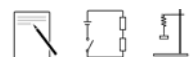


# A Level Physics Online

## OCR Physics Specification A - H156/H556

### Module 4: Electrons, Waves and Photons

You should be able to demonstrate and show your understanding of:	Progress and understanding:			
	1	2	3	4
<b>4.1 Charge and Current</b>				
Electric current as rate of flow of charge; $I = \Delta Q / \Delta t$				
The coulomb as the unit of charge.				
The elementary charge $e$ equals $1.6 \times 10^{-19}\text{C}$ and that an electron has charge $-e$ and a proton a charge $+e$ .				
Net charge on a particle or an object is quantised and a multiple of $e$ .				
Current as the movement of electrons in metals and movement of ions in electrolytes.				
Conventional current and electron flow.				
Kirchhoff's first law; conservation of charge.				
Mean drift velocity of charge carriers.				
$I = Anev$ , where $n$ is the number density of charge carriers.				
Distinction between conductors, semiconductors and insulators in terms of $n$ .				
<b>4.2 Energy, Power and Resistance</b>				
Circuit symbols and circuit diagrams using these symbols.				
Potential difference (p.d.); the unit volt.				
Electromotive force (e.m.f.) of a source such as a cell or a power supply.				
Distinction between e.m.f. and p.d. in terms of energy transfer.				
Energy transfer; $W = VQ$ $W = \epsilon Q$				



You should be able to demonstrate and show your understanding of:	Progress and understanding:			
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Energy transfer $eV = \frac{1}{2}mv^2$ for electrons and other charged particles.				
Resistance, the unit ohm; $R = V/I$ [not in the data book]				
Ohm's law.				
$I$ - $V$ characteristics of resistor, filament lamp, thermistor, diode and light-emitting diode (LED).				
Techniques and procedures used to investigate the electrical characteristics for a range of ohmic and non-ohmic components.				
Light-dependent resistor (LDR); variation of resistance with light intensity.				
Resistivity of a material, the equation: $R = \rho L / A$				
Techniques and procedures used to determine the resistivity of a metal.				
The variation of resistivity of metals and semiconductors with temperature.				
Negative temperature coefficient (NTC) thermistor; variation of resistance with temperature.				
The equations; $P = VI$ $P = I^2R$ $P = V^2 / R$				
Energy transfer; $W = VIt$				
The kilowatt-hour (kW h) as a unit of energy; calculating the cost of energy.				
<b>4.3 Electrical Circuits</b>				
Kirchhoff's second law; the conservation of energy.				
Kirchhoff's first and second laws applied to electrical circuits.				
Total resistance of two or more resistors in series; $R = R_1 + R_2 + \dots$				
Total resistance of two or more resistors in parallel; $1/R = 1/R_1 + 1/R_2 + \dots$				



You should be able to demonstrate and show your understanding of:	Progress and understanding:			
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Analysis of circuits with components, including both series and parallel.				
Analysis of circuits with more than one source of e.m.f.				
Source of e.m.f.; internal resistance.				
Terminal p.d.; 'lost volts'.				
The equations: $\mathcal{E} = I(R+r) \text{ and } \mathcal{E} = V + Ir$				
Techniques and procedures used to determine the internal resistance of a chemical cell or other source of e.m.f.				
Potential divider circuit with components. You will also be expected to know about a potentiometer as a potential divider.				
Potential divider circuits with variable components, e.g. LDR and thermistor.				
Potential divider equations; $V_{\text{out}} = \frac{R_2}{R_1 + R_2} \times V_{\text{in}} \quad \text{and} \quad \frac{V_1}{V_2} = \frac{R_1}{R_2}$				
Techniques and procedures used to investigate potential divider circuits which may include a sensor such as a thermistor or an LDR.				
<b>4.4 Waves</b>				
Progressive waves; longitudinal and transverse waves.				
Displacement, amplitude, wavelength, period, phase difference, frequency and speed of a wave.				
Techniques and procedures used to use an oscilloscope to determine frequency.				
The equation; $f = 1/T$				
The wave equation; $v = f\lambda$				
Graphical representations of transverse and longitudinal waves.				
Reflection, refraction, polarisation and diffraction of all waves. You will be expected to know that diffraction effects become significant when the wavelength is comparable to the gap width.				



You should be able to demonstrate and show your understanding of:	Progress and understanding:			
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Techniques and procedures used to demonstrate wave effects using a ripple tank.				
Techniques and procedures used to observe polarising effects using microwaves and light.				
Intensity of a progressive wave; $I = P / A$ $intensity \propto (amplitude)^2$				
Electromagnetic spectrum; properties of electromagnetic waves.				
Orders of magnitude of wavelengths of the principal radiations from radio waves to gamma rays.				
Plane polarised waves; polarisation of electromagnetic waves. You will be expected to know about polarising filters for light and metal grilles for microwaves in demonstrating polarisation.				
Refraction of light; refractive index; $n = c / v$ $n \sin \theta = \text{constant}$ at a boundary where $\theta$ is the angle to the normal				
Techniques and procedures used to investigate refraction and total internal reflection of light using ray boxes, including transparent rectangular and semi-circular blocks.				
Critical angle; $\sin C = 1 / n$ Total internal reflection for light.				
The principle of superposition of waves.				
Techniques and procedures used for superposition experiments using sound, light and microwaves.				
Graphical methods to illustrate the principle of superposition.				
Interference, coherence, path difference and phase difference.				
Constructive interference and destructive interference in terms of path difference and phase difference.				
Two-source interference with sound and microwaves.				



You should be able to demonstrate and show your understanding of:	Progress and understanding:			
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Young's double-slit experiment using visible light. This experiment gave a classical confirmation of the wave-nature of light.				
$\lambda = ax/D$ for all waves where $a \ll D$				
Techniques and procedures used to determine the wavelength of light using a double-slit and a diffraction grating.				
Stationary (standing) waves using microwaves, stretched strings and air columns.				
Graphical representations of a stationary wave.				
Similarities and the differences between stationary and progressive waves.				
Nodes and antinodes.				
Stationary wave patterns for a stretched string and air columns in closed and open tubes.				
Techniques and procedures used to determine the speed of sound in air by formation of stationary waves in a resonance tube.				
The idea that the separation between adjacent nodes (or antinodes) is equal to $\lambda/2$ where $\lambda$ is the wavelength of the progressive wave.				
Fundamental mode of vibration (1st harmonic); harmonics.				
<b>4.5 Quantum Physics</b>				
The particulate nature (photon model) of electromagnetic radiation.				
Photon as a quantum of energy of electromagnetic radiation.				
Energy of a photon; $E = hf$ and $E = hf/\lambda$				
The electronvolt (eV) as a unit of energy.				
Using LEDs and the equation $eV = hc/\lambda$ to estimate the value of Planck constant $h$ .				
Determine the Planck constant using different coloured LEDs.				
Photoelectric effect, including a simple experiment to demonstrate this effect and that the photoelectric effect provides evidence for the particulate nature of electromagnetic radiation.				



You should be able to demonstrate and show your understanding of:	Progress and understanding:			
	1	2	3	4
Demonstration of the photoelectric effect using a gold-leaf electroscope and zinc plate.				
A one-to-one interaction between a photon and a surface electron.				
Einstein's photoelectric equation; $hf = \phi + KE_{max}$				
Work function; threshold frequency.				
The idea that the maximum kinetic energy of the photoelectrons is independent of the intensity of the incident radiation.				
The idea that rate of emission of photoelectrons above the threshold frequency is directly proportional to the intensity of the incident radiation.				
Electron diffraction, including experimental evidence of this effect.				
Diffraction of electrons travelling through a thin slice of polycrystalline graphite by the atoms of graphite and the spacing between the atoms.				
The de Broglie equation; $\lambda = h / p$				

The material in this checklist is based on the OCR Physics A Specification published at [ocr.org.uk/alevelphysicsa](http://ocr.org.uk/alevelphysicsa) by Oxford, Cambridge and RSA Examinations.

