GCSE to A-level progression

AQA A-level Physics should be a natural progression from the GCSE course and there are many familiar topics that are taken a stage further. Some topics, such as electricity, are studied in greater detail while others, such as energy transfer, broaden the GCSE experience and include a greater use of mathematics so that the qualitative understanding becomes quantitative. A large change at A-level is the inclusion of optional topics, all of which build on familiar topics from GCSE and give students the chance to study in areas they have a specific interest in, and is the first step towards specialising towards a particular career.

Content

Kinetic theory

GCSE specification reference: 1.1.2

A-level specification reference: 6.2.2 (Ideal gases) and 6.2.3 (Molecular kinetic theory model).

There is no quantitative work at GCSE, just an appreciation of the basic model of constantly moving atoms, molecules and particles, as well as the different energy states of solid, liquid and gases.

The kinetic theory at A-level is described by assumptions and mathematical interpretation linking micro and macro to generate, for gases, $PV = nRT$ (as well as $pV = NkT$) , moles, work done, Avogadro constant, N_A, Boltzmann's constant k and absolute temperature, (T). Link between $(KE)_{av}$ and T is also covered at A-level.

Energy transfer by heating

GCSE specification reference: 1.1.3

A-level specification reference: 6.2.1 (Thermal energy transfer).

There is use of $Q = mc\Delta T$ in both the GCSE and A-level specifications. Definition of c and measurement as well as ideas about cooling by evaporation also appear in both.

A-level also deals with quantitative appreciation of latent heat and $Q = mL$ for fusion and evaporation.

Energy and efficiency

GCSE specification reference: 1.2.1

A-level specification reference: 4.1.8 (Conservation of energy).

Both GCSE and A-level have definitions of efficiency and assumed principles of conservation of energy.

At A-level the use of efficiency is restricted to transformers in section 7.4.6 (the operation of a transformer).

Transferring electrical energy

GCSE specification reference: 1.3.1

A-level specification reference: 5.1.4 (Circuits).

GCSE and A-level have common equations for power and energy. At GCSE the equation is restricted to $P=IV$, and knowledge of kW, kWh.

At A-level the power equation is also defined as $P=I^2R$ and $P= V^2/R$.

Generating electricity/The National Grid

GCSE specification reference: 1.4.1 and 1.4.2

A-level specification reference: 5 (Electricity) and 7.4 (Magnetic fields).

Knowledge of National Grid and use of transformers is assumed at A-level and the transmission of energy by power lines is common to both GCSE and A-level.

A-level develops an equation for generating of an AC voltage (rotating coil), includes the transformer and deals quantitatively with power loss in transmission lines.

General properties of waves

GCSE specification reference: 1.5.1

A-level specification reference: 3 (Waves)

Both GCSE and A-level require a basic knowledge of longitudinal and transverse waves, their nature and properties, including speed of electromagnetic waves in a vacuum. Also common are the wave equations (using different symbols for velocity) ie $v = f\lambda$ and $c = f\lambda$.

At A-level, the oscillation of particles in a medium and the idea of phase difference is introduced with a formal definition of frequency ( ), and polarisation.

Refraction of waves at an interface and diffraction are treated qualitatively at GCSE. At A-level refractive index/Snell’s law and total internal reflection (critical angle) are treated quantitatively and their application in fibre optics is introduced.

At A-level single slit diffraction,Young’s slits and the diffraction grating are explained mathematically through superposition and interference.

Sound

GCSE specification reference: 1.5.3

A-level specification reference: 3.1.1 (Progressive waves) to 3.2.1 (Interference).

Implied knowledge of longitudinal nature and the requirement of a medium is included in both GCSE and A-level specifications.

At A-level, the concept of stationary waves, superposition, interference and the determination of the speed of sound is included.

Resultant forces

GCSE specification reference: 2.1.1

A-level specification reference: 4.1.1 (Scalars and vectors).

The outcome of resultant forces through vector addition and the concept of equilibrium (resultant force=zero) is common to both GCSE and A-level for parallel forces, including acceleration in the direction of the resultant force.

At A-level, the calculation of the resultant of two forces at 90 and resolution of forces are treated mathematically.

Forces and motion

GCSE specification reference: 2.1.2

A-level specification reference: 4.1.3 (Motion along a straight line), 4.1.4 (Projectile motion), 4.1.5 (Newton's laws of motion) and 4.1.6 (Momentum).

Both GCSE and A-level assume knowledge of *F = ma*, but at A-level all three of Newton's laws are required. GCSE content is restricted to motion in a straight line and definitions of velocity and acceleration, including graphical representation for uniform straight line motion to determine acceleration and distance travelled.

At A-level, all *suvat* equations and displacement are defined and the use of *Δ* for changes in is introduced, including non-uniform acceleration. The acceleration due to gravity (*g*) and its measurement is an A-level requirement. Projectile motion is analysed mathematically taking account of air resistance.

Forces and Terminal velocity

GCSE specification reference: 2.1.4

A-level specification reference: 4.1.4 (Projectile motion).

This builds on the idea of equilibrium (balanced forces: *mg* and resistive forces). Both GCSE and A-level require a knowledge of why there is a terminal speed(velocity), that fluid resistance depends on speed and how drag forces can be useful. Interpretation of υ-t graphs for objects falling under gravity with drag forces present is also included.

Lift forces are considered only at A-level.

Forces and elasticity

GCSE specification reference: 2.1.5

A-level specification reference: 4.2.1 (Bulk properties of solids) and 4.2.2 (The Young modulus).

Both GCSE and A-level include an understanding of Hooke's law and expressions in terms of a spring constant, (or stiffness at A-level). Mathematical expressions of force and extension: (GCSE) and (A-level) including elastic, strain and potential energy stored are also included.

At A-level the concept of elastic limit, plastic behaviour, breaking stress, fracture and brittle behaviour are included with the use of stress and strain graphs. The area under a force-extension graph is equated to energy stored as and also the transformation of energy in a mass and spring system between KE and PE. Use of stress and strain curves to determine the Young modulus and its measurement is at A-level only.

Forces and energy

GCSE specification reference: 2.2.1

A-level specification reference: 4.1.7 (Work, energy and power) 4.1.8 (Conservation of energy).

Both specifications require knowledge of the terms work, energy and power (including the Joule and *kW*) as well as the conservation of energy including the equation for work done. Both specifications involve a definition of power in terms of energy/work transformed per second and the equations for *PE* and *KE*.

A-level also considers work done against resistive forces. For 'non parallel force and displacement' A-level considers when work is done or not done by a force ($W = Fs\cos\theta$) and power in respect of force and velocity ( ), and that the area under a force-displacement graph is work done for both constant and variable forces.

Momentum

GCSE specification reference: 2.2.2

A-level specification reference: 4.1.6 (Momentum).

Both GCSE and A-level define momentum and conservation of momentum, including the concept of a 'closed system', for collisions and explosions.

At A-level, linear momentum in one dimension is specified and involves the understanding that force results from a momentum change per second. The idea of impulse ('force × time') including an appreciation of impact forces and contact times is introduced and for constant and variable forces, the area under a force-time graph is used for momentum change. There is also consideration at A-level for both elastic (conservation of KE) and inelastic collisions, with calculations.

Electrical circuits

GCSE specification reference: 2.3.2

A-level specification reference: 5 (Electricity).

Both GCSE and A-level include circuit symbols; the terms, I, Q, V; and the definitions of current, voltage (PD), and work done in a circuit. The concept of resistance ( ), and I-V characteristics for ohmic and non ohmic components, and series/parallel circuits is common to both.

At A-level, the potential divider/potentiometer is introduced as a control mechanism, as are cells in series and parallel. Conservation of charge and energy in a DC circuit and the equation for resistors in parallel are considered only at A-level, as is resistivity and superconductors.

Atomic structure

GCSE specification reference: 2.5.1

A-level specification reference: 2 (Particles and radiation), 8 (Nuclear physics).

Simple ‘Bohr model’ of an atom in terms of protons, neutrons, electrons, and the relative masses of these particles is common to both GCSE and A-level. The idea of neutrality (number of electrons = number of protons) and ions and isotopes. 'Atomic number' is used at GCSE and 'proton number, Z' is used at A-level. 'Mass number' is referred to in GCSE and 'nucleon number' in A-level.

For A-level only, evidence for the nucleus (Rutherford) and specific charge of nuclei, ions and protons/electrons and the concept of a nuclide with symbolic representation. including masses and the *amu*.

Atoms and radiation

GCSE specification reference: 2.5.2

A-level specification reference: 2 (Particles and radiation), 8 (Nuclear physics) and 9.2.3 (Classification by temperature, black body radiation-Astrophysics option).

A general appreciation of radioactive substances, the three types of radiation and their properties, safety, hazards, background and half life is assumed at A-level. At GCSE (higher), only the nuclear equation for α–decay is required. At A-level, the equation for β–decay (including the neutrino) is also required. A-level requires more detail about the reasons for instability, including the N against Z curve, and the forces involved in decay such as the strong nuclear force and short range attractive.

The experimental investigation of evidence for α, β and γ is required at A-level, along with the inverse square law for γ. Count rate (elimination of background), mathematical definition of half-life and manipulation of exponential decay equations are all required at A-level, along with knowledge of natural logs.

Nuclear fission and Nuclear fusion

GCSE specification reference: 2.6.1 and 2

A-level specification reference: 8.1.6 (Mass and energy) and 8.1.7 (Induced fission).

Knowledge of the fissile substances used in thermal reactors and that the process involves the nucleus and neutrons is common to both GCSE and A-level, as is the fact that fusion involves nuclei ‘joining’ at high temperatures.

At A-level, the concepts of binding energy and use of $E = mc^2$ for calculations of mass difference and energy are required. An understanding of critical mass, moderator, control rods and coolant in a thermal reactor is necessary.

Other applications using light

GCSE specification reference: 3.1.5

A-level specification reference: 3.2.3 (Refraction at a plane surface).

Most specification content is common so that an appreciation of total internal reflection, optical fibres and lasers is assumed.

At A-level the critical angle is related to refractive index by $\sin\theta_c$ = ratio of two refractive indices. A-level deals in slightly more detail for optical fibres with a step index.

Centre of mass

GCSE specification reference: 3.2.1

A-level specification reference: 4.1.2 (Moments) and 6.1.2 (Simple harmonic motion).

The definition of centre of mass and stability in general is assumed as are the general properties of a simple pendulum.

At A-level there is analysis of the simple pendulum time period equation.

Moments

GCSE specification reference: 3.2.2

A-level specification reference: 4.1.2 (Moments).

Both GCSE and A-level specifications require the definition of a moment and the principle of moments, including the idea of equilibrium/stability.

A-level introduces the concept of parallel opposite forces forming a couple.

Circular motion

GCSE specification reference: 3.2.4

A-level specification reference: 6.1.1 (Circular motion).

Both GCSE and A-level require knowledge of centripetal forces, their origins and how these forces depend on mass, speed and radius.

The equation $F =$ and the link $v = \omega r$ are only required at A-level.

The motor effect

GCSE specification reference: 3.3.1

A-level specification reference: 7.4 (Magnetic fields).

An understanding of how current-carrying conductors react in magnetic fields is included for both specifications. In particular, Fleming's left hand rule is required for currents and fields at 90°.

A-level considers the concept of B (flux density) and moving charges with equations for F used to explain how a current balance works and the circular motion of particles, eg in a cyclotron.

Transformers

GCSE specification reference: 3.3.2

A-level specification reference: 7.4.6 (The operation of a transformer).

The concept of electrical induction, including simple experiments, is expected at both GCSE and A-level, as is the structure of a transformer, its turns ratio and power ratio for an ideal transformer.

A-level requires an understanding of Lenz's and Faraday's laws for induction, flux and flux linkage (topic 7.4.4), leading to an appreciation of energy losses in a transformer – Eddy currents/laminations. Calculations are included at A-level on transformers with efficiency below 100%.

Document URL
http://www.aqa.org.uk/resources/science/as-and-a-level/physics-7407-7408/teach/gcse-to-a-level-progression

Last updated 22 May 2015