:
for a point charge
for a collection of up to four point charges
inside and outside a solid charged conducting sphere
inside and outside a hollow charged conduction sphere
between two opposite charged parallel plates

The kinetic energy of a charged particle stays constant in a magnetic field.
The determination of the charge to mass ratio for a charged particle by investigating its path in a uniform magnetic field is required.
The determination of the direction of the magnetic field based in the current direction in a current-carrying straight wire is required.
For parallel current carrying wires, the force is attractive when the current is flowing in the same direction.
Recall of chemical symbols is not required.
Only a qualitative approach to the Geiger–Marsden–Rutherford experiment is required for standard level.
Rutherford's simple energy conservation considerations can be used to determine the distance of closest approach.
For scattering experiments, energy values will be low enough so as only to consider the particle being repelled by the electric force.
An interpretation of binding energy curves is required.
Nuclear masses will be expressed in kg, in $MeVc^{-2}$ and in (unified) atomic mass units u.
Real-life contexts for this topic should include the choice of isotope in medical use, leaks in underground pipes, thickness of materials, and radioactive dating based on the penetration of the decay particle and half-life.
The weak nuclear force is not considered in this course.
An application of the radioactive decay equations for arbitrary time intervals is required for additional higher level.
The determination of the half-life of a nuclide is required.
Calculations to determine the energy released in fission reactions are required.
The impact of the long-term storage of nuclear waste should be considered.
Energy release calculations are required.
The conversion between astronomical units (AU), light years (ly) and parsecs (pc) is required.
The sketching and interpretation of HR diagrams, including the location of main sequence stars, red giants, super giants, white dwarfs, the instability strip and lines of constant radius, is required.
HR diagrams will be labelled with luminosity on the vertical axis and temperature on the horizontal axis.
The surface temperature and composition of a star can be determined from the stellar spectrum.
The determination of stellar radii using luminosity and surface temperature is required.
Cepheid variables are not required.

How will we assess impact?

- Peer and self-assessment
- Previous lesson recap quiz
- Check point tasks
- End of topic tests
- Teacher questioning
- Cumulative linear knowledge tests
- End of L6 and mid- U6 PPE examinations using unseen exam board paper

How can you enhance your learning at home?

- IB Physics revision
- Grade Gorilla
- Isaac Physics
- Physics Tube
- The institute of physics
- Physics and maths tutor
- Minute Physics
- Hyperphysics

Suggested homework tasks

Learn definitions of key terms
Group and independent research projects
Past examination question practice
Practical activity preparation, simulations and follow up.

International Opportunities

Visits Programmes

- **Community lectures on International themes**
- **International day across the school**
- **Primary research using student cultural diversity**

Within the curriculum

The Physics IB Standard curriculum is designed to deepen understanding and appreciation of how our International society makes decisions about world scientific issues.

Students are encouraged to research each theme beyond lessons using International research methods and set work to ensure that they can draw on a worldwide knowledge of the skills, techniques and theoretical understanding required for the further study of Physical Sciences at an International level.

"Time and space are finite in extent, but they don't have any boundary or edge. They would be like the surface of the earth, but with two more dimensions."
— **Stephen W. Hawking, Black Holes and Baby Universes and Other Essays**