

Higher Physics: Electricity

The left hand column below details the content in which students should develop knowledge and understanding. The middle column contains notes, which give further details of the content.

The right-hand column gives suggested contexts in which knowledge and understanding and skills can be developed.

Content	Notes	Contexts
1. Electrons and Energy		
a) Monitoring and measuring a.c.	a.c. as a current which changes direction and instantaneous value with time. Monitoring a.c. signals with an oscilloscope, including measuring frequency, and peak and r.m.s. values.	Using a multimeter as an ammeter, voltmeter and ohmmeter. Oscilloscope as a voltmeter and waveform monitor.
b) Current, voltage, power and resistance	Current, voltage and power in series and parallel circuits. Calculations involving voltage, current and resistance may involve several steps. Potential dividers as voltage controllers.	Investigating simple a.c. or d.c. circuits with switches and resistive components. Potential dividers in measurement circuits and used with variable resistors to set and control voltages in electronic circuits.
c) 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.	Investigating the reduction in mains voltage as additional appliances are connected. Investigating internal resistance of low voltage power supplies. Load matching.
d) 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.	Energy storage. Flash photography. Smoothing and suppressing. Capacitance based touch screens.

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2. Electrons at Work		
a) Conductors, semiconductors and insulators	<p>Solids can be categorised into conductors, semiconductors or insulators by their ability to conduct electricity.</p> <p>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.</p> <p>In metals which are good conductors, 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.</p> <p>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.</p> <p>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>	<p>Conducting cables and insulating material.</p> <p>Breakdown voltage and lightning.</p> <p>Hall effect sensor.</p> <p>Investigating the change in resistance of a negative temperature coefficient thermistor as its temperature is increased.</p>
b) p-n junctions	<p>During manufacture, the conductivity of semiconductors can be controlled, resulting in two types: p-type and n-type.</p> <p>When p-type and n-type material are joined, a layer is formed at the junction. The electrical properties of this layer are used in a number of devices.</p> <p>Solar cells are p-n junctions designed so that a potential difference is produced when photons enter the layer. This is the photovoltaic effect.</p> <p>LEDs are p-n junctions which emit photons when a current is passed through the junction.</p>	<p>Investigating the output voltage of a solar cell and its dependence on the irradiance and frequency of incident light.</p> <p>Investigating the switch on voltage of different coloured LEDs.</p>