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 1 Measurement and Uncertainty, Topic 2 Mechanics, Topic 3 Thermal Physics: - Physical Quantities. S.I.units. Measurements and Uncertainties. Scalars and vectors. Newton's equations of motion. Car stopping distances. Freefall and g. projectile motion. Force, mass, and weight. Drag and terminal velocity. Couples and torques. Archimedes' principle. Conservation of Energy. Power and Efficiency. Newton's laws. Linear momentum and Impulse. Molecular theory of solids, liquids, and gases. Temperature and absolute temperature. Internal energy. Specific heat capacity. Phase change. Specific latent heat. Pressure. Equation of state for an ideal gas. Kinetic model of an ideal gas. Mole, molar mass, and the Avogadro constant. Differences between real and ideal gases.

Topic 4 Waves, Topic 5 Electricity and Magnetism, Topic 6 Circular Motion and Gravitation: - Simple harmonic oscillations. Time period, frequency, amplitude, displacement, and phase difference. Conditions for simple harmonic motion. Travelling waves. Wavelength, frequency, period, and wave speed. Transverse and longitudinal waves. The nature of electromagnetic waves. The nature of sound waves. Wavefronts and rays. Amplitude and intensity. Superposition. Polarization. Reflection and refraction. Snell's law, critical angle, and total internal reflection. Diffraction through a single-slit and around objects. Interference patterns. Double-slit interference. Path difference. The nature of standing waves. Boundary conditions. Nodes and antinodes. Charge. Electric field. Coulomb's law. Electric current. Direct current (dc). Potential difference. Circuit diagrams. Kirchhoff's circuit laws. Heating effect of current and its consequences. Resistance. Ohm's law. Resistivity. Power dissipation. Cells. Internal resistance. Secondary cells. Terminal potential difference. Electromotive force (emf). Magnetic fields. Magnetic force. Period, frequency, angular displacement, and angular velocity. Centripetal force. Centripetal acceleration. Newton's law of gravitation. Gravitational field strength.

Topic 7 Atomic, nuclear and particle physics, Topic 8 Energy production: - Discrete energy and discrete energy levels. Transitions between energy levels. Radioactive decay. Fundamental forces and their properties. Alpha particles, beta particles and gamma rays. Half-life. Absorption characteristics of decay particles. Isotopes. Background radiation. The unified atomic mass unit. Mass defect and nuclear binding energy. Nuclear fission and nuclear fusion. Quarks, leptons, and their antiparticles. Hadrons, baryons, and mesons. The conservation laws of charge, baryon number, lepton number and strangeness. The nature and range of the strong nuclear. Feynman diagrams. Confinement. The Higgs boson. Specific energy and energy density of fuel sources. Sankey diagrams. Primary energy sources. Electricity as a secondary and versatile form of energy. Renewable and non-renewable energy sources. Conduction, convection, and thermal radiation. Black-body radiation. Albedo and emissivity. The solar constant. The greenhouse effects. Energy balance in the Earth surface–atmosphere system force, weak nuclear force, and electromagnetic force. Exchange particles.

Knowledge, understanding & Skills

Term 1:- Demonstrate knowledge, understanding, and application of: - units for physical quantities. S.I. base quantities and units, their symbols, and prefixes. derived units of S.I. base units and the quantities that use them. systematic errors and random errors in measurements. precision and accuracy of measurements and data. uncertainties in measurements, including when data are combined by addition, subtraction, multiplication, division, and raising to powers. graphical treatment of errors and uncertainties. scalar and vector quantities. addition of two vectors with scale drawings and with calculations. resolution of a vector into two perpendicular components. calculations involving vectors. average and instantaneous speed. Distance–time graphs to determine speed. displacement and velocity. displacement–time graphs to determine velocity. acceleration. velocity–time graphs to determine acceleration and displacement. The equations of motion for constant acceleration in a straight line. thinking distance and braking distance. the equations of motion for falling objects in a uniform gravitational field. measuring g., the equations of motion for projectiles. Forces, free-body diagrams, and centre of mass. drag and terminal velocity. Moments and equilibrium. Measuring pressure, density and up thrust. Measuring and describing energy transfers. Power and efficiency of mechanical systems. Conservation of momentum. Impulse and force-time graphs. Elastic and Inelastic collisions. Describing temperature change in terms of internal energy. Using Kelvin and Celsius temperature scales and converting between them. Applying the calorimetric techniques of specific heat capacity or specific. latent heat experimentally. Describing phase change in terms of molecular behaviour. Sketching and interpreting phase change graphs. Calculating energy changes involving specific heat capacity and specific latent heat of fusion and vaporization. Solving problems using the equation of state for an ideal gas and gas laws. Sketching and interpreting changes of state of an ideal gas on pressure–volume, pressure–temperature and volume–temperature diagrams.

Term 2:- Qualitatively describing the energy changes taking place during one cycle of an oscillation. Sketching and interpreting graphs of simple harmonic motion examples. Explaining the motion of particles of a medium when a wave passes through it for both transverse and longitudinal cases. Sketching and interpreting displacement–distance graphs and displacement– time graphs for transverse and longitudinal waves. Solving problems involving wave speed, frequency, and wavelength. Investigating the speed of sound experimentally. Sketching and interpreting diagrams involving wavefronts and rays. Solving problems involving amplitude, intensity, and the inverse square law. Sketching and interpreting the superposition of pulses and waves. Describing methods of polarization. Sketching and interpreting diagrams illustrating polarized, reflected, and transmitted beams. Solving problems involving Malus's law. Sketching and interpreting incident reflected and transmitted waves at boundaries between media. Solving problems involving reflection at a plane interface. Solving problems involving Snell's law, critical angle and total internal. Reflection. Determining refractive index experimentally. Qualitatively describing the diffraction pattern formed when plane waves are incident normally on a single slit. Quantitatively describing double-slit interference intensity patterns. Describing the nature and formation of standing waves in terms of superposition.

What does excellence look like?

- Carrying out practical processes logically, precisely, and accurately.
- Linking ideas together to answer questions logically and sequenced.
- Linking big ideas to answer real life Physics problems.
- Estimate orders of magnitude in a variety of context
- Checking for homogeneity in manipulated equations
- Process uncertainties and present them graphically
- Use qualitative and quantitative data to evaluate precision and accuracy
- Give examples of scalar and vector quantities
- Able to resolve2 or more coplanar vectors by scale drawing or calculation
- Substitute numerical values into algebraic equations using appropriate units for physical quantities
- Solve algebraic equations, including quadratic equations
- Translate information between graphical, numerical and algebraic forms
- Determine the slope and intercept of graphs
- Change the subject of an equation, including non-linear equations
- Apply the concepts underlying calculus by solving equations involving rates of change, e.g., t x Δ Δ = −λ x using a graphical method or spreadsheet modelling.
- Use of pressure gauges, barometers and manometers to take measurements to investigate the gas laws
- Can determine the energy transferred during phase changes both experimentally and by calculation
- Can describe total energy in terms of the potential and kinetic energy of the particles in a substance
- Can use temperature-time graphs to determine energy transferred during phase changes
- Can describe and justify the assumptions that underpin the ideal gas law
- Can use temperature-time graphs to determine energy transferred during phase changes Can plot and interpret graphs describing simple harmonic motion including displacement–
- time, velocity–time, acceleration–time and acceleration–displacement graphs
- Can use and manipulate equations linking displacement, velocity and acceleration in a simple harmonic oscillator
- Can derive the defining equation for simple harmonic motion from first principlesCan present both longitudinal and transverse waves using wavefronts and rays and use such diagrams to show and determine speed changes in different mediaCan describe and explain uses of polarisation for example in measuring sugar concentrationCan use and manipulate Malus's law to determine transmission and absorption of incident light
- Can use and manipulate Snell's law in terms of angle, velocity or refractive index
- Calculate force or field strength using or manipulating Coloumb's law
- Derive expressions for work done, field strength and potential using Coloumb's law
- Use IV graphs to characterise electric components and take measurements from these to determine resistance
- Use Fleming's left hand rule to determine the force experienced by a charge in a magnetic field
- Explain how Foucault's pendulum gives observable proof of the rotation of the Earth
- Determine experimentally how the friction a mass on a turntable experiences varies with angular speed
- Use data loggers to improve reliability of measurements
- Use video analysis to describe objects in circular motion
- Describe how the law of gravitation relates to the motion of satellites, planets, moons and galaxies.
- Explain how dealing with the radioactive output of nuclear decay is important in the debate over nuclear power stations
- Explain how carbon dating is used in providing evidence for evolution

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 papers

Knowledge, understanding & Skills

Demonstrate knowledge, understanding, and application of: - Solving problems using the drift speed equation. Solving problems involving current, potential difference and charge. Drawing and interpreting circuit diagrams. Identifying ohmic and non-ohmic conductors through a consideration of the V/I characteristic graph. Solving problems involving potential difference, current, charge, Kirchhoff's circuit laws, power, resistance, and resistivity. Investigating combinations of resistors in parallel and series circuits. Describing ideal and non-ideal ammeters and voltmeters. Describing practical uses of potential divider circuits, including the advantages of a potential divider over a series resistor in controlling a simple circuit. Investigating factors that affect resistance experimentally. Investigating practical electric cells (both primary and secondary). Describing the discharge characteristic of a simple cell (variation of terminal potential difference with time). Identifying the direction of current flow required to recharge a cell. Determining internal resistance experimentally. Solving problems involving emf, internal resistance and other electrical quantities. Determining the direction of force on a charge moving in a magnetic field. Determining the direction of force on a current-carrying conductor in a magnetic field. Sketching and interpreting magnetic field patterns. Determining the direction of the magnetic field based on current direction. Solving problems involving magnetic forces, fields, current and charges. Identifying the forces providing the centripetal forces such as tension, friction, gravitational, electrical, or magnetic. Solving problems involving centripetal force, centripetal acceleration, period, frequency, angular displacement, linear speed, and angular velocity. Qualitatively and quantitatively describing examples of circular motion. Including cases of vertical and horizontal circular motion. Describing the relationship between gravitational force and centripetal force. Applying Newton's law of gravitation to the motion of an object in circular orbit around a point mass. Solving problems involving gravitational force, gravitational field strength, orbital speed, and orbital period. Determining the resultant gravitational field strength due to two bodies.

Term 3:- Describing the emission and absorption spectrum of common gases. Solving problems involving atomic spectra, including calculating the wavelength of photons emitted during atomic transitions. Completing decay equations for alpha and beta decay. Determining the half-life of a nuclide from a decay curve. Investigating half-life experimentally (or by simulation). Solving problems involving mass defect and binding energy. Solving problems involving the energy released in radioactive decay, nuclear fission, and nuclear fusion. Sketching and interpreting the general shape of the curve of average binding energy per nucleon against nucleon number. Describing the Rutherford-Geiger-Marsden experiment that led to the discovery of the nucleus. Applying conservation laws in particle reactions. Describing protons and neutrons in terms of quarks. Comparing the interaction strengths of the fundamental forces, including gravity. Describing the mediation of the fundamental forces through exchange Particles. Sketching and interpreting simple Feynman diagrams. Describing why free quarks are not observed. Solving specific energy and energy density problems. Sketching and interpreting Sankey diagrams. Describing the basic features of fossil fuel power stations, nuclear power stations, wind generators, pumped storage hydroelectric systems and solar power cells. Solving problems relevant to energy transformations in the context of these generating systems. Discussing safety issues and risks associated with the production of nuclear power. Describing the differences between photovoltaic cells and solar heating panels. Sketching and interpreting graphs showing the variation of intensity with wavelength for bodies emitting thermal radiation at different temperatures. Solving problems involving the Stefan–Boltzmann law and Wien's displacement law. Describing the effects of the Earth's atmosphere on the mean surface temperature. Solving problems involving albedo, emissivity, solar constant and the Earth's average temperature.

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**