Higher Physics
Electricity
Key Definitions

Word/Term	Definition
Direct Current	When current flows in only one direction at all times. E.g. a battery.
Alternating Current	When current changes direction every fraction of a second. E.g. the mains.
Mains Voltage	In the UK, the mains has a declared value of **230 V**.
r.m.s. value	A sort of 'average' value of voltage or current for an a.c. supply. It is also known as the 'declared value'.
Peak Voltage	The maximum voltage in an a.c. supply. For an a.c. voltage wave shown on an oscilloscope screen, it is given by the crest of the wave.
Peak Current	The maximum current in an a.c. supply.
Y-gain	A setting on an oscilloscope which controls the **voltage per centimetre**. It affects the **vertical component** of the wave and can be used to determine the **peak voltage** of an a.c. supply.
Time-base	A setting on an oscilloscope which controls the **time per centimetre**. It affects the **horizontal component** of the wave and can be used to determine the **frequency** of an a.c. supply.
Period	The time taken for one wave to pass a point. In terms of an oscilloscope trace, it is given by the time-base setting multiplied by the number of divisions.
Frequency	The number of waves per second. In terms of an a.c. supply, it is given by the inverse of the period.
Current	The electric charge transferred per unit time. In a circuit, it is measured using an **ammeter**.
Potential Difference	The energy given to each coulomb of charge that passes through a power supply. It is also known as **voltage**. In a circuit, it is measured using a **voltmeter**.
Resistance	An opposition to current flow. In a circuit, it is measured using an **ohmmeter**. It depends on the type, length, thickness and temperature of a material.

Word/Term	Definition
Ohm's Law	The voltage across a resistor is directly proportional to the current passing through it, as long as temperature remains constant. That is, V I. This follows for any ohmic conductor.
Potential Divider	A series circuit with two or more resistors in which each resistor receives a **share** of the supply voltage. The splitting of the voltage depends on the relative resistances of the resistors.
Wheatstone Bridge	Two potential divider circuits connected in parallel, often with a voltmeter in the middle. The voltage across the voltmeter can be determined by calculating the voltage across each of the bottom resistors and then calculating the difference between the two.
Power	The electrical energy transferred per second. It can also be written in terms of current and voltage, current and resistance and voltage and resistance.
Electrical Source	A device that supplies electrical energy e.g. a power supply.
Electromotive Force (e.m.f.)	The energy supplied to each coulomb of charge which passes through a source. It is measured in volts, V.
Open Circuit	A circuit in which no current is flowing, i.e. the switch is open.
Internal Resistance	The resistance that a power supply (or battery) has when current is flowing in a circuit.
Real Source	A source of electrical energy (battery) in series with a small internal resistance.
Ideal Source	A source with no internal resistance (i.e. it has only an e.m.f.).
Lost Volts	The energy wasted inside an electrical source due to its internal resistance when current is drawn from the source.
Terminal Potential Difference (t.p.d.)	The voltage available at the terminals of an electrical source. That is, the voltage remaining after the lost volts has been subtracted from the e.m.f.
External Resistance	The total resistance in a circuit (excluding the power supply). This could be from a load resistor, R.

Word/Term	Definition
Short Circuit	When a battery is short-circuited (e.g. by connecting it to itself), the load resistance, R, is effectively zero. Since $V_{tpd} = IR$, this means that V_{tpd} must also be zero. A short circuit can be dangerous as with no load resistance, current can become incredibly high.
Capacitor	A device that can store charge and therefore energy in an electrical circuit.
Capacitance	The ability of a capacitor to store charge. More precisely, it is the charge stored per volt of potential difference across a capacitor. It is given by the gradient of the line on a Q-V graph.
RC Circuit	A circuit containing both a resistor and a capacitor.
Conductor	A material that allows electrons to flow through it and therefore conduct electricity e.g. metals and carbon.
Insulator	A material that does not allow electrons to flow through it and therefore does not conduct electricity e.g. rubber, plastic and glass.
Semiconductor	A material that behaves as an insulator when pure, but can be made to conduct by adding an impurity or exposing it to heat, light etc e.g. silicon and germanium.
Band Theory	In isolated atoms, electrons occupy discrete energy levels (orbits). However, when atoms are brought together to form solids, these energy levels interact with each other and become grouped into bands. These bands represent a continuous range of energies, but there are some groups of energy that are not allowed (band gaps). Discussions around band theory usually involve the terms **conduction band**, **valence band** and **band gap**.
Conduction Band	The band above the valence band. Electrons can jump into this band from the valence band when they have enough energy. It is not completely full of electrons meaning that electrons can move freely. This means that the band can conduct when an electric field is applied.
Valence Band	The band that the outermost electrons can occupy. Electrons will jump from this band into the conduction band when excited.

Word/Term	Definition
Doping	The addition of an impurity atom to an intrinsic semiconductor during manufacture, in order to increase its conductivity.
Valency	The number of electrons in the outer shell of an atom.
Pure/Intrinsic Semiconductor	A semiconductor that has not been doped; it is in its purest form.
Extrinsic Semiconductor	A semiconductor that has been doped with an impurity atom.
N-type Doping	The addition of a **Group V element** like arsenic to an intrinsic semiconductor is called n-type doping. Most conduction takes place by the movement of free electrons, which are negatively charged. The majority charge carriers are therefore electrons.
P-type Doping	The addition of a **Group III element** like boron to an intrinsic semiconductor is called p-type doping. Most conduction takes place by the movement of holes, which are positively charged. The majority charge carriers are therefore holes.
Hole	The absence of an electron. We can think of holes as positively charged particles that move in the opposite direction to electrons.
P-N Junction (diode)	The junction formed when a piece of p-type material is grown together with a piece of n-type material.
Depletion Region	The region around the p-n junction that consists of 'filled holes' i.e. no free charge carriers. It is also known as the depletion layer.
Biasing	Applying a voltage to a p-n junction to make it behave in a particular way.
Forward Bias	When the negative terminal of the cell is connected to the n-type and the positive terminal of the cell is connected to the p-type. The diode **conducts** because the depletion layer has been removed. Forward bias therefore **reduces the electric field** in the p-n junction.

Word/Term	Definition
Reverse Bias	When the negative terminal of the cell is connected to the p-type and the positive terminal of the cell is connected to the n-type. The diode **will not conduct** since the depletion layer width is increased. Reverse bias therefore **increases the electric field** in the p-n junction.
LED	A forward biased p-n junction diode that emits photons due to recombination.
Recombination	When electrons drop energy level from the conduction band to the valence band (i.e. when electrons 'fall' into holes).
Solar Cell	A p-n junction that produces a potential difference when photons are absorbed. It is used to store solar energy.
Photovoltaic Effect	The name given to the production of a voltage when a solar cell absorbs incident photons.