SUBJECT: **PHYSICS**

AWARD RECEIVED: **HIGHER**

ENTRY LEVEL
Students should ideally have N5 Physics, at A or B. It could be possible for a student without previous experience of Physics to follow this course, in which case they should speak with a Physics teacher for advice.

COURSE CONTENT
The Course is split up into 4 Units, with the Key Areas covered in each outlined below:

Unit 1 - Our Dynamic Universe
This Unit covers the Key Areas of:
Motion — equations and graphs
- ♦ Equations of motion for objects moving with constant acceleration in a straight line.
- ♦ Motion-time graphs for motion with constant acceleration in a straight line.
- ♦ Displacement, velocity and acceleration-time graphs and their interrelationship.
- ♦ Graphs for bouncing objects and objects thrown vertically upwards.
- ♦ All graphs restricted to constant acceleration in one dimension, inclusive of change of direction.

Forces, energy and power
- ♦ Balanced and unbalanced forces. The effects of friction. Terminal velocity.
- ♦ Forces acting in one plane only.
- ♦ Analysis of motion using Newton's First and Second Laws. Frictional force as a negative vector quantity. No reference to static and dynamic friction.
- ♦ Tension as a pulling force exerted by a string or cable on another object.
- ♦ Velocity-time graph of a falling object when air resistance is taken into account, including the effect of changing the surface area of the falling object.
- ♦ Resolving a force into two perpendicular components.
- ♦ Forces acting at an angle to the direction of movement.
- ♦ Resolving the weight of an object on a slope into a component acting down the slope and a component acting normal to the slope.
- ♦ Systems of balanced forces with forces acting in two dimensions.
- ♦ Work done, potential energy, kinetic energy and power in familiar and unfamiliar situations.
- ♦ Conservation of energy.

Collisions, explosions and impulse
- ♦ Conservation of momentum in one dimension and in cases where the objects may move in opposite directions.
- ♦ Kinetic energy in elastic and inelastic collisions.
- ♦ Explosions and Newton's Third Law.
- ♦ Conservation of momentum in explosions in one dimension only.
- ♦ Force-time graphs during contact of colliding objects.
- ♦ Impulse found from the area under a force-time graph.
- ♦ Equivalence of change in momentum and impulse.
- ♦ Newton's Third Law of motion.

Gravitation
- ♦ Projectiles and satellites.
- ♦ Resolving the motion of a projectile with an initial velocity into horizontal and vertical components and their use in calculations.
- ♦ Comparison of projectiles with objects in free fall. Gravitational Field Strength of planets, natural satellites and stars. Calculating the force exerted on objects placed in a gravity field.
- ♦ Newton's Universal Law of Gravitation.

Special relativity
- ♦ The speed of light in a vacuum is the same for all observers.
- ♦ The constancy of the speed of light led Einstein to postulate that measurements of space and time

for a moving observer are changed relative to those for a stationary observer.
♦ Length contraction and time dilation.

The Expanding Universe
♦ The Doppler Effect is observed in sound and light.
♦ The Doppler Effect causes shifts in wavelengths of sound and light. The light from objects moving away from us is shifted to longer (more red) wavelengths.
♦ The redshift of a galaxy is the change in wavelength divided by the emitted wavelength. For slowly moving galaxies, redshift is the ratio of the velocity of the galaxy to the velocity of light. Hubble's Law shows the relationship between the recession velocity of a galaxy and its distance from us.
♦ Hubble's Law allows us to estimate of the age of the universe.
♦ Evidence for the expanding universe.
♦ We can estimate the mass of a galaxy by the orbital speed of stars within it.
♦ Evidence for dark matter from observations of the mass of galaxies.
♦ Evidence for dark energy from the accelerating rate of expansion of the universe.
♦ The temperature of stellar objects is related to the distribution of emitted radiation over a wide range of wavelengths. The wavelength of the peak of this distribution is shorter for hotter objects than for cooler objects.
♦ Qualitative relationship between radiation per unit surface area and temperature of a star.
♦ Cosmic microwave background radiation as evidence for the big bang and subsequent expansion of the universe.

Unit 2 - Particles and Waves
This Unit covers the Key Areas of:
The Standard Model
♦ Orders of magnitude — the range of orders of magnitude of length from the very small (sub-nuclear) to the very large (distance to furthest known celestial objects).
♦ The standard model of fundamental particles and interactions.
♦ Evidence for the sub-nuclear particles and the existence of antimatter.
♦ Fermions, the matter particles, consist of quarks (6 types) and leptons (electron, muon and tau, together with their neutrinos).
♦ Hadrons are composite particles made of quarks. Baryons are made of three quarks and mesons are made of two quarks.
♦ The force mediating particles are bosons (photons, W and Z bosons, and gluons).
♦ Description of beta decay as the first evidence for the neutrino

Forces on charged particles
♦ Fields exist around charged particles and between charged parallel plates.
♦ Examples of electric field patterns for single point charges, systems of two point charges and between parallel plates.
♦ Movement of charged particles in an electric field.
♦ The relationship between potential difference, work and charge gives the definition of the volt.
♦ Calculation of the speed of a charged particle accelerated by an electric field.
♦ A moving charge produces a magnetic field.
♦ The determination of the direction of the force on a charged particle moving in a magnetic field for negative and positive charges (right hand rule for negative charges).
♦ Basic operation of particle accelerators in terms of acceleration, deflection and collision of charged particles.

Nuclear reactions
♦ Nuclear equations to describe radioactive decay, fission and fusion reactions with reference to mass and energy equivalence, including calculations.
♦ Coolant and containment issues in nuclear fission and fusion reactors.

Wave particle duality
♦ Photoelectric effect as evidence for the particulate nature of light.
♦ Photons of sufficient energy can eject electrons from the surface of materials.
♦ The threshold frequency is the minimum frequency of a photon required for photoemission.
♦ The work function of the material is the minimum energy required to cause photoemission.
♦ Determination of the maximum kinetic energy of photoelectrons.

Interference and diffraction

- ♦ Conditions for constructive and destructive interference.
- ♦ Coherent waves have a constant phase relationship and have the same frequency, wavelength and velocity. Constructive and destructive interference in terms of phase between two waves.
- ♦ Interference of waves using two coherent sources.
- ♦ Maxima and minima are produced when the path difference between waves is a whole number of wavelengths or an odd number of half wavelengths respectively.
- ♦ The relationship between the wavelength, distance between the sources, distance from the sources and the spacing between maxima or minima.
- ♦ The relationship between the grating spacing, wavelength and angle to the maxima.

Refraction of light
- ♦ Absolute refractive index of a material is the ratio of the sine of angle of incidence in vacuum (air) to the sine of angle of refraction in the material. Refractive index of air treated as the same as that of a vacuum.
- ♦ Situations where light travels from a more dense to a less dense medium/material.
- ♦ Refractive index can also be found from the ratio of speed of light in vacuum (air) to the speed in the material and the ratio of the wavelengths.
- ♦ Variation of refractive index with frequency.
- ♦ Critical angle and total internal reflection.

Spectra
- ♦ Irradiance and the inverse square law.
- ♦ Irradiance is power per unit area.
- ♦ The relationship between irradiance and distance from a point light source.
- ♦ Line and continuous emission spectra, absorption spectra and energy level transitions.
- ♦ The Bohr model of the atom.
- ♦ Movement of electrons between energy levels.
- ♦ The terms ground state, energy levels, ionisation and zero potential energy for the Bohr model of the atom.
- ♦ Emission of photons due to movement of electrons between energy levels and dependence of photon frequency on energy difference between levels.
- ♦ The relationship between photon energy, Planck’s constant and photon frequency.
- ♦ Absorption lines in the spectrum of sunlight provides evidence for the composition of the Sun’s upper atmosphere.

Unit 3 - Electricity
Monitoring and measuring a.c.
- ♦ a.c. as a current which changes direction and instantaneous value with time.
- ♦ Calculations involving peak and r.m.s. values.
- ♦ Determination of frequency from graphical data.

Current, potential difference, power and resistance
- ♦ Use relationships involving potential difference, current, resistance and power to analyse circuits.
- ♦ Calculations involving potential dividers circuits

Electrical sources and internal resistance.
- ♦ Electromotive force, internal resistance and terminal potential difference. Ideal supplies, short circuits and open circuits.
- ♦ Determining internal resistance and electromotive force using graphical analysis.

Capacitors
- ♦ Capacitors and the relationship between capacitance, charge and potential difference.
- ♦ The total energy stored in a charged capacitor is the area under the charge against potential difference graph. Use the relationships between energy, charge, capacitance and potential difference.
- ♦ Variation of current and potential difference against time for both charging and discharging.
- ♦ The effect of resistance and capacitance on charging and discharging curves.

Conductors, semiconductors and insulators
- ♦ Solids can be categorised into conductors, semiconductors or insulators by their ability to conduct electricity.
- ♦ The electrons in atoms are contained in energy levels. When the atoms come together to form

solids, the electrons then become contained in energy bands separated by gaps.

- ♦ In metals the highest occupied band is not completely full and this allows the electrons to move and therefore conduct. This band is known as the conduction band.
- ♦ In an insulator the highest occupied band (called the valence band) is full. The first unfilled band above the valence band is the conduction band. For an insulator the gap between the valence band and the conduction band is large and at room temperature there is not enough energy available to move electrons from the valence band into the conduction band where they would be able to contribute to conduction. There is no electrical conduction in an insulator.
- ♦ In a semiconductor the gap between the valence band and conduction band is smaller and at room temperature there is sufficient energy available to move some electrons from the valence band into the conduction band allowing some conduction to take place. An increase in temperature increases the conductivity of a semiconductor.

p-n junctions

- ♦ During manufacture, the conductivity of semiconductors can be controlled, resulting in two types: p-type and n-type.
- ♦ When p-type and n-type materials are joined, a layer is formed at the junction. The electrical properties of this layer are used in a number of devices.
- ♦ Solar cells are p-n junctions designed so that a potential difference is produced when photons enter the layer. This is the photovoltaic effect.
- ♦ LEDs are p-n junctions which emit photons when a current is passed through the junction.

Unit 4 - Researching Physics

This Unit covers the key skills necessary to undertake research in Physics. Learners will research the relevance of Physics theory to everyday life by exploring the physics behind a topical issue. Learners will develop the key skills associated with collecting and synthesising information from a number of different sources. Equipped with the knowledge of common Physics apparatus and techniques, they will plan and undertake a practical investigation related to a topical issue.

ASSESSMENT

To gain an overall Award for this Course, students need to pass the:

- **Unit Assessment** for each of the Units – these are marked internally in school;
- **Course Assessment**, which is marked by the SQA and includes an**:**
    1. **Assignment** (20 marks)
    2. **Exam** (100 marks)

The Course assessment is graded A–D. The grade is determined on the basis of the total mark for all Course assessments together.

HOMEWORK

Homework is an essential part of the course. Homework will include practise problems, questions from a textbook and regular revision of all the material covered in the course.

TRANSFERABLE SKILLS

There are many very useful and valuable transferable skills gained by studying Higher Physics, including: researching, ICT, reporting, numeracy, literacy, graphing, investigating, practical experimental skills, analysing, presentation, evaluating, to name a few.

PROGRESSION

There is very good progression from this Course on to Advanced Higher Physics.