# U5 - Electricity

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| **What is the circuit symbol of a switch?** |  |
| **What is the circuit symbol of a cell/battery?** |  |
| **What is the circuit symbol of a diode?** |  |
| **What is the circuit symbol of both a resistor and variable resistor?** |  |
| **What is the circuit symbol of a L.E.D?** |  |
| **What is the circuit symbol of a lamp?** |  |
| **What is the circuit symbol of a fuse?** |  |
| **What is the circuit symbol of a voltmeter?** |  |
| **What is the circuit symbol of an ammeter?** | *These ideally should have zero resistance.* |
| **What is the circuit symbol of a thermistor?** |  |
| **What is the circuit symbol of a L.D.R?** |  |
| **What happens to both insulators and conductors when a voltage is applied across them and why?** | * In **insulators**, **no current passes** ∵ electrons are **fixed**. * In **metallic conductors**, **current passes** ∵ some electrons are **delocalised** (i.e., the charge carriers). |
| **What is 1 C?** | The **amount of charge** that flows via a point in **1 s** when there is a current of **1 A**. |
| **What is current?** | * The rate of the flow of charge. * 1 A is 1 C flowing via a point every second. |
| **What is current ∝ to under constant resistance and why?** | The **emf** of the battery ∵ the **more energy** supplied to the charge carriers, the **faster** they will move. |
| **How does charge flow? And how does the the flow of current differ?** | * Charge flows from - to + due to repulsion and attraction. * Current flows opposite to charge by convention.     *Always make conventional current on diagrams unless stated otherwise.* |
| **What is potential difference and hence 1 V?** | * The energy transferred (**work done**) **per unit of charge**. * 1 V is 1 J transferred per coulomb of charge. |
| **Why are voltmeters used in parallel?** | Have a **very high resistance** ∴ you want as **little current to pass** through them ∴ you put them in parallel.  *You still need a tiny bit of current to calculate voltage.* |
| **When is maximum power delivered to the load?** | When load resistance = internal resistance. |
| **What can resistance be described as?** | How hard it is for current to flow through a component.  *It being R = V/I means it’s a measure of how much current you get for a particular p.d.* |
| **What is resistance caused by?** | The repeated collisions between the charge carriers and positive ions. |
| **Why does resistance lead to the material heating up?** | **Energy** is **transferred** during the **collisions** between the charge carriers and the positive ions. |
| **Why does an increase in temperature increase resistance?** | Particles **vibrate more frequently** (1) ∴ **collide more frequently** with charge carriers (1) preventing them from flowing through so easily. |
| **Why is resistivity useful?** | It allows resistances of **different materials** to be **compared** when under the **same physical conditions**. |
| **How does resistance vary with dimensions and why?** | * It **increases with length** ∵ charge carriers have **more to flow through**. * It **decreases with area** ∵ charge carriers have **more options** in taking the path of **least resistance**. |
| **What is *Ohm’s Law*?** | “Provided physical conditions remain constant, the current via an ohmic conductor is directly proportional to the p.d. across it.”  *This means that doubling the p.d. doubles the current in the circuit (as the particles have more energy so move faster).* |
| **What is a non-ohmic conductor?** | A conductor whose resistance isn’t constant. |
| **Give an example of an ohmic conductor with its current-voltage graph** | A resistor at constant temperature. |
| **Give the current-voltage graph of a filament bulb with an explanation** | Its **resistance increases** as it heats up due to **wasted energy**. |
| **What does a diode do and how?** | It **only allows current** to flow in the **forward direction** by having a very high resistance in the backwards direction. |
| **What applications do diodes have?** | To protect components in circuits. |
| **Give the current-voltage graph of a diode with an explanation** | * Has a t**hreshold voltage** of **0.60 V** before conduction. * Can **conduct** in the **reverse direction** if the p.d. is high enough (this is its **breakdown voltage**). |
| **Give an example of a semiconductor** | A thermistor. |
| **What key feature does a thermistor have, what does this mean and why?** | **Negative temperature coefficient** (NTC) ⇒ its **resistance decreases** (1) as its **temperature increases** (1) as **electrons are released** (1). |
| **What happens to a LDR as light intensity changes?** | Its r**esistance decreases** as its **light intensity increases**. |
| **What is a superconductor defined as?** | A material with **ZERO RESISTANCE** at or below its **critical temperature**. |
| **Why are superconductors used (with examples)?** | To have **NO ENERGY LOSSES** in machines with huge currents (e.g., in particle accelerators). |
| **What is an intrinsic semiconductor?** | A pure semiconducting material. |
| **How does resistance work in series and why?** | Total resistance = sum of all individual resistances ∵ VT = V1 + V2 ⇒ IRT = IR1 + IR2 ⇒ RT= R1 + R2. |
| **How does current work in series and why?** | It is the **same wherever** you put the ammeter because it’s a **rate**. |
| **What is the effective resistance for parallel resistors and why?** | * The reciprocal of the total resistance is equal to the sum of the reciprocals of the resistances of all the components. * As it increases the possible routes for current to take thus making it easier for current to flow and thus the effective resistance smaller.   *This is because you that know IT = I1 + I2⇒ V / RT = V / R1 + V / R2 ⇒ 1 / RT = 1 / R1 + 1 / R2* |
| **How does p.d. work in parallel and why?** | **Same across all lines** ∵ it is merely the **energy transferred per coulomb of charge** which is the same for each coulomb. |
| **How does current work in parallel and why?** | It **splits up** at a junction **according to resistance**; **more current** will flow via the **least resistance** because voltage has to be constant.  *Think of charge as being lazy, more will flow down the route with the least resistance.* |
| **What is Kirchhoff’s First Law?** | “At any junction, the sum of the currents entering = the sum of the currents leaving.”  *This is fundamentally a statement about the conservation of charge.* |
| **What is Kirchhoff’s Second Law?** | “In any loop (path) around a circuit, the sum of the emf’s = the sum of the p.d.’s.”  **S**econd for **S**um. |
| **Justify Kirchhoff’s Second Law** | Each charge carrier **must transfer all its energy** within the circuit and **return to the cell with none** remaining. |
| **What is electromotive force (ε)?** | The energy transferred (1) by the cell per unit charge (1). |
| **What does an ideal voltmeter measure around a cell?** | Terminal p.d. |
| **What is a potential divider?** | A circuit that uses **two or more resistors** in series to supply a **variable p.d**. |
| **What fact is the potential divider based on and why? And what does this mean?** | * **P.d. ∝ resistance** under constant current ∵ electrons **need more energy** to overcome the resistance. * Meaning the resistor with **greater resistance** will have a **greater share of the p.d**. |
| **What is equal in a potential divider circuit and why?** | The **ratio of the voltages** to the **ratio of the resistances** because current is constant. |
| **Give a developed application of a potential divider** | Temperature control. E.g., for the diagram below, if R1 is a thermistor, when it gets colder, its resistance increases ⇒ the its p.d. (Vout) increases too which could then be used to turn on a heater. |
| **Why is measuring emf using an open/close switch and a voltmeter not ideal in reality?** | There's still some current flowing through the circuit to power the voltmeter so by ε = V + Ir, ε ≠ V. This current leads to the internal resistance having an effect.  *Thus, it's better to measure emf indirectly. Yet, in an ideal physics world, where a voltmeter has infinite resistance, no current passes via the circuit so the internal resistance has no effect so the emf is displayed.* |
| **How do e.m.f sources in opposite polarities work?** | * Current will flow from the positive to negative terminal of the source with the largest emf. * The source acting in opposite reduces the total emf. |