Blackwater Community School

Leaving Cert Physics learning outcomes

Each topic has a set of boxes which the pupil can tick to show how they understand and know the topic. This is useful for revision and self-evaluation. **Bold** text indicates **higher level only content only**. Items <u>underlined</u> are mandatory experiments. Any items indented with an arrow represent a link to other areas of the Physics course that overlap in terms of calculations, concepts and questions asked in the Leaving Cert

Contents

Introduction to Physics

Introduction to Physics By the end of this section pupils should be able to:	Good	Fair	Poor
Explain what Leaving Certificate Physics is Demonstrate familiarity with the use of complex functions on scientific calculators, particularly: exp, Sin/Cos/Tan, x^2, x^{-1}, 1/x, add/multiply/divide/subtract Familiarise themselves with SI units Recognise the need for SI units in Physics Compare and contrast standard and derived units and the physical quantities they represent Assemble a derived unit from basic equations Explain the concept of proportionality Demonstrate an understanding of lab safety in Physics Understand the headings required for Leaving Cert Physics experiments			

Mechanics

M1 Linear Motion By the end of this section pupils should be able to:	Good	Fair	Poor
Be familiar with the SI units of mass, length and time Define displacement, velocity and acceleration and give their units Be able to manipulate and use the equations of motion in linear (horizontal and vertical) motion calculations **Be able to derive the equations of motion** <u>Measure velocity and acceleration using lab apparatus</u> <u>Measure 'g' using lab apparatus</u> Plot distance-time and velocity-time graphs Read and critically analyse distance time and velocity time graphs to calculate velocities, accelerations and distances travelled Identify the relevance of linear motion in real world examples such as athletics, cars, rocket motion, etc.			
M2 Vectors and Scalars By the end of this section pupils should be able to:	Good	Fair	Poor
Distinguish between vectors and scalars Calculate the resultant of horizontal vectors **Calculate the resultant of perpendicular vectors using the triangle and parallelogram laws** **Resolve a vector into perpendicular components** **Find the resultant of two or more vectors by calculation and experiment** Interpret everyday examples of vectors, e.g. a ball rolling down a hill, wheelchair going up a ramp, etc.			

M3 Newton's Laws of motion By the end of this section pupils should be able to:	Good	Fair	Poor
State Newton's 3 Laws <u>Verify Newton's 2nd Law using lab apparatus</u> Define force and momentum and give their units Identify the vector nature of force and momentum and as such calculate resultant forces and momentums Explain how F=ma is a special case of Newton's 2nd Law Be able to use F=ma in conjunction with uvast equations in calculations Define friction as an opposing force of motion Identify everyday applications of Newton's Laws, e.g. seatbelts, rocket travel, sports, ball games, ***Specialist equations: The elevator, skydiver,*** Identify everyday examples of friction, e.g. tyre grip, reduce with lubricants, air resistance			
M4 Conservation of Momentum By the end of this section pupils should be able to:	Good	Fair	Poor
State the Principle of Conservation of Momentum <u>Demonstrate the PCM using lab apparatus</u> Use the PCM in, conjunction with F=ma and uvast equations to complete appropriate calculations on mechanical collisions ***Specialist questions: Gun and bullet, golf ball and club, bullet and block, car and lorry in opposite directions*** Give real world examples of mechanical collisions, e.g. ball games, spacecraft, jet aircraft, gun ⇨ Synthesise the PCM with other areas of the Physics course, namely: conservation of momentum in nuclear decay and particle collisions			

M5 Pressure, Gravity, Moments By the end of this section pupils should be able to:	Good	Fair	Poor
Density/Pressure: Define pressure and density and give their units Calculate pressures exerted in solids using P=F/A Calculate pressures exerted in liquids using P = ρhg State Archimedes' Principle and the Law of Flotation Explain what is meant by upthrust and give examples of its application, e.g. keeping up ships, measuring impurity of King's crown Demonstrate Archimedes' Principle and the Law of Flotation Outline how a hydrometer works and give examples of its uses ***Specialist questions: block under water (float/sink?), buoyancy calculations, submarine, horse on water barge*** <u>Verify Boyle's Law</u> Demonstrate pressure in gases using collapsing coke can Appreciate the historical significance as Robert Boyle as a local scientist and the implications of his discoveries for the scientific world Give everyday examples of pressures in gases, e.g. the bends, the weather Calculate changes in pressure according to changes in volume using Boyle's Law (PV=k) *Gravity:* State Newton's Universal Law of Gravitation Explain why Newton's Universal Law of Gravitation is an example of an inverse square law			

Explain why certain planets (E.g. Earth) can hold an atmosphere Use Newton's Equation $F = G\frac{m_1 m_2}{r^2}$ to calculate forces, masses, distances between bodies, and values for g and weights on other planets ***Specialist questions: weightlessness between Earth and Moon*** Understand the relationship between gravitational force and weight Calculate values for g on Earth and other planets using $g = GM/d^2$ *Moments:* Define moments, levers, couple and give examples of each Use M=Fd in calculations involving perpendicular, coplanar forces **Use M=Fd and vectors to calculate moments for non-perpendicular forces** ***Specialist questions: People carrying large weight on a bar, walking up hill with bar*** ⇨ Synthesise the concepts of work, energy and power with other areas of the Physics course, namely moments experience by current carrying coil in a magnetic field Distinguish between static and dynamic equilibrium State the conditions of equilibrium for a set of coplanar forces <u>Verify the conditions of equilibrium for a set of coplanar forces</u>			

M6 Work, Energy, Power By the end of this section pupils should be able to:	Good	Fair	Poor
Define work and give its unit Use the formula work = Force x Distance, along with uvast equations, Newton's Laws and PCM in appropriate calculations Identify energy as the ability to do work Describe the different forms of energy State the principle of conservation of energy Be able to give examples of energy changes from one form to another Explain what is meant by renewable and non-renewable energy and state sources of each Use the PE and KE equations, along with uvast/PCM/ Newton's Laws, work = Fd in suitable calculations ***Specialist questions: Pendulum swinging, find vertical height from angle and max speed from v^2=2gh*** Define power Apply the concept of power in estimating average powers of people running up steps, lifting weights etc Analyse the application of power in different energy converting devices, e.g. motors, light bulbs etc Use P = W/t in calculations Calculate % efficiency of devices using % efficiency = Power output/input x 100/1 ⇨ Synthesise the concepts of work, energy and power with other areas of the Physics course, namely: Heating appliances, electrical devices, electric circuits			

M7 Circular Motion By the end of this section pupils should be able to:	Good	Fair	Poor
Explain what is meant by radians **Convert radians into degrees and degrees into radians** **Define linear and angular velocity** **Compare and contrast linear and angular velocity** **Derive $v = r\omega$ and use in calculations** **Explain what is meant by centripetal acceleration and centripetal force** **Use $a = r\omega^2$, $a = v^2/r$ and $F = m r \omega^2$ and $F = m v^2/r$ in calculations** ⇨ **Synthesise the phenomenon of circular motion in mechanics with other areas of the Physics course, namely: calculating the radius of circular paths of charged particles in magnetic fields** **Demonstrate circular motion in action using simple lab examples and worldly uses, e.g. cars going round a bend, ice-skater pirouetting cyclotron, CRT, planetary orbits, satellites.** **Derive the relationship between the period of a satellites orbit and its radius and use in calculations** **Explain what is meant by geostationary/parked orbits and calculate relevant height for such orbits** ***Specialist questions: ISS orbiting Earth, number of sunrises seen in a day***			

M8 Simple harmonic motion (SHM), Hooke's Law By the end of this section pupils should be able to:	Good	Fair	Poor
Explain what is meant by elasticity, elastic limit and restoring forces **Give examples of elastic bodies** **State Hooke's Law** **Use F = -ks in calculations** **Explain what it means for a body to be moving with SHM** **Analyse various motions to determine if they are SHM,e.g. the tides, oscillating pendulum** **Relate the motion of a body obeying Hooke's Law to SHM** **Identify the formula for the period of a body executing SHM as $T = 2\pi/\omega$ and its acceleration as $a = -\omega^2 s$** **Combine the above equations in calculations on SHM and Hooke's Law** ***Specialist questions: Tide going in/out, man oscillating on springs of bike*** **<u>Investigate the relationship between the period and length of a simple pendulum and hence calculate a value for 'g'</u>**			

Heat

H1 Temperature By the end of this section pupils should be able to:	Good	Fair	Poor
Explain the concept of temperature Compare the SI unit of Temperature, the Kelvin, to degrees Celsius and convert one to the other Explain what is meant by thermometric property and give examples Demonstrate some examples of thermometric properties in the lab Plot the calibration for (i) a liquid in glass thermometer, (ii) a thermocouple, using the mercury thermometer as a standard Understand that a thermometer measures temperature Evaluate why two different will differ according to their thermometric properties Understand the need for practical thermometers Conceptualise heat as a form of energy that causes a rise in temperature when added or a fall in temperature when withdrawn Define, and give the units of - Heat capacity - Specific heat capacity - Latent heat - Specific latent heat of fusion of ice - Specific latent heat of vaporisation of water Use the equations for the energy transfer in ($mc\Delta T$, and ml) in relevant calculations ***Specialist questions: heat pump, transferring heat from a hot saucepan to a room, hot copper to cold water, phase change material, athlete sweating*** Measure the specific heat capacity of a liquid by electrical method Measure the specific latent heat of fusion of ice			

<u>Measure the specific latent heat of vaporisation of water</u> Explain how a storage heaters and a heat pump works Connect the concept of latent heat with the phenomenon of perspiration in humans Explain what is meant by conduction, convection, radiation and demonstrate each of these in the lab Compare the conductivity of different solids Explain what is meant by conductors and insulators of heat Define U-Value and Solar constant Apply the concepts of U-value and solar constant to insulation in homes and solar heating			

Waves and sound

WS1 properties of waves and wave phenomena By the end of this section pupils should be able to:	Good	Fair	Poor
Explain what is meant by a wave and give examples in everyday life Differentiate between transverse and longitudinal waves and give examples of each Express the relationship between speed, frequency of a wave as c = fλ Understand that something can only be classified as a wave if it exhibits all of the following phenomena: - Reflection - Refraction - Diffraction - Interference Explain what is meant by each of the above phenomena and give examples of wave forms exhibiting each Demonstrate the above phenomena in the lab using a ripple tank Evaluate why only transvers waves can be polarised and give applications of this effect (e.g. stress polarisation, sunglasses) ⇨ Synthesis the phenomenon of diffraction with the wave nature of light section of the Physics course Explain what is meant by the Doppler effect Describe this effect using diagrams, in terms of changes in frequency/wavelength when approaching/receding from a stationary observer ***Specialist concept: Breaking the sound barrier sonic boom,*** Describe everyday applications of the Doppler effect, e.g. red shift in stars, Garda speed traps **Use the Doppler equations in calculations**			

WS2 Vibrations and sound By the end of this section pupils should be able to:			
Understand that every source of sound is a vibrating object Understand that sound exhibits the 5 wave phenomena Demonstrate interference using 2 loudspeakers and a signal generator Evaluate the importance of sound interference in the acoustics of theatres, studios, etc. and the impact of noise pollution and the use of interference in noise reduction Demonstrate using a bell jar, vacuum pump and electric bell that sounds requires a medium to travel Explain why the speed of sound changes in various media Describe the characteristics of musical notes and demonstrate an understanding of the properties of sound waves on which they depend i.e. - Loudness (depends on amplitude) - Pitch (frequency) - Quality (number and types of overtones) Define fundamental frequency and natural frequency Demonstrate natural frequencies using tuning forks Define resonance and describe examples of resonance, e.g. breaking glass, barton's pendulum, Tacoma narrows bridge **Explain what are meant by stationary waves and harmonics and create each and harmonics using signal generators** Determine the relationship between frequency and length for stretched strings and pipes open at both ends and closed at one end Give examples of musical instruments based on these designs **Draw diagrams of harmonics on stretched strings and pipes and calculate the number and types of harmonics possible** Measure the speed of sound in air using the resonance tube method			

Use the equation $f = \frac{1}{2L}\sqrt{\frac{T}{m}}$ **in stretched string calculations** Investigate the variation of the fundamental frequency of a stretched string with length Investigate the variation of the fundamental frequency of a stretched string with tension Define sound intensity and give its unit Explain what is meant by threshold of hearing and the limits of audibility Demonstrate how and why a sound level meter is used and describe the dBA scale **Understand that doubling sound intensity increases the intensity level by 3dB** Connect the concept of sound intensity and intensity level with the occurrence of hearing impairment and the use of ear protection in industry			

Optics

O1 Reflection By the end of this section pupils should be able to:	Good	Fair	Poor
State the laws of reflection of light and demonstrate these laws in the lab using a ray box and plane mirror Understand what is meant by lateral inversion in plane mirrors and vertical inversion in curved mirrors and lenses Understand what is meant by a real and virtual image Construct ray diagrams for the formation of real and virtual images in a concave and convex mirrors Give examples of uses of these types of mirrors Use the mirror formulae of 1/u + 1v = 1/f and M = v/u in calculations <u>Measure the focal length of a concave mirror</u>			
O2 Refraction By the end of this section pupils should be able to:			
State the laws of refraction Demonstrate the concept of refraction using lab apparatus and give examples of refraction in nature/everyday life Explain what is meant by the refractive index of a medium Use n = sin i/ sin r in calculations, along with **n = (speed of light in air) / (speed of light in medium)** and n = (real depth)/ (apparent depth) ***Specialist questions: Diamonds, thickness of glass block*** <u>Verify Snell's Law and measure the refractive index of a glass block</u> <u>Measure the refractive index of a liquid by means of real and apparent depth</u> State what is meant by critical angle			

Connect critical angle with refractive index and the equation $n = 1/(\text{Sin } C)$ Explain what is meant by total internal reflection (TIR) Demonstrate critical angle and TIR in the lab using ray box, glass blocks and prisms Describe how light is transmitted along optical fibres using TIR Give advantages of optical fibres for information transmission Identify applications of TIR in life, e.g. reflective road signs, mirages, optical fibres in phone lines, Christmas tree lights, endoscopy Distinguish between convex (converging) and concave(diverging) lenses Construct ray diagrams for the formation of real and virtual images in a concave and convex lenses Give examples of uses of these types of lenses Use the lens formulae of $1/u + 1v = 1/f$ and $M = v/u$ in calculations Measure the focal length of a convex lens Explain what is meant by the power of a lens Use $P = 1/f$ in calculations and be able to calculate the combined power of 2 lenses using $Pt = P1 + P2$ Identify the optical structures and functioning of the eye Describe how short and long sightedness occur and state the lens required to remedy each condition			

Wave nature of light

W1 Diffraction and interference By the end of this section pupils should be able to:	Good	Fair	Poor
Outline the basis of Young's double slit experiment and discuss its implications Demonstrate diffraction and interference in the lab using double slits and a monochromatic light source **Derive the expression $n\lambda = dSin\theta$ from Young's experiment** Evaluate why a diffraction grating is more suitable for LC Physics experiments than double slits Explain what is meant by grating constant d and be able to calculate grating constants Use $n\lambda = dSin\theta$ in appropriate calculations <u>Measure the wavelength of monochromatic light by laser method</u> Describe everyday examples of light interference patterns, e.g. petrol films, soap bubbles Demonstrate light polarisation, thereby identifying light as a transverse wave Explain what is meant by dispersion Demonstrate dispersion using a prism and diffraction, and evaluate the differences in spectra Understand the phenomenon of dispersion as seen everyday examples such as CD surfaces, rainbows, polished gemstones Explain what is meant by primary, secondary and complementary colours and give examples of each Understand how combinations of these various colours are used, for example, in stage lighting, television, etc. Explain what is meant by the electromagnetic spectrum Arrange the various forms of electromagnetic radiation in order of frequency and wavelength Describe uses for the various forms of electromagnetic radiation Draw a diagram of a spectrometer and label its principle parts Demonstrate how to use a spectrometer to measure angles of diffraction, including how to read a vernier scale			

Electricity

E1 Static electricity By the end of this section pupils should be able to:	Good	Fair	Poor
Understand the difference between static electricity and current electricity Demonstrate electrification by contact by rubbing things together Understand the difference between positive and negative charges Identify that like charges repel, unlike charges attract and demonstrate this using simple experiments Explain what is meant by electrical conductors and insulators and give examples of each Identify the unit of electric charge as the coulomb Give examples of static electricity phenomena, e.g. TV screen dust, sparks from clothes, flour mill hazards, fuelling aircraft precautions Draw and label a diagram of a gold leaf electroscope Explain the uses for a gold leaf electroscope Demonstrate electrification by contact using an insulated conductors and a nearby charged object Explain, with the aid of diagrams, how to charge objects by induction Explain how a Van de Graaff generator works. Demonstrate, using the Van de Graaff generator, that - Total charge resides on the outside of a conductor - Charge accumulate at points, (electric wind) - Electric charge tries to find the easiest path (hair standing up) - Like charges repel Explain, using diagrams, the phenomenon of point discharge Describe real world examples of point discharge, e.g. lightning conductor, oil tanker, integrated circuits			

E2 Electric fields By the end of this section pupils should be able to:	Good	Fair	Poor
State Coulomb's Law of force between electric charges Explain why Coulomb's Law is an example of an inverse square law Apply the use of Coulomb's Law in using $F = \frac{Q_1 Q_2}{4\pi\varepsilon_o r^2}$ with appropriate calculations ***Specialist questions: three charges in a line, at what point is force zero? , electrostatic force of repulsion Vs gravitational force of attraction between protons in a nucleus*** ⇨ **Synthesise the concept of electrostatic Vs gravitational force with the presence of the strong nuclear force in particle physics section** ⇨ **Synthesise the link between Coulomb's Law and Newton's Law as inverse square laws** Explain what is meant by electric fields Understand that electric fields are represented by electric field lines Understand that electric fields run outwards from positive charges and inwards to negative charges Draw diagrams of electric field lines between different sign charges Demonstrate the formation of electric field lines in the lab Give applications of electric fields, e.g. xerography, electrostatic precipitators, IC hazards **Define electric field strength** **Recognise that electric field strength at some point from a charge is the same as the coulomb force on a charge of 1 at that charge** **Use E = F/Q in calculations for charges in a straight line** ***Specialist question: At what point between the charges is the EFS = 0?***			

E3 Potential difference (pd) and capacitance By the end of this section pupils should be able to:	Good	Fair	Poor
Understand that pd and voltage are the same thing Define potential difference and give its unit Understand that voltage applied to a circuit is called an emf Define capacitance and give its unit Use C = Q/V in appropriate calculations Give examples of uses for capacitors ⇨ **Synthesise the use of capacitors with Cockroft/Walton accelerator in Particle Physics section of the course** Explain, with the aid of diagrams, why the capacitance of a charged conductor is increased by bringing an oppositely charge conductor or an earthed object near it Demonstrate the working of parallel plate capacitor Explain why capacitors conduct ac but not dc **Investigate the factors that affect the capacitance of a parallel plate capacitor** **Use** $C = \frac{\epsilon A}{d}$ **and W = (1/2) CV^2 in calculations** ***Specialist questions: defibrillator, keyboard button***			
E4 Current electricity By the end of this section pupils should be able to:	Good	Fair	Poor
Describe electric current as a flow of electric charge and state its unit Understand that circuits must be complete in order for current to flow Understand that electric current starts to flow at all points in an electric circuit at the same time when turned on Understand the difference between conventional current and the actual flow of charges in a circuit Understand that $1A = 1Cs^{-1}$ Distinguish between ac and dc Explain the difference between primary and secondary cells and give examples of sources of each Identify and draw circuit symbols for - the instruments used to measure V, I and R			

- the various electric components in a circuit

Understand that pd is the amount of energy converted from electrical to other forms between 2 points when 1C of charge passes any point of that circuit

Understand that in series total voltage = V1 + V2 + V3
Understand that in parallel voltages are equal

Use $V = W/QW$ and $I = Q/t$ in appropriate calculations

Understand that electrical resistance is anything which opposes the flow of current
Define resistance as $R = V/I$ and give its unit
Give examples of practical uses of resistors, including variable resistors

State Ohm's Law
Investigate the variation of current with pd through the following:

- Metallic conductor
- Filament bulb
- Copper sulphate solution with copper electrodes
- Semiconductor diode

Know that in series, total R = R1 + R2 + R3
Know that in parallel, total R is given as 1/R = 1/R1 + 1/R2 + 1/R3
Derive the expression for the effective resistance of resistors in series and parallel

Use $V = IR$, voltage in series/parallel and resistance in series/parallel equations in circuit calculations ('big circuit' questions)

Identify the factors that affect the resistance of a conductor

Investigate the variation of the resistance of

- A metallic conductor
- A thermistor

With temperature

<table>
<tr><td>Define resistivity
<u>Measure the resistivity of the material of a wire</u>

Use $\rho = \frac{RA}{L}$ in appropriate calculations

Draw a diagram of a wheatstone bridge and explain its operation
Use the wheatstone bridge formula in appropriate calculations
Understand the metre bridge as special case of the wheatstone bridge
Explain practical uses of a wheatstone bridge

Explain what is meant by a potential divider circuit</td><td></td><td></td><td></td></tr>
<tr><td>E5 Effects of electric current and domestic circuits
By the end of this section pupils should be able to:</td><td>Good</td><td>Fair</td><td>Poor</td></tr>
<tr><td>Understand that electric current has a heating, magnetic and chemical effect and give examples of how each are demonstrated

Use $W = I^2Rt$, $P = VI$ and $P = I^2R$ in appropriate calculations
Specialist questions: Hairdryer circuit, kettle
⇨ Synthesis the concept of electric power with % efficiency and heat from other sections from the Physics course

Verify Joule's Law

Outline the advantages of using EHT voltage in the transmission of electrical energy

Explain what is meant by an ion
Identify the charge carriers in and the relationship between I and V for a
- Metallic conductor
- Filament bulb
- Semiconductor
- Ionic solutions with active and inactive electrodes
- Gas
- Vacuum</td><td></td><td></td><td></td></tr>
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and draw IV graphs for each of these components Understand what is meant by a ring main circuit Explain what is meant by a fuse and calculate the appropriate fuse size for various electrical appliances Understand why appliances that take a large current (cooker, fridge) have their own fuses Outline the purpose of MCBs, RCDs and earthing in domestic electricity Identify the colour and purpose of the three wires in a 3-pin plug and explain what is meant by doubled bonded/insulated in appliances that have a 2-pin plug Explain how the earth wire works in the case of an electrical fault State what is meant by a kilowatt-hour and calculate the number of kilowatt-hours used by different electrical appliances			
E6 Semiconductors By the end of this section pupils should be able to:	Good	Fair	Poor
Understand what is meant by a semiconductor Explain what is meant by valency and explain in terms of p-type and n-type crystal Understand the concept of the 'positive hole' as a charge carrier Explain what is meant by intrinsic conduction Describe ways in which the intrinsic conduction of a semiconductor can be increased/decreased and demonstratre applications of these methods (thermistor, LDR) Explain what is meant by extrinsic conduction and apply this concept in the formation of a p-n junction diode Explain what is meant by a depletion layer in a p-n diode Understand what is meant by connecting a diode in forward and reverse bas Describe, with the aid of diagrams, the effect on the size of the depletion layer in connecting a diode in forward and reverse bias Outline uses of diodes in rectifying ac and in ICs			

E7 Electromagnetism By the end of this section pupils should be able to:	Good	Fair	Poor
Demonstrate the main properties of bar magnets in the lab Understand that magnetic poles exist in pairs Understand that electricity has a magnetic effect Understand the vector nature of a magnetic field Explain what is meant by magnetic fields and magnetic field lines Plot the magnetic field of a bar magnet Show the magnetic effect of an electric current Plot the magnetic field due to the current in a long straight wire Apply the right hand grip rule in deducing the direction of magnetic field in a long straight wire, a circular loop and a solenoic Demonstrate the use of an electromagnet and give real world examples of this device Understand the concept of the Earth's magnetic field with poles opposite to the geographic poles Outline the importance of counting for magnetic declination in ship navigation Demonstrate that a current-carrying conductor in a magnetic field experiences a force Give applications of this effect (motors, meters, loudspeakers) Use Fleming's left hand rule to deduce the directions of current, field and force Apply Fleming's left hand rule In describing the motion of a coil in a magnetic field Define magnetic flux density and state its unit Define the unit of magnetic flux densit, the Tesla Understand the factors upon which the size of the force on a current-carrying conductor in a magnetic field depend Use F = BIl in appropriate calculations on forces in current-carrying wires perpendicular to a magnetic field **Use F = BILSinθ in appropriate calculations on forces in current-carrying wires cutting magnetic fields at angles less than 90 degrees** ⇨ **Synthesise F = BIl for coils of wire with calculation of moments/couples from mechanics section of Physics course** **Understand that a charged particle entering a magnetic field moves in a circle** **Derive F = qvB and use in appropriate calculations** ⇨ **Synthesise calculations on F = qvB with centripetal force and particles accelerate in cyclotron from the mechanics and**			

particle physics sections of the course Demonstrate the magnetic force between two current carrying conductors **Define the ampere and the Coulomb** Understand the concept of electromagnetic (EM) induction Demonstrate EM induction in the lab Apply the phenomenon of EM induction in the functioning of an electrical generator, dynamo Define magnetic flux and use $\phi = BA$ in appropriate calculations for coils/wires cutting magnetic fields at right angles **Use $\phi = BA\sin\theta$ for coils/wires cutting magnetic fields at angles less than 90 degrees** State Faraday's Law of EM induction Use Faraday's Law in appropriate calculations ***Specialist questions: Coils moving at certain velocities/rotating into magnetic fields, calculating current and resistance values from induced emfs*** State Lenz's Law and demonstrate in the lab Describe applications of Lenz's Law (Arago's disc, induction motor) **Explain what is meant by rms and peak values of ac in the context of the heating effect an electric current** **Use rms and peak values in calculations on voltage, current and power** **Explain the concepts of mutual and self-induction** **Outline self-induction in the lighting of a neon lamp** **Describe applications of self-induction (induction coil, stage lighting dimmers)** **Understand that coils oppose dc due to ohmic resistance and ac due to ohmic resistance and back emf** Understand what a transformer is and discuss its uses Explain the structure and principle operation of a transformer Use the transformer equation in appropriate calculations			

Modern Physics

MP1 The electron By the end of this section pupils should be able to:	Good	Fair	Poor
Categorise the electron as an indivisible unit of negative charge, of extremely small mass orbiting the nuclei of atoms State who named the electron and who discovered it was negatively charged Understand the principle of thermionic emission and its application to the producing of a beam of electrons Summarise the workings of a cathode ray tube (CRT) and the properties of cathode rays Outline the deflection of cathode rays in electric and magnetic fields Describe uses for CRTs Establish that the energy of the photon produced on the screen of the CRT and X-Ray machine depends on the kinetic energy (KE) of the electron which in turns depends on the voltage between anode and cathode, thereby formulating the relationship that $eV = ½ mv^2 = hf$ Differentiate between the electron volt (eV) and the Joule as units of energy and convert from one to the other Explain what is meant by the photoelectric effect (PE) and demonstrate this effect Describe the structure and demonstrate the action of a photocell Discuss applications of photoelectric sensing devices Explain the effect of the intensity and frequency of incident light in liberating electrons from metal plates Appreciate the strides taken throughout to try and explain the PE **Understand the concepts of threshold frequency and work function** **Articulate an explanation for the PE using Einstein's theory, thereby arriving at this expression $E = \theta + KE$** **Use Einstein's PE expression in appropriate calculations** State who discovered X-Rays Outline, with the aid of diagrams, the principles and operation of an X-Ray machine Summarise the properties of X-rays Evaluate why X-ray production is the invers of the PE **Use $eV = ½ mv^2 = hf$ in appropriate calculations on voltages/speeds of electrons/frequencies of x-rays produced in an X-ray tube**			

MP2 The Nucleus By the end of this section pupils should be able to:	Good	Fair	Poor
Understand the nature of atoms as having a nucleus containing protons and neutrons with electrons orbiting in clouds Summarise Rutherford's experiment in determining the nature of the atom Explain what emission line spectra are Apply the principles of line spectra in atoms to describing Bohr's discovery of electron energy levels Connect the concept of raised energy levels in electrons with the technology behind a laser Describe uses of spectroscopy as a tool in Science, e.g. deducing that the Sun is surrounded by He gas Differentiate between the atomic and mass numbers of an atom and use each to calculate number of protons and neutrons in atoms Explain what isotopes are and give common examples Appreciate that Becquerel discovered radioactivity Understand the concept of an unstable nucleus ('suitcase'model) Define radioactivity Understand what is meant by transmutation of an element Construct an equation for the 1^{st} ever artificial transmutation of an element by Rutherford and proof that nuclei contain protons Summarise the properties of the three types of radiation Outline an experiment to demonstrate the - penetrating power - ionising ability of the three types of radiation Apply the concept of changes in mass and atomic numbers due to emission of alpha and beta particles in the completion of equations of nuclear reactions Explain what is meant by the activity of a radioactive nucleus and state the unit of activity State the Law of radioactive decay Understand the concept of half-life and apply to calculating fractions of radioactive samples decayed/undecayed over time ($1/2^n$) **Use the $T_{½} = \ln 2/\lambda$, $A = -\lambda N$ in appropriate calculations** **Connect the concept of atomic mass with the unified atomic mass unit (u)**			

Apply the concepts of the mole and Avagadro's constant to calculating number of atoms in a given mass of a radioactive sample

Identify uses of radioisotopes
Outline the principle of operation of a Geiger-Muller tube and a solid state detector

Explain what is meant by nuclear fission and nuclear fusion
Understand the principle of a fission chain reaction and uses of an uncontrolled (fission bomb) and controlled (nuclear power) chain reaction

Illustrate the functioning of the various parts of a fission reactor

Outline the advantages and disadvantages of nuclear power

Evaluate the potential of creating fusion power reactors
Understand fusion as the source of the Sun's energy

Discuss the uses and health hazards of ionising radiations
Specialist cases: Radon, medical imaging, Chernobyl, Hiroshima/Nagasaki, disposal of nuclear waste

Understand Einstein's mass-energy equivalence $E=mc^2$ and use in appropriate calculations

MP3 Particle Physics By the end of this section pupils should be able to:	Good	Fair	Poor
Understand that momentum, mass-energy and nuclear charge are conserved in nuclear reactions Complete appropriate calculations and equations relating to conservation in nuclear reactions ***Specialist questions: Beta decay*** Discuss the concept of the neutrino as an explanation for momentum not being conserved in beta decay Appreciate the historical significance of Ernest Walton as a local scientist and Ireland's only Nobel Physics laureate Summarise the principle of the Cockroft Walton accelerator and write the equation for the 1st artificial transmutation of an element using artificially accelerated particles Complete appropriate calculations relating to Cockroft and Walton's experiment Understand that energy in particle collisions can be converted into matter Explain what antimatter is Evaluate the nature of antiparticles Assess the 'Big Bang' theory as an explanation for the origin of the universe based on the conversion of energy into matter Outline the conditions required for pair production Explain the concept of pair annihilation Complete appropriate calculations related to pair production and annihilation ***Specialist question: electron/positron formation*** Understand that CERN is the centre for particle acceleration in Geneva and conducts/analyses particle collisions in 2 circular accelerators Examine the advantages of circular accelerators over linear accelerators Explain the concept of the 'particle zoo'C Appreciate the origins of the fundamental forces and building blocks of nature throughout history Name and describe the characteristics of the 4 fundamental forces of nature Classify particles into their various 'families' based on size and forces felt Understand the concept of the 'Quark Model' and identify the 6 'flavours' of quarks Deduce the quark composition and overall charge of a particle			