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Course Outline

Physics A LEVEL

Overview

Pearson Edexcel International A level in Physics Syllabus at GEMS Wesgreen International School aims to provide the students an opportunity to develop attitudes relevant to Physics such as concern for accuracy and precision, objectivity, and inquiry. Pearson Edexcel International A level Physics helps learners develop the knowledge and skills that will prepare them for successful university study.

Learning Outcomes

Students should be helped to understand how, through the ideas of physics, the complex and diverse phenomena of the natural world can be described in terms of several key ideas which are of universal application, and which can be illustrated in the separate topics set out below. These ideas include:

- The use of models, as in the particle model of matter or the wave models of light and of sound.
- The concept of cause and effect in explaining such links as those between force and acceleration, or between changes in atomic nuclei and radioactive emissions.
- The phenomena of 'action at a distance' and the related concept of the field as the key to analysing electrical, magnetic, and gravitational effects.
- Those differences, for example between pressures or temperatures or electrical potentials, are the drivers of change.

Topic Overviews

IA2- Level Term 1

IA2 Unit 4: Further Mechanics, Fields and Particles

***Unit code: WPH14/01**

This topic covers further mechanics, electric and magnetic fields, and nuclear and particle physics. This topic may be studied using applications that relate to mechanics, for example transportation and fields, for example communications and display techniques. This topic also enables students to develop practical and mathematical skills.

4.3 Further Mechanics

Approximate length:16 hours(theory) + 7 hours (practical)

This topic covers impulse, conservation of momentum in two dimensions and circular motion. It can be studied using applications that relate to, for example, a modern rail transportation system. This unit includes many opportunities for developing experimental skills and techniques by carrying out more than just the core practical experiments.

Specific objectives with the Pearson Edexcel syllabus covered:

- to understand how to use the equation impulse = $F\Delta t = \Delta p$ (Newton's second law of motion)
- to Investigate (CORE PRACTICAL 9) the relationship between the force exerted on an object and its change of momentum
- to understand how to apply conservation of linear momentum to problems in two dimensions
- to use (CORE PRACTICAL 10:)ICT to analyse collisions between small spheres, e.g. ball bearings on a table top
- to understand how to determine whether a collision is elastic or inelastic
- be able to derive and use the equation $E_k = \frac{p^2}{2m}$ for the kinetic energy of a non-relativistic particle
- be able to express angular displacement in radians and in degrees, and convert between these units
- to understand what is meant by angular velocity and be able to use the equations $v = r\omega$ and $\omega = 2\pi / T$
- be able to use vector diagrams to derive the equations for centripetal acceleration $a = \frac{v^2}{r} = r\omega^2$ and understand how to use these equations
- understand that a resultant force (centripetal force) is required to produce and maintain circular motion
- be able to use the equations for centripetal force $F = ma = \frac{mv^2}{r} = mr\omega^2$.

4.4 Electric and Magnetic**Fields Approximate length: 20 hours(theory) + 7hours (practical)**

This topic covers Coulomb's law, capacitors, magnetic flux density and the laws of electromagnetic induction. This topic may be studied using applications that relate to, for example, communications and display techniques. This unit includes many opportunities for developing experimental skills and techniques by carrying out more than just the core practical experiment.

Specific objectives with the Pearson Edexcel syllabus covered:

- to understand that an electric field (force field) is defined as a region where a charged particle experiences a force
- to understand that electric field strength is defined as $F = E/Q$ and be able to use this equation
- to be able to use the equation $F = \frac{Q_1Q_2}{4\pi\epsilon_0r^2}$ for the force between two charges
- to be able to use the equation $E = \frac{Q}{4\pi\epsilon_0r^2}$ for the electric field due to a point charge 96 know and understand the relation between electric field and electric potential
- to be able to use the equation $E = V/d$ for an electric field between parallel plates
- to be able to use $V = \frac{Q}{4\pi\epsilon_0r}$ for a radial field
- to be able to draw and interpret diagrams using field lines and equipotential to describe radial and uniform electric fields
- to understand that capacitance is defined as $C = Q/V$ and be able to use this equation

- to be able to use the equation $W = \frac{1}{2}QV$ for the energy stored by a capacitor, be able to derive the equation from the area under a graph of potential difference against charge stored and be able to derive and use the equations $W = \frac{1}{2}CV^2$; and $W = \frac{1}{2}\frac{Q^2}{C}$

4.5 Nuclear and Particle Physics Fields Approximate length: 16 hours(theory) + 4 hours (practical)

This topic covers atomic structure, particle accelerators and the standard quark-lepton model. This topic is the subject of current research, involving the acceleration and detection of high-energy particles. It may be taught by exploring a range of experiments such as

- alpha scattering and the nuclear model of the atom
- accelerating particles to high energy
- detecting and interpreting interactions between particles.

Specific objectives with the Pearson Edexcel syllabus covered:

- to understand what is meant by nucleon number (mass number) and proton number (atomic number)
- to understand how large-angle alpha particle scattering gives evidence for a nuclear model of the atom and how our understanding of atomic structure has changed over time
- to understand that electrons are released in the process of thermionic emission and how they can be accelerated by electric and magnetic fields
- to understand the role of electric and magnetic fields in particle accelerators (linac and cyclotron) and detectors (general principles of ionization and deflection only)
- to be able to derive and use the equation $r = \frac{p}{BQ}$ for a charged particle in a magnetic field
- be able to apply conservation of charge, energy and momentum to interactions between particles and interpret particle tracks
- to understand why high energies are required to investigate the structure of nucleons
- be able to use the equation $\Delta E = c^2 \Delta m$ in situations involving the creation and annihilation of matter and antimatter particles 119 be able to use MeV and GeV (energy) and MeV/c², GeV/c² (mass) and convert between these and SI units 120 understand situations in which the relativistic increase in particle lifetime is significant (use of relativistic equations not required)
- to know that in the standard quark-lepton model particles can be classified as:
 - baryons (e.g. neutrons and protons), which are made from three quarks
 - mesons (e.g. pions), which are made from a quark and an antiquark
 - leptons (e.g. electrons and neutrinos), which are fundamental particles
 - photons and that the symmetry of the model predicted the top quark
- to know that every particle has a corresponding antiparticle and be able to use the properties of a particle to deduce the properties of its antiparticle and vice versa
- to understand how to use laws of conservation of charge, baryon number and lepton number to determine whether a particle interaction is possible
- be able to write and interpret particle equations given the relevant particle symbols

Term 2-A Level

IA2 Unit 5: Thermodynamics, Radiation, Oscillations and Cosmology

***Unit code: WPH15/01**

This topic covers thermal energy, nuclear decay, oscillations and astrophysics and cosmology. This topic may be studied using applications that relate to thermodynamics, for example space technology, and to nuclear radiation, for example nuclear power stations and medical physics. This topic also enables students to develop practical and mathematical skills.

5.3 Thermodynamics

Fields Approximate length: 16 hours(theory) + 5hours (practical)

This topic covers specific heat capacity, specific latent heat, internal energy and the gas equation. This topic may be studied using applications that relate, for example, to space technology. This unit includes many opportunities for developing experimental skills and techniques by carrying out more than just the core practical experiments.

Specific objectives with the Pearson Edexcel syllabus covered:

- be able to use the equations $\Delta E = mc\Delta\theta$ and $\Delta E = L\Delta m$
- to calibrate (CORE PRACTICAL 12) a thermistor in a potential divider circuit as a thermostat
- to (CORE PRACTICAL 13) determine the specific latent heat of a phase change
- to understand the concept of internal energy as the random distribution of potential and kinetic energy amongst molecules
- to understand the concept of absolute zero and how the average kinetic energy of molecules is related to the absolute temperature
- be able to use the equation $pV = NkT$ for an ideal gas
- to (CORE PRACTICAL 14) investigate the relationship between pressure and volume of a gas at fixed temperature
- be able to derive and use the equation $\frac{1}{2}m\langle c^2 \rangle = \frac{3}{2}kT$

5.4 Nuclear Decay Fields

Approximate length: 16 hours(theory) + 4 hours (practical)

This topic covers radioactive decay. This topic may be studied using applications that relate to, for example, medical physics and carbon dating. This unit includes many opportunities for developing experimental skills and techniques by carrying out more than just the core practical experiments.

Specific objectives with the Pearson Edexcel syllabus covered:

- to understand the concept of nuclear binding energy and be able to use the equation $\Delta E = c^2 \Delta m$ in calculations of nuclear mass (including mass deficit) and energy
- to use the atomic mass unit (u) to express small masses and convert between this and SI units
- to understand the processes of nuclear fusion and fission with reference to the binding energy per nucleon curve
- to understand the mechanism of nuclear fusion and the need for very high densities of matter and very high temperatures to bring about and maintain nuclear fusion

- to understand that there is background radiation and how to take appropriate account of it in calculations
- to understand the relationships between the nature, penetration, ionising ability and range in different materials of nuclear radiations (alpha, beta and gamma)
- be able to write and interpret nuclear equations given the relevant particle symbols
- to (CORE PRACTICAL 15) investigate the absorption of gamma radiation by lead
- to understand the spontaneous and random nature of nuclear decay
- be able to determine the half-lives of radioactive isotopes graphically and be able to use the

equations for radioactive decay activity $A = \lambda N$, $\frac{dN}{dt} = -\lambda N$, $\lambda = \frac{\ln 2}{t_{1/2}}$, $N = N_0 e^{-\lambda t}$ and $A = A_0 e^{-\lambda t}$; and derive and use the corresponding log equations.

5.5 Oscillations

Approximate length: 14 hours(theory) + 4hours (practical)

This topic covers simple harmonic motion and damping. This topic may be studied using applications that relate to, for example, the construction of buildings in earthquake zones. This unit includes many opportunities for developing experimental skills and techniques by carrying out more than just the core practical experiments.

Specific objectives with the Pearson Edexcel syllabus covered:

- to understand that the condition for simple harmonic motion is $F = -kx$, and hence understand how to identify situations in which simple harmonic motion will occur
- be able to use the equations $a = -\omega^2 x$, $x = A \cos \omega t$, $v = -A\omega \sin \omega t$, $a = -A\omega^2 \cos \omega t$, and $\omega = 2\pi f$ and $\omega = 2\pi/T$ as applied to a simple harmonic oscillator
- be able to use equations for a simple harmonic oscillator $k/m T = 2\pi$, and a simple pendulum $g l T = 2\pi$
- to be able to draw and interpret a displacement-time graph for an object oscillating and know that the gradient at a point gives the velocity at that point
- to be able to draw and interpret a velocity-time graph for an oscillating object and know that the gradient at a point gives the acceleration at that point
- to understand what is meant by resonance
- to (CORE PRACTICAL 16) determine the value of an unknown mass using the resonant frequencies of the oscillation of known masses
- to understand how to apply conservation of energy to damped and undamped oscillating systems
- to understand the distinction between free and forced oscillations
- to understand how the amplitude of a forced oscillation changes at and around the natural frequency of a system and know, qualitatively, how damping affects resonance
- to understand how damping and the plastic deformation of ductile materials reduce the amplitude of oscillation.

5.6 Astrophysics and Cosmology Approximate length: 12 hours(theory) + 4hours (practical)

This topic covers gravitational fields and the physical interpretation of astronomical observations, the formation and evolution of stars and the history and future of the universe.

Specific objectives with the Pearson Edexcel syllabus covered:

- to understand that a gravitational field (force field) is defined as a region where a mass experiences a force
- to understand that gravitational field strength is defined as $g = F/m$ and be able to use this equation
- to be able to use the equation $F = \frac{Gm_1m_2}{r^2}$ (Newton's law of universal gravitation)
- to be able to derive and use the equation $g = \frac{Gm}{r^2}$ for the gravitational field due to a point mass
- to be able to use the equation $V_{grav} = \frac{-Gm}{r}$ for a radial gravitational field
- to be able to compare electric fields with gravitational fields
- to be able to apply Newton's laws of motion and universal gravitation to orbital motion
- to understand what is meant by a black body radiator and be able to interpret radiation curves for such a radiator
- to be able to use the Stefan-Boltzmann law equation $L = \sigma AT^4$ for black body radiators
- to be able to use Wien's law equation $\lambda_{max}T = 2.898 \times 10^{-3} \text{ m K}$ for black body radiators
- to be able to use the equation, intensity $I = \frac{L}{4\pi d^2}$, where L is luminosity and d is distance from the source
- to understand how astronomical distances can be determined using trigonometric parallax
- to understand how astronomical distances can be determined using measurements of intensity received from standard candles (objects of known luminosity)
- to be able to sketch and interpret a simple Hertzsprung-Russell diagram that relates stellar luminosity to surface temperature
- to understand how to relate the Hertzsprung-Russell diagram to the life cycle of stars
- to understand how the movement of a source of waves relative to an observer/detector gives rise to a shift in frequency (Doppler effect)
- to be able to use the equations for redshift $z = \frac{\Delta\lambda}{\lambda} = \frac{\Delta f}{f} = \frac{v}{c}$ for a source of electromagnetic radiation moving relative to an observer and $v = H_0d$ for objects at cosmological distances
- to understand the controversy over the age and ultimate fate of the universe associated with the value of the Hubble constant and the possible existence of dark matter.

IA2 Unit 6: Practical Skills in Physics II***Unit code: WPH16/01**

Students are expected to further develop the experimental skills they acquired in Units 1 and 2. Students are expected to develop these skills, and a knowledge and understanding of experimental techniques, by carrying out a range of practical experiments and investigations while they study Units 4 and 5. This unit will assess students' knowledge and understanding of experimental procedures and techniques that were developed when they conducted these experiments.

Assessment

Formative: Throughout the units, the students will complete graded work, quizzes and practical, research activities, which allows the teacher to assess the students' attainment and inform their planning.

For each unit the students complete a pre- and post-test. This allows us to see progress across the units and to inform our planning.

Summative: At the end of first term, we complete internal tests – Unit based and combined Units. Students complete standardized tests such as Mock Exam. This allows us to measure the students' progress throughout the term and year.