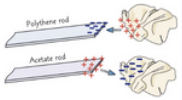
ELECTRICITY

static electricity

- When insulating materials are rubbed together, negatively charged electrons will be scraped off one and dumped onto the other
- This will leave the materials electrically charged; one +ve and the other -ve
- Which way the electrons are transferred depends on the two materials involved



- Eg. polythene and acetate rods rubbed with a cloth duster
- The +ve and -ve charges are only ever produced by the movement of electrons
- The charges do not move
- +ve charge is caused by electrons moving away (loses some electrons which are -vely charged so there is an overall +ve charge)

ELECTRIC FIELDS

- When two electrically charged objects are close they exert a force on each other

- Opposite charges attract, same charges repel
- These forces get weaker with distance, but can cause objects to move (electrostatic attraction/repulsion, non contact force)
- To see this, suspend rod with known charge from piece of string so it is free to move, object with same charge makes rod move away, object with opposite charge makes rod move towards it

- As electric charge builds up on object, the pd between object and the earth (which is 0V) increases
- If pd gets large enough, electrons can jump across gap between charged object and the earth - this is the spark
- They can also jump to any earthed conductor that is nearby - which is why you can get static shocks when getting out of the car

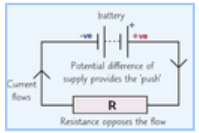
- Charge builds up on car's metal frame, when you touch it the charge travels through you to the earth
- Usually happens when gap is fairly small

CURRENT

- Current is the flow of electrical charge
- Electrical charge only flows in a complete/closed circuit if there is a potential difference
- Potential difference is the driving force that pushes charge round
- Resistance is anything that slows the flow down
- Current flowing through a component depends on the potential difference across it and the resistance of the component
- Greater resistance = smaller current

V = IR

POTENTIAL DIFFERENCE(V) = CURRENT(A) X RESISTANCE(Ω)

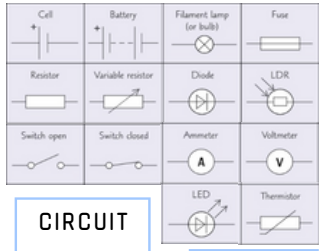


- Size of current is the rate of flow of charge
- More charge passes through circuit when a larger current flows

Q = IT

CHARGE(C) = CURRENT(A) X TIME(S)

CIRCUIT SYMBOLS



circuits

SERIES & PARALLEL

Series Circuits:

- Different components are connected in a line
- If a component is removed the circuit is broken and everything stops
- Total potential difference is the sum of potential differences TOTAL V = V1 + V2 + V3 ...
- Current is same everywhere I1 = I2 = I3 ...
- Total resistance is sum of resistances

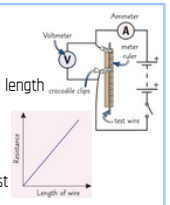
TOTAL R = R1 + R2 + R3 ...

Parallel Circuits:

- Each component is on a separate 'branch'
- If a component is removed it won't really affect the rest of the circuit
- Potential difference is same everywhere V1 = V2 = V3 ...
- Total current is sum of currents TOTAL I = I1 + I2 + I3 ...
- Total resistance is resistance of smallest resistor

TOTAL R = SMALLEST R

1. Attach crocodile clip to wire level with 0cm on ruler
2. Attach second crocodile clip to wire at certain distance from first clip; record this distance
3. Close switch and record current and pd across the wire
4. Open switch, move second clip and record current and pd again
5. Repeat for different lengths
6. Use data to calculate resistance
7. Plot graph of resistance against wire length
8. Draw a line of best fit
9. Graph should show direct proportion
10. If it does not go through 0 then first clip was not attached correctly -> systematic error



FACTORS AFFECTING RESISTANCE

- Resistance varies depending on many factors eg series, parallel, length of wire
- Effect of wire length can be investigated

RESISTANCE & IV CHARACTERISTICS

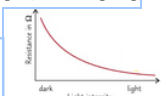
resistance

- For some components, as current changes, their resistance changes as well
- Resistance of an ohmic conductor does not change with current
- At constant temperature, current flowing through an ohmic conductor (eg wire, resistor) is directly proportional to the pd across it
- Resistance of some resistors/components DOES change (eg diode, filament lamp)
- When charge flows through filament lamp, some energy is transferred to thermal energy store of filament which is designed to heat up
- Resistance increases with temperature so current increase = temperature increase = resistance increase
- Resistance in diodes depends on direction

CIRCUIT DEVICES

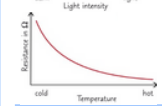
Light Dependent Resistor (LDR):

- Bright light = resistance decreases
- Darkness = resistance increases
- Uses: automatic night lights, outdoor lighting, burglar detectors

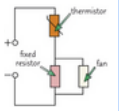


Thermistor:

- Hot = resistance decreases
- Cold = resistance increases
- Uses: car engine temperature sensors, electronic thermostats

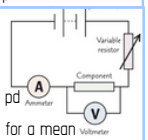


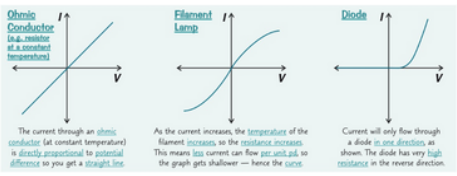
- LDRs and thermistors can be used in sensing circuits
- Sensing circuits used to turn on/increase the power to components depending on conditions they are in
- Fixed resistor & fan have same pd
- Power supply pd is shared between thermistor and fixed resistor & fan loop
- Room gets hotter = thermistor resistance decreases = loop pd rises



Investigating IV characteristics:

1. Set up circuit
2. Vary variable resistor which alters current and pd
3. Take readings of current and pd; repeat twice for a mean
4. Swap wires connected to cell so current direction is reversed
5. Repeat steps 2-3 and plot a graph of current against voltage





POWER & ELECTRICAL APPLIANCES

E = PT

ENERGY TRANSFERRED(J) = POWER(W) X TIME(S)

P = VI

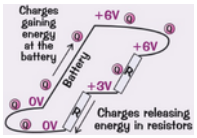
POWER(W) = PD(V) X CURRENT(A)

- Electrical appliances are designed to transfer energy to components in the circuit when a current flows
- No appliance transfers all energy completely usefully
- Higher current = more energy transferred to thermal energy stores of components and then surroundings
- Total energy transferred by appliance depends on how long it is on for and its power

- When electrical charge goes through a change in pd, the energy is transferred
- Energy is supplied to charge at power source to 'raise' it through a potential
- The charge gives up this energy when it 'falls' through any potential drop in components elsewhere in the circuit

E = QV

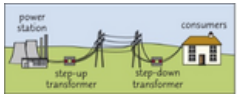
ENERGY TRANSFERRED(J) = CHARGE FLOW(C) X PD(V)



electricity in the home

NATIONAL GRID

- To transmit huge amount of power needed, you need either a high pd or high current
- High current is inefficient as energy is transferred from wires to thermal energy stores of surroundings
- Cheaper to boost pd to 400,000V and keep current as low as possible
- Transformers are used to step up pd for efficient transmission and step it down to safe usable levels for consumers



- National grid is giant system of cables and transformers that covers the UK and connects power stations to consumers
- During the day, electricity usage/demand changes so power stations need to be able to provide for these changes
- They can predict when this will happen & they often run at much below maximum power output so there is spare capacity to meet demand

ELECTRICITY SUPPLIES

- Two types of electricity supplies: alternating current (current is constantly changing, produced by alternating voltage: +ve & -ve ends switch) & direct current (current always flows in same direction)
- UK mains supply is an ac supply at around 230V with frequency of 50Hz
- Cells & batteries are dc
- Most electrical appliances are connected to the mains supply by three-core cables which have three wires in them

Neutral wire:
- completes circuit, carries away current, 0V

Live wire:
- provides pd of 230V

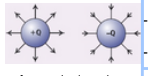
Earth wire:
- safety, 0V

- Live wire can give you an electric shock
- Contact with live wire makes you a link between supply and earth so current will flow through you

-

Static Electricity

- Electric field is created around any electrically charged object
- Closer to object = stronger field
- Show the field using field lines eg for an isolated charged sphere:



- Field lines go from +ve to -ve
- Always at right angle to surface
- Closer together = stronger field

- When charged object is placed in electric field of another, it feels a force
- Force causes attraction or repulsion
- Force is caused by electric fields of object interacting with each other
- Stronger field = stronger force

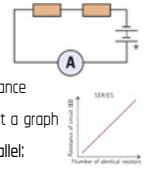
- Q's electric field interacts with q's electric field
- Forces act on Q and q
- Forces move Q and q closer together

- Sparks caused when there is a high enough pd between a charged object and the earth
- High pd = strong electric field between charged object and earth
- Strong electric field causes electrons in air particles to be removed (ionisation)
- Air is normally an insulator, but when ionised it is more conductive so current flows through it - spark

Resistors in series and parallel

Investigating adding resistors in series:

1. Set up circuit and record pd of battery
2. Measure current through circuit using ammeter
3. Calculate resistance of circuit
4. Add another resistor in series
5. Measure current and calculate resistance
6. Repeat with more resistors then plot a graph



Investigating adding resistors in parallel:

1. Build circuit, measure current and calculate resistance
2. Add another resistor in parallel
3. Measure current and calculate resistance
4. Repeat with more resistors then plot a graph