

## Revision checklists

The tables below can be used as a revision checklist.

For more information please see the [OCR A Level Physics A specification](#).

The table headings are explained below:

<b>Assessable learning outcomes</b> You will be required to show and apply knowledge and understanding of:	R	A	G	<b>Comments</b>
<p>Here is a list of the learning outcomes for this qualification and the content you need to cover and work on.</p> <p>You may wish to also have a copy of the <a href="#">data, Formulae and relationships booklet</a> for reference.</p> <h2 style="margin-top: 20px;">Student revision checklist</h2> <p>Version 1</p>	<p>You can use the tick boxes to show when you have revised an item and how confident you feel about it.</p> <p>R = <b>RED</b> means you are really unsure and lack confidence; you might want to focus your revision here and possibly talk to your teacher for help.</p> <p>A = <b>AMBER</b> means you are reasonably confident but need some extra practice.</p> <p>G = <b>GREEN</b> means you are very confident.</p> <p>As your revision progresses, you can concentrate on the <b>RED</b> and <b>AMBER</b> items in order to turn them into <b>GREEN</b> items.</p> <p>You might find it helpful to highlight each topic in red, orange or green to help you prioritise.</p>			<p>You can use the comments column to:</p> <ul style="list-style-type: none"> <li>add more information about the details for each point</li> <li>add formulae or notes</li> <li>include a reference to a useful resource</li> <li>highlight areas of difficulty or things that you need to talk to your teacher about or look up in a textbook.</li> </ul>

<b>Module 1 Development of practical skills in physics</b>				
<b>1.1 Practical skills assessed in a written examination</b>				
<b>1.1.1 Planning</b>				
<b>Learning outcomes</b> You will be required to show and apply knowledge and understanding of:	<b>R</b>	<b>A</b>	<b>G</b>	<b>Comments</b>
(a) experimental design, including to solve problems set in a practical context  Including selection of suitable apparatus, equipment and techniques for the proposed experiment.  Learners should be able to apply scientific knowledge based on the content of the specification to the practical context.				
(b) identification of variables that must be controlled, where appropriate				
(c) evaluation that an experimental method is appropriate to meet the expected outcomes				

<b>1.1.2 Implementing</b>				
(a) how to use a wide range of practical apparatus and techniques correctly  As outlined in the content of the specification and the skills required for the Practical Endorsement.				
(b) appropriate units for measurements				
(c) presenting observations and data in an appropriate format				
<b>1.1.3 Analysis</b>				
(a) processing, analysing and interpreting qualitative and quantitative experimental results  Including reaching valid conclusions, where appropriate.				

<p>(b) use of appropriate mathematical skills for analysis of quantitative data</p> <p>Refer to Section 5d for a list of mathematical skills that learners should have acquired competence in as part of their course.</p>				
<p>(c) appropriate use of significant figures</p>				
<p>(d) plotting and interpreting suitable graphs from experimental results, including:</p> <p>(i) selection and labelling of axes with appropriate scales, quantities and units.</p> <p>(ii) measurement of gradients and intercepts</p>				
<p><b>1.1.4 Evaluation</b></p>				
<p>(a) how to evaluate results and draw conclusions</p> <p>Learners should be able to evaluate how the scientific community use results to validate new knowledge and ensure integrity.</p>				
<p>(b) the identification of anomalies in experimental measurements</p>				

(c) the limitations in experimental procedures				
(d) precision and accuracy of measurements and data, including margins of error, percentage errors and uncertainties in apparatus				
(e) refining of experimental design by suggestion of improvements to the procedures and apparatus				
<b>1.2 Practical skills assessed in the practical endorsement</b>				
<b>1.2.1 Practical skills</b>				
<b>Learning outcomes</b> Practical work carried out throughout the course will enable learners to develop the following skills:	<b>R</b>	<b>A</b>	<b>G</b>	<b>Comments</b>
<b>Independent thinking</b>  (a) apply investigative approaches and methods to practical work  Including how to solve problems in a practical context.				
<b>Use and application of scientific methods and practices</b>  (b) safely and correctly use a range of practical equipment and materials				

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<p>See Section 5g in the specification.</p> <p>Including identification of potential hazards. Learners should understand how to minimise the risks involved.</p>				
(c) follow written instructions				
(d) make and record observations/measurements				
(e) keep appropriate records of experimental activities				
<p>See Section 5g.</p>				
(f) present information and data in a scientific way				
(g) use appropriate software and tools to process data, carry out research and report findings				
<p><b>Research and referencing</b></p> <p>(h) use online and offline research skills including websites, textbooks and other printed scientific sources of information</p>				

<p>(i) correctly cite sources of information</p> <p>The Practical Skills Handbook provides guidance on appropriate methods for citing information.</p>				
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<p><b>Instruments and equipment</b></p> <p>(j) use a wide range of experimental and practical instruments, equipment and techniques appropriate to the knowledge and understanding including in the specification</p> <p>See Section 5g.</p>				
<p><b>1.2.2 Use of apparatus and techniques</b></p>				
<p><b>Learning outcomes</b> Through use of the apparatus and techniques listed below, and the minimum of 12 assessed practicals (see Section 5g), learners should be able to demonstrate all of the practical skills listed within 1.2.1 and CPAC (Section 5g, Table 2) as exemplified through:</p>	R	A	G	<b>Comments</b>
<p>(a) use of appropriate analogue apparatus to record a range of measurements (to include length/distance, temperature, pressure, force, angles and volume) and to interpolate between scale marking</p>				
<p>(b) use of appropriate digital instruments, including electrical multimeters, to obtain a range of measurements (to include time, current, voltage, resistance and mass)</p>				
<p>(c) use of methods to increase accuracy of measurements, such as timing over multiple</p>				

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oscillations, or use of fiducial marker, set square or plumb line				
(d) use of a stopwatch or light gates for timing				
(e) use of calipers and micrometers for small distances, using digital or Vernier scales				
(f) correctly constructing circuits from circuit diagrams using DC power supplies, cells, and a range of circuit components, including those where polarity is important				
(g) designing, constructing and checking circuits using DC power supplies, cells, and a range of circuit components				
(h) use of a sign generator and oscilloscope, including volts/division and time-base				
(i) generating and measuring waves, using microphone and loudspeaker, or ripple tank, or vibration transducer, or microwave/radio wave source				

(j) use of a laser or light source to investigate characteristics of light, including reference and diffraction				
(k) use of ICT such as computer modelling, or data logger with a variety of sensors to collect data or use of software to process data				
(l) use of ionising radiation, including detectors				

**Module 2 Foundations in physics**

**2.1 Physical quantities and units**

**2.1.1 Physical quantities**

**Learning outcomes**

You will be required to show and apply knowledge and understanding of:

<b>R</b>	<b>A</b>	<b>G</b>
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**Comments**

(a) physical quantities have a numerical value and a unit

(b) making estimates of physical quantities listed in this specification

**2.1.2 S.I. units**

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<p>(a) Système Internationale (S.I.) base quantities and their units – mass (kg), length (m), time (s), current (A), temperature (K), amount of substance (mol)</p>				
<p>(b) derived units of S.I. base units</p> <p>Examples: momentum <math>\rightarrow</math> kg m s<sup>-1</sup> and Density <math>\rightarrow</math> kg m<sup>-3</sup></p>				
<p>(c) units listed in the specification</p>				
<p>(d) checking the homogeneity of physical equations using S.I. base units</p>				
<p>(e) prefixes and their symbols to indicate decimal submultiples or multiples of units – pico (p), nano (n), micro (<math>\mu</math>), milli (m), centi (c), deci (d), kilo (k), mega (M), giga (G), tera (T)</p>				
<p>(f) the conventions used for labelling graph axes and table columns</p> <p>e.g. speed / m s<sup>-1</sup> (see practical skills handbook)</p>				

2.2 Making measurements and analysing data				
2.2.1 Measurements and uncertainties				
Learning outcomes You will be required to show and apply knowledge and understanding of:	R	A	G	Comments
(a) systematic errors (including zero errors) and random errors in measurements				
(b) precision and accuracy				
(c) absolute and percentage uncertainties when data are combined by addition, subtraction, multiplication, division and raising to powers  A rigorous statistical treatment is not expected.				
(d) graphical treatment of errors and uncertainties; line of best fit; worst line; absolute and percentage uncertainties; percentage difference  An elementary knowledge of error bars is expected at A level.				

2.3 Nature of quantities				
2.3.1 Scalars and vectors				
Learning outcomes You will be required to show and apply knowledge and understanding of:	R	A	G	Comments
(a) Scalar and vector quantities  Learners will also be expected to give examples of each.				
(b) vector addition and subtraction				
(c) vector triangle to determine the resultant of any two coplanar vectors  To be done by calculations or by scale drawing.				
(d) resolving a vector into two perpendicular components; $F_x = F \cos \theta$ ; $F_y = F \sin \theta$				

<b>Module 3 Forces and motion</b>				
<b>3.1 Motion</b>				
<b>3.1.1 Kinematics</b>				
<b>Learning outcomes</b> You will be required to show and apply knowledge and understanding of:	<b>R</b>	<b>A</b>	<b>G</b>	<b>Comments</b>
(a) displacement, instantaneous speed, average speed, velocity and acceleration				
(b) graphical representations of displacement, speed, velocity and acceleration  Using data-loggers to analyse motion.				
(c) displacement–time graphs, velocity is gradient				
(d) velocity–time graphs, acceleration is gradient; displacement is area under graph  Learners will also be expected to estimate the area under non-linear graphs.				

3.1.2 Linear motion				
<p>(a) (i) the equations of motion for constant acceleration in a straight line, including motion of bodies falling in a uniform gravitational field without air resistance</p> $v = u + at \quad s = \frac{1}{2}(u + v)t$ $s = ut + \frac{1}{2}at^2 \quad v^2 = u^2 + 2as$ <p>(ii) techniques and procedures used to investigate the motion and collisions of objects</p> <p>Apparatus may include trolleys, air-track gliders, ticker timers, light gates, data-loggers and video techniques.</p>				
<p>(b) (i) acceleration <math>g</math> of free fall</p> <p>(ii) techniques and procedures used to determine the acceleration of free fall using trapdoor and electromagnet arrangement or light gates and timer</p> <p>Determining <math>g</math> in the laboratory.</p>				

(c) reaction time and thinking distance; braking distance and stopping distance for a vehicle				
<b>3.1.3 Projectile motion</b>				
(a) independence of the vertical and horizontal motion of a projectile				
(b) two-dimensional motion of a projectile with constant velocity in one direction and constant acceleration in a perpendicular direction				
<b>3.2 Forces in action</b>				
<b>3.2.1 Dynamics</b>				
<b>Learning outcomes</b> You will be required to show and apply knowledge and understanding of:	<b>R</b>	<b>A</b>	<b>G</b>	<b>Comments</b>
(a) net force = mass × acceleration; $F = ma$  Learners will also be expected to recall this equation.				
(b) the newton as the unit of force				

(c) weight of an object; $W = mg$  Learners will also be expected to recall this equation.				
(d) the terms tension, normal contact force, upthrust and friction				
(e) free-body diagrams				
(f) one- and two-dimensional motion under constant force				
<b>3.2.2 Motion with non-uniform acceleration</b>				
(a) drag as the frictional force experienced by an object travelling through a fluid				
(b) factors affecting drag for an object travelling through air				
(c) motion of objects falling in a uniform gravitational field in the presence of drag				

<p>(d) (i) terminal velocity</p> <p>(ii) techniques and procedures used to determine terminal velocity in fluids.</p> <p>E.g. ball-bearing in a viscous liquid or cones in air.</p> <p>Investigating factors affecting terminal velocity.</p>				
<p><b>3.2.3 Equilibrium</b></p>				
<p>(a) moment of force</p>				
<p>(b) couple; torque of a couple</p>				
<p>(c) the principle of moments</p>				
<p>(d) centre of mass; centre of gravity; experimental determination of centre of gravity</p>				
<p>(e) equilibrium of an object under the action of forces and torques</p>				
<p>(f) condition for equilibrium of three coplanar forces; triangle of forces</p>				

3.2.4 Density and pressure				
(a) density; $\rho = \frac{m}{V}$				
(b) pressure; $p = \frac{F}{A}$ for solids, liquids and gases				
(c) $p = h\rho g$ ; upthrust on an object in a fluid; Archimedes' principle				

3.3 Work, energy and power				
3.3.1 Work and conservation of energy				
Learning outcomes You will be required to show and apply knowledge and understanding of:	R	A	G	Comments
(a) work done by a force; the unit joule				
(b) $W = Fx \cos \theta$ for work done by a force				

(c) the principle of conservation of energy				
(d) energy in different forms; transfer and conservation				
(e) transfer of energy is equal to work done				
<b>3.3.2 Kinetic and potential energies</b>				
(a) kinetic energy of an object; $E_k = \frac{1}{2}mv^2$  Learners will also be expected to recall this equation and derive it from first principles.				
(b) gravitational potential energy of an object in a uniform gravitational field; $E_p = mgh$  Learners will also be expected to recall this equation and derive it from first principles.				
(c) the exchange between gravitational potential energy and kinetic energy				

3.3.3 Power				
(a) power; the unit watt; $P = \frac{W}{t}$				
(b) $P = Fv$  Learners will also be expected to derive this equation from first principles.				
(c) efficiency of a mechanical system;  efficiency = $\frac{\text{useful output energy}}{\text{total input energy}} \times 100\%$				

3.4 Materials				
3.4.1 Springs				
Learning outcomes You will be required to show and apply knowledge and understanding of:	R	A	G	Comments
(a) tensile and compressive deformation; extension and compression				
(b) Hooke's law				

(c) force constant $k$ of a spring or wire; $F = kx$				
(d) (i) force-extension (or compression) graphs for springs and wires  (ii) techniques and procedures used to investigate force-extension characteristics for arrangements which may include springs, rubber bands, polythene strips.				
<b>3.4.2 Mechanical properties of matter</b>				
(a) force-extension (or compression) graph; work done is area under graph				
(b) elastic potential energy; $E = \frac{1}{2}Fx$ ; $E = \frac{1}{2}kx^2$				
(c) stress, strain and ultimate tensile strength				
(d) (i) Young modulus = $\frac{\text{tensile stress}}{\text{tensile strain}}$ , $E = \frac{\sigma}{\epsilon}$  (ii) techniques and procedures used to determine the Young modulus for a metal.				

(e) stress-strain graphs for typical ductile, brittle and polymeric materials				
(f) elastic and plastic deformations of materials Investigating the properties of materials.				
<b>3.5 Newton's laws of motion and momentum</b>				
<b>3.5.1 Newton's laws of motion</b>				
<b>Learning outcomes</b> You will be required to show and apply knowledge and understanding of:	<b>R</b>	<b>A</b>	<b>G</b>	<b>Comments</b>
(a) Newton's three laws of motion				
(b) linear momentum; $p = mv$ ; vector nature of momentum				
(c) net force = rate of change of momentum; $F = \frac{\Delta p}{\Delta t}$ Learners are expected to know that $F = ma$ is a special case of this equation.				

(d) impulse of a force; impulse = $F\Delta t$				
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<p>(e) impulse is equal to the area under a force-time graph</p> <p>Learners will also be expected to estimate the area under non-linear graphs.</p> <p>Using a spreadsheet to determine impulse from <math>F-t</math> graph.</p>				
<p><b>3.5.2 Collisions</b></p>				
<p>(a) the principle of conservation of momentum</p>				
<p>(b) collisions and interaction of bodies in one dimension and in two dimensions</p> <p>Two-dimensional problems will only be assessed at A level.</p>				
<p>(c) perfectly elastic collision and inelastic collision</p>				

Module 4 Electrons, waves and photons				
4.1 Charge and current				
4.1.1 Charge				
Learning outcomes You will be required to show and apply knowledge and understanding of:	R	A	G	Comments
(a) electric current as rate of flow of charge; $I = \frac{\Delta Q}{\Delta t}$				
(b) the coulomb as the unit of charge				
(c) the elementary charge $e$ equals $1.6 \times 10^{-19}$ C  Learners will be expected to know that an electron has charge $-e$ and a proton $+e$ .				
(d) net charge on a particle or an object is quantised and a multiple of $e$				
(e) current as the movement of electrons in metals and movement of ions in electrolytes				
(f) conventional current and electron flow				
(g) Kirchhoff's first law; conservation of charge				

4.1.2 Mean drift velocity				
(a) mean drift velocity of charge carriers				
(b) $I = Anev$ , where $n$ is the number density of charge carriers				
(c) distinction between conductors, semiconductors and insulators in term of $n$				
4.2 Energy, power and resistance				
4.2.1 Circuit symbols				
<b>Learning outcomes</b> You will be required to show and apply knowledge and understanding of:	<b>R</b>	<b>A</b>	<b>G</b>	<b>Comments</b>
(a) circuit symbols  As set out in ASE publication <i>Signs, Symbols and Systematics (The ASE Companion to 16-19 Science, 2000)</i> .				
(b) circuit diagrams using these symbols				
4.2.2 E.m.f and p.d				

(a) potential difference (p.d.); the unit volt				
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<p>(b) electromotive force (e.m.f.) of a source such as a cell or a power supply</p> <p>Epsilon is used as the symbol for e.m.f. to avoid confusion with E which is used for energy and electric field. The ASE guide 'Signs, symbols and systematics' details E as the correct symbol for e.m.f. and this will be credited in all examinations.</p>				
<p>(c) distinction between e.m.f. and p.d. in terms of energy transfer</p>				
<p>(d) energy transfer; <math>W = VQ</math>; <math>W = \mathcal{E}Q</math></p>				
<p>(e) energy transfer <math>eV = \frac{1}{2}mv^2</math> for electrons and other charged particles</p>				
<p><b>4.2.3 Resistance</b></p>				
<p>(a) resistance; <math>R = \frac{V}{I}</math>; the unit ohm</p> <p>Learners will also be expected to recall this equation.</p>				
<p>(b) Ohm's law</p>				



<p>(c) (i) <math>I</math>-<math>V</math>; characteristics of resistor, filament lamp, thermistor, diode and light-emitting diode (LED)</p> <p>(ii) techniques and procedures used to investigate the electrical characteristics for a range of ohmic and non-ohmic components.</p> <p>Investigating components and analysing data using spreadsheet.</p>				
<p>(d) light-dependent resistor (LDR); variation of resistance with light intensity</p>				
<p><b>4.2.4 Resistivity</b></p>				
<p>(a) (i) resistivity of a material; the equation <math>R = \frac{\rho L}{A}</math>; the unit ohm</p> <p>(ii) techniques and procedures used to determine the resistivity of a metal.</p>				
<p>(b) the variation of resistivity of metals and semiconductors with temperature</p>				
<p>(c) negative temperature coefficient (NTC) thermistor; variation of resistance with temperature</p>				



4.3 Electrical circuits				
4.3.1 Series and parallel circuits				
Learning outcomes You will be required to show and apply knowledge and understanding of:	R	A	G	Comments
(a) Kirchhoff's second law; the conservation of energy				
(b) Kirchhoff's first and second laws applied to electrical circuits				
(c) total resistance of two or more resistors in series; $R = R_1 + R_2 + \dots$				
(d) total resistance of two or more resistors in parallel; $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$				
(e) analysis of circuits with components, including both series and parallel				
(f) analysis of circuits with more than one source of e.m.f.				

<b>4.3.2 Internal resistance</b>				
(a) source of e.m.f.; internal resistance				
(b) terminal p.d.; 'lost volts'				
(c) (i) the equations $\mathcal{E} = I(R + r)$ and $\mathcal{E} = V + Ir$  (ii) techniques and procedures used to determine the internal resistance of a chemical cell or other source of e.m.f.  Investigating the internal resistance of a power supply.				
<b>4.3.3 Potential dividers</b>				
(a) potential divider circuit with components				
(b) potential divider circuits with variable components e.g. LDR and thermistor				

<p>(c) (i) potential divider equations e.g.  <math display="block">V_{out} = \frac{R_2}{R_1 + R_2} \times V_{in} \text{ and } \frac{V_1}{V_2} = \frac{R_1}{R_2}</math></p> <p>(ii) techniques and procedures used to investigate potential divider circuits which may include a sensor such as a thermistor or an LDR.</p> <p>Designing temperature and light sensing circuits.</p>				
<p><b>4.4 Waves</b></p>				
<p><b>4.4.1 Wave motion</b></p>				
<p><b>Learning outcomes</b> You will be required to show and apply knowledge and understanding of:</p>	<b>R</b>	<b>A</b>	<b>G</b>	<b>Comments</b>
<p>(a) progressive waves; longitudinal and transverse waves</p>				
<p>(b) (i) displacement, amplitude, wavelength, period, phase difference, frequency and speed of a wave</p> <p>(ii) techniques and procedures used to use an oscilloscope to determine frequency.</p>				
<p>(c) the equation <math>f = \frac{1}{T}</math></p>				

(d) the wave equation $v = f\lambda$				
(e) Graphical representations of transverse and longitudinal waves				
(f) (i) reflection, refraction, polarisation and diffraction of all waves  (ii) techniques and procedures used to demonstrate wave effects using a ripple tank  (iii) Techniques and procedures used to observe polarising effecting using microwaves and light.				
(g) intensity of a progressive wave; $I = \frac{P}{A}$ ; intensity $\propto$ (amplitude) <sup>2</sup>				
<b>4.4.2 Electromagnetic waves</b>				
(a) electromagnetic spectrum; properties of electromagnetic waves				
(b) orders of magnitude of wavelengths of the principal radiations from radio waves to gamma rays				

<p>(c) plain polarised waves, polarisation of electromagnetic waves</p> <p>Learners will be expected to know about polarising filters for light and metal grilles for microwaves in demonstrating polarisation.</p>				
<p>(d) (i) refraction of light; refractive index; <math>n = \frac{c}{v}</math>; <math>n \sin \theta = \text{constant}</math> at a boundary where <math>\theta</math> is the angle to the normal</p> <p>(ii) techniques and procedures used to investigate refraction and total internal reflection of light using ray boxes, including transparent rectangular and semi-circular block.</p>				
<p>(e) critical angle; <math>\sin c = \frac{1}{n}</math>; total internal reflection for light</p>				
<p><b>4.4.3 Superposition</b></p>				
<p>(a) (i) the principle of superposition of waves</p> <p>(ii) techniques and procedures used for superposition experiments using sound, light and microwaves.</p>				

(b) graphical methods to illustrate the principle of superposition				
(c) interference, coherence, path difference and phase difference				
(d) constructive interference and destructive interference in terms of path difference and phase difference				
(e) two-source interference with sound and microwaves				
(f) Young double-slit experiment using visible light  Learners should understand that this experiment gave a classical confirmation of the wave-nature of light.  Internet research on the ideas of Newton and Huygens about the nature of light.				
<b>4.4.4 Stationary waves</b>				
(a) stationary (standing) waves using microwaves, stretched strings and air columns				
(b) graphical representations of a stationary wave				

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(c) similarities and the differences between stationary and progressive waves				
(d) nodes and antinodes				
(e) (i) stationary wave patterns for a stretched string and air columns in closed and open tubes  (ii) techniques and procedures used to determine the speed of sound in air by formation of stationary waves in a resonance tube.				
(f) the idea that the separation between adjacent nodes (or antinodes) is equal to $\lambda/2$ , where $\lambda$ is the wavelength of the progressive wave				
(g) fundamental mode of vibration (1 <sup>st</sup> harmonic) harmonics				
<b>4.5 Quantum Physics</b>				
<b>4.5.1 Photons</b>				
<b>Learning outcomes</b> You will be required to show and apply knowledge and understanding of:	<b>R</b>	<b>A</b>	<b>G</b>	<b>Comments</b>

(a) the particulate nature (photon model) of electromagnetic radiation				
(b) photon as a quantum of energy of electromagnetic radiation				
(c) energy of photon; $E = hf$ and $E = \frac{hc}{\lambda}$				
(d) the electronvolt (eV) as a unit of energy				
(e) (i) using LEDs and the equation $eV = \frac{hc}{\lambda}$ estimate the value of Planck constant $h$  (ii) Determine the Planck constant using different coloured LEDs.  No knowledge of semiconductor theory is required.				
<b>4.5.2 The photoelectric effect</b>				
(a) (i) photoelectric effect, including a simple experiment to demonstrate this effect  (ii) demonstration of the photoelectric effect using, e.g. gold-leaf electroscope and zinc plate.				

<p>Learners should understand that the photoelectric effect provides evidence for particulate nature of electromagnetic radiation.</p> <p>Internet research on the development of quantum physics.</p>				
(b) a one-to-one interaction between a photon and a surface electron				
(c) Einstein's photoelectric equation $hf = \phi + KE_{\max}$				
(d) work function; threshold frequency				
(e) the idea that the maximum kinetic energy of the photoelectrons is independent of the intensity of the incident radiation				
(f) the idea that rate of emission of photoelectrons above the threshold frequency is directly proportional to the intensity of the incident radiation				
<b>4.5.3 Wave-particle duality</b>				
(a) electron diffraction, including experimental evidence of this effect				

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Learners should understand that electron diffraction provides evidence for wave-like behaviour of particles.				
(b) diffraction of electrons travelling through a thin slice of polycrystalline graphite by the atoms of graphite and the spacing between the atoms				
(c) the de Broglie equation $\lambda = \frac{h}{p}$				

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[www.ocr.org.uk/i-need-to-find-resources](http://www.ocr.org.uk/i-need-to-find-resources)

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#### General qualifications

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Facsimile 01223 552627

Email

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