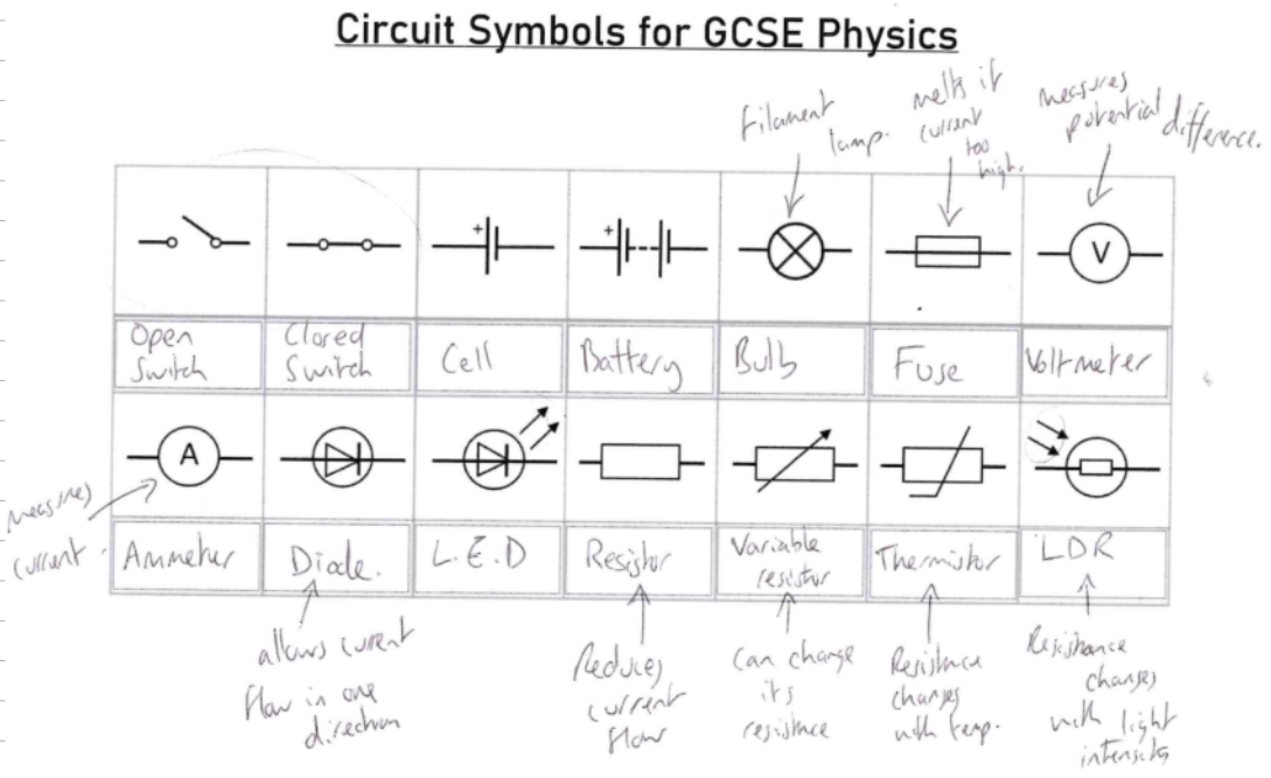
Current

26th March



Electric current is the RATE of flow of ELECTRICAL CHARGE.

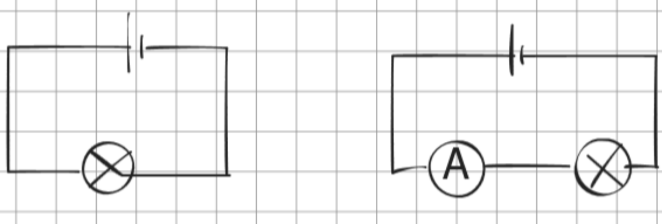
A measurement of current tells us how much charge is flowing past a point per second.

$$\text{Current} = \frac{\text{Charge}}{\text{time}}$$

Charge = Current x time $\qquad Q = It$

- Charge: in coulombs, C
- Current: in amperes (amps), A
- time: in seconds, s

We measure current flow with an AMMETER which must be connected in SERIES (in the same loop) as the component we wish to measure current through.



This ammeter tells us the current through the bulb and the cell, as it is in the same loop as both.

Potential Difference

1st April

The electric potential is a measure of how much energy (in joules) each coulomb of electric charge has.

In a circuit we can use a VOLTMETER to measure the difference in electrical potential between two points.

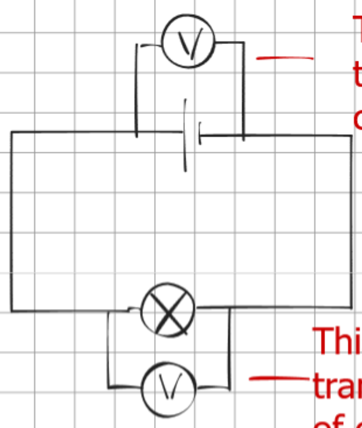
We call this reading a POTENTIAL DIFFERENCE.

$$\text{Potential difference} = \frac{\text{Energy}}{\text{Charge}}$$

Energy = Potential difference x charge

$$E = VQ$$

in joules, J — in volts, V — in coulombs, C

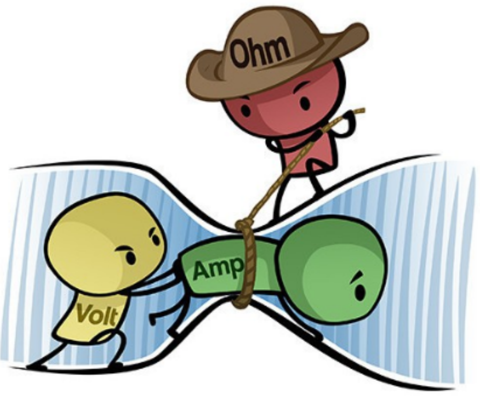


This voltmeter shows the energy transferred TO each coulomb of charge

This voltmeter shows the energy transferred BY each coulomb of charge as it passes through the bulb

Resistance

3rd April



All components have some level of electrical resistance.

Resistance is anything that opposes a flow of electrical charge (current).

The size of the current depends on the size of the potential difference and the size of the resistance.

$$\text{Resistance} = \frac{\text{potential difference}}{\text{current}}$$

potential difference = current x resistance

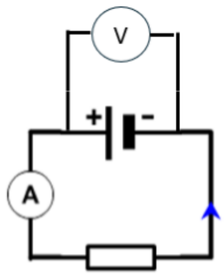
$$V = IR$$

- V: in volts, V
- I: in amps, A
- R: in ohms, Ω

GCSE Required Practical 3 (Part One)

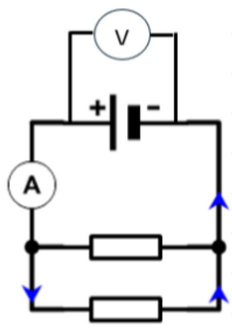
SERIES:

1. Set up the circuit shown to the right using one 10Ω resistor, an ammeter and a voltmeter.
2. Calculate the total resistance of the circuit using the ammeter reading and the voltmeter reading.
3. Repeat step 2 for 2 resistors in series then 3 resistors in series (in the same loop)



PARALLEL:

1. Set up the circuit as shown using two 10Ω resistors in parallel
2. Calculate total resistance using the ammeter reading and the voltmeter reading.
3. Add a third resistor in parallel and repeat



Independent Variable
qualitative data (in categories)

Number of resistors	Current/A	Voltage/V	Resistance/Ω
1 resistor			
2 resistors in series			
3 resistors in series			
2 resistors in parallel			
3 resistors in parallel			

Dependent variable

quantitative continous data

If we add more components into the same loop in a circuit (in series) we INCREASE the overall resistance of the circuit.

This means that for the same potential difference, we would have a lower current.

The TOTAL RESISTANCE of COMPONENTS IN SERIES is just the SUM of the RESISTANCE OF EACH COMPONENT.

Adding more components in PARALLEL actually DECREASES the OVERALL RESISTANCE of a circuit.

This is because we get a GREATER CURRENT through the power supply for the SAME POTENTIAL DIFFERENCE.

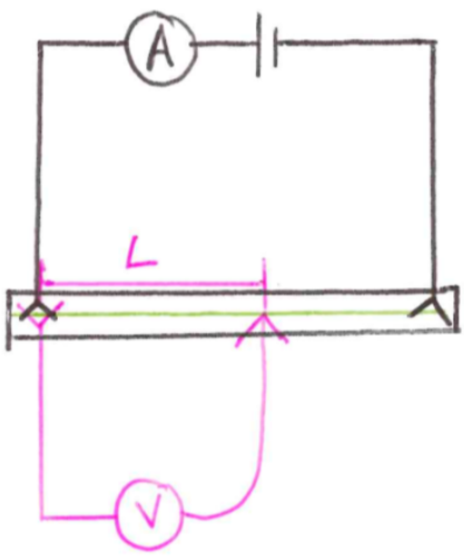
We have ADDED MORE PATHWAYS for current to flow through.

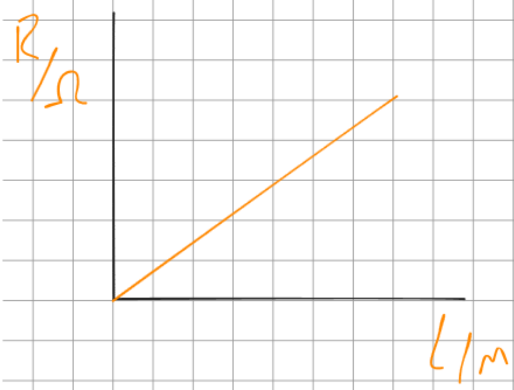
The TOTAL RESISTANCE of components in PARALLEL is always LESS than the MOST RESISTIVE COMPONENT.

How does changing the length of a wire effect it's resistance?

Make your own summary notes for each practical based on this template

Independent Variable(s) The one you vary.	Dependent Variable(s) The one you measure.	Control Variables Kept the same for a fair test.
length of wire.	Resistance of wire	temperature of wire

Method		Diagram of set up.
Step 1	Measure I and V across 10cm (0.10m) of wire (L=0.10m)	
Step 2	~~increase~~ calculate the resistance when L=0.10m ✓ ~~[illegible]~~ (R = V/I)	
Step 3	increase L by 0.10m & repeat steps 1 and 2	
Step 4	Plot a graph with R on y-axis and L on x-axis	
Step 5		
Step 6		
Step 7		



The RESISTANCE of a wire is DIRECTLY PROPORTIONAL to its LENGTH.

Doubling the length would double the resistance.

The graph of R vs L gives a STRAIGHT LINE through THE ORIGIN (0, 0)

Note: during this experiment the wire may become HOT, which can also affect resistance. We should turn the circuit off between readings, or keep the current constant by adjusting a VARIABLE RESISTOR.

I-V Characteristics (GCSE Required Practical 4)

13th May

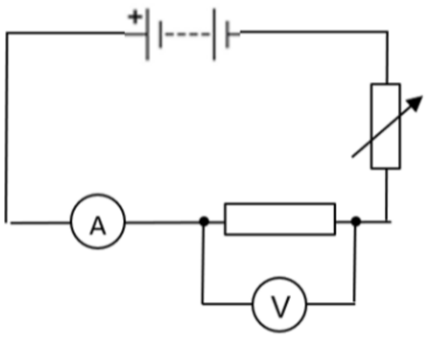
An I-V characteristic is a graph that shows how the CURRENT through a component changes when we change the POTENTIAL DIFFERENCE across it.

Required Practical: Investigating the I–V Characteristic of a Resistor

In this practical, you will investigate how the current through a resistor varies with the potential difference across it.

Apparatus

- 10 Ω resistor
- Resistor holder
- Battery
- Ammeter
- Voltmeter
- Several connecting wires



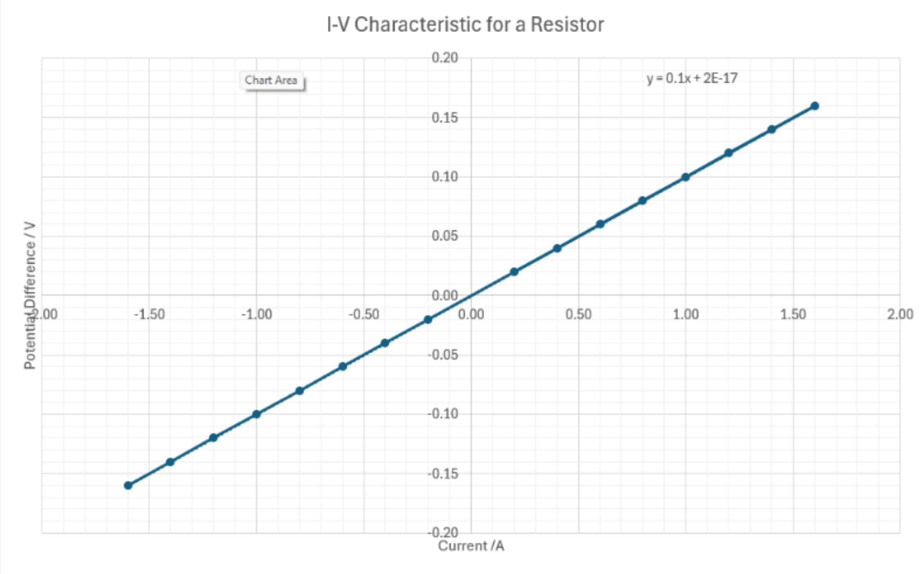
How connect your variable resistor.

Method – read this carefully before you begin.

1. Collect all equipment and check that each component is working properly.
2. Clip the 10 Ω resistor securely into the resistor holder.
3. Lay out the circuit according to the diagram on the left, without connecting any wires yet. Make sure all components are correctly positioned.
4. Once the layout is correct, begin connecting the wires one at a time to complete the circuit.
5. Check that the readings on both the ammeter and voltmeter are **positive**. If **both** are showing negative readings, then swap the connections on the battery. If only **one** of them is showing a negative reading swap the connections to that component.
6. Adjust the slider on the variable resistor to obtain 8 different pairs of positive readings of potential difference (V) and current (I). Record each pair in a results table. Make sure you have the correct units in the table column headers.
7. Reverse the connections on the battery to allow negative readings to be taken.
8. Take another 8 readings of potential difference and current. Record each pair in your results table. You should have 16 I-V pairs in total.
9. Once all data is collected disconnect the circuit and tidy the equipment away.

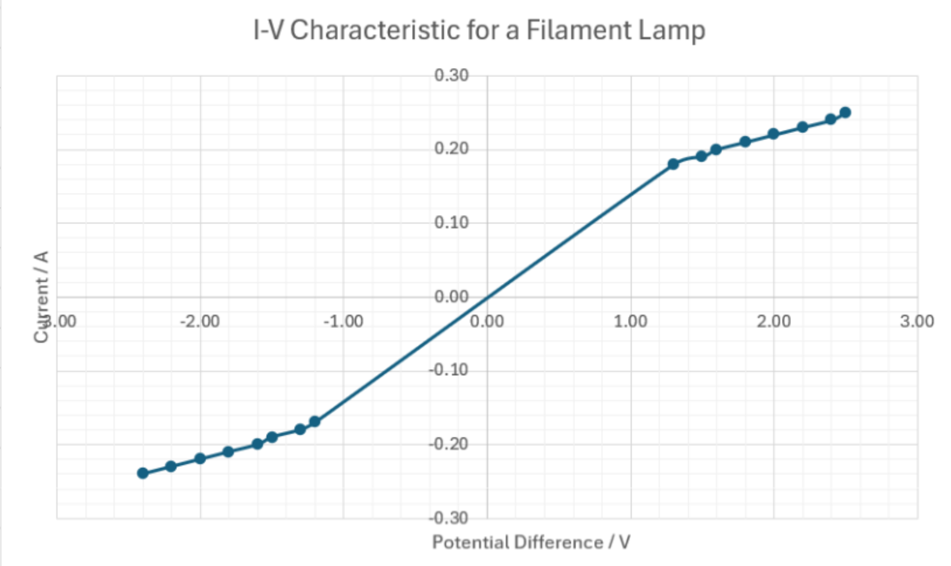
Resistor

Potential Difference /V	Current /A
0.20	0.02
0.40	0.04
0.60	0.06
0.80	0.08
1.00	0.10
1.20	0.12
1.40	0.14
1.60	0.16
-0.20	-0.02
-0.40	-0.04
-0.60	-0.06
-0.80	-0.08
-1.00	-0.10
-1.20	-0.12
-1.40	-0.14
-1.60	-0.16



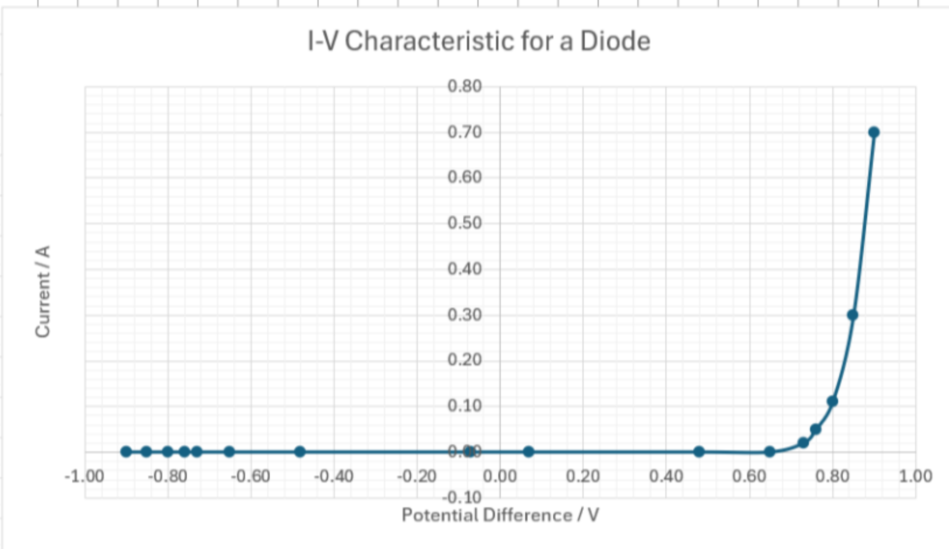
Filament Lamp

Potential Difference /V	Current /A
2.50	0.25
2.40	0.24
2.20	0.23
2.00	0.22
1.80	0.21
1.60	0.20
1.50	0.19
1.30	0.18
-1.20	-0.17
-1.30	-0.18
-1.50	-0.19
-1.60	-0.20
-1.80	-0.21
-2.00	-0.22
-2.20	-0.23
-2.40	-0.24



Diode

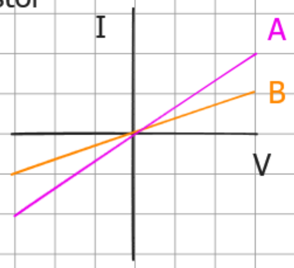
Potential Difference /V	Current /A
-0.90	0.00
-0.85	0.00
-0.80	0.00
-0.76	0.00
-0.73	0.00
-0.65	0.00
-0.48	0.00
-0.07	0.00
0.07	0.00
0.48	0.00
0.65	0.00
0.73	0.02
0.76	0.05
0.80	0.11
0.85	0.30
0.90	0.70



Explaining I-V Characteristics

21st May

Resistor



The current through a resistor is DIRECTLY PROPORTIONAL to the p.d. across it.

The I-V characteristic is a straight line through the origin.

These resistors obey OHM'S LAW.

'Current is directly proportional to potential difference at a constant temperature'.
- Ohm's Law

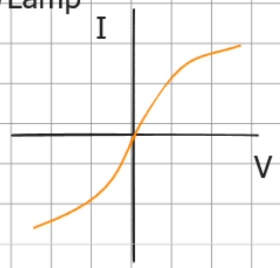
We can see that at any value of p.d. the current is less through resistor B than A.

This means that B has a bigger resistance than A.

To find the resistance we would pick a value of p.d. and find the value of current, then use:

$V = IR$ rearranged to $R = V/I$

Bulb/Lamp



As current flows through the bulb electrons collide with positive ions in the filament.

As we increase p.d. the current increases.

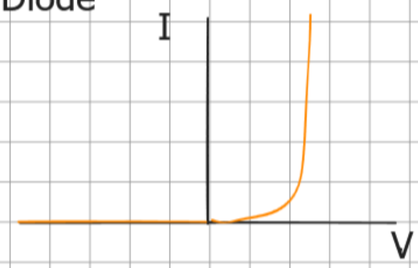
As current increases the rate of collisions of electrons with ions increases.

This means the ions gain kinetic energy and vibrate more.

This means the temperature of the filament has increased. This increases the resistance of the bulb/lamp.

The relationship between current and voltage is the same when current flows the other way.

Diode



In the reverse direction a diode has a VERY large resistance, hence no current flows.

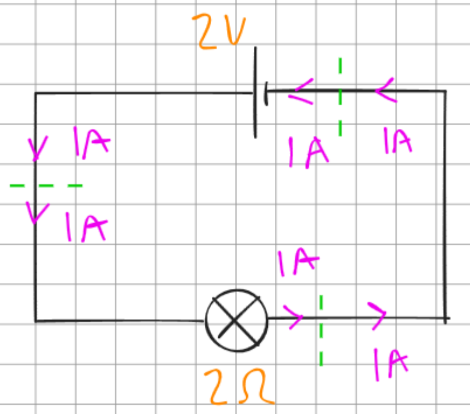
In the forward direction, the resistance becomes very low (above approx 0.7 V).

Conservation of Charge and Energy in Circuits

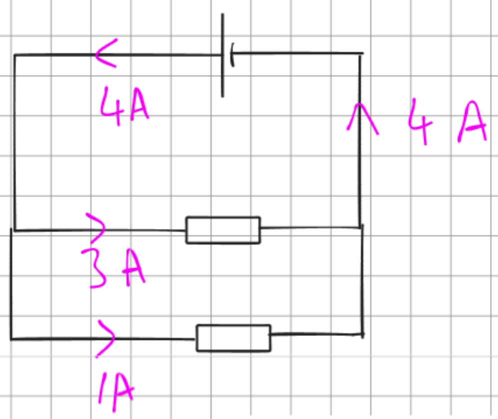
3rd June

The 'current' law: all of the charge that enters a point in a circuit must leave that point

current in = current out

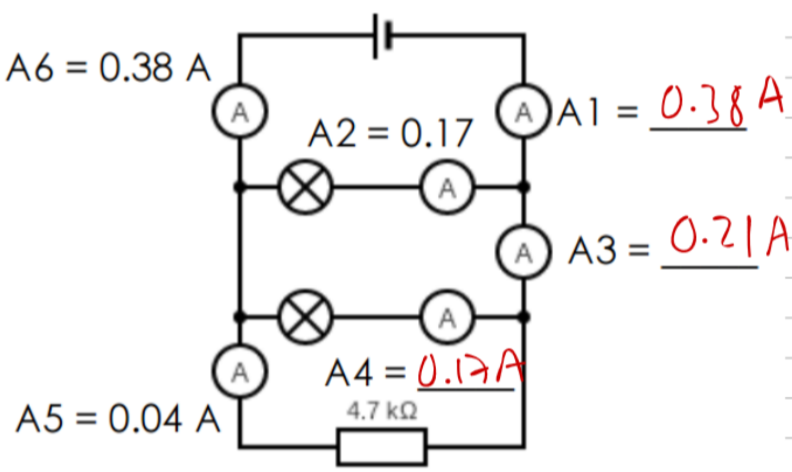


By applying the current law we can see that in a circuit with a single loop the current is the SAME at every point.



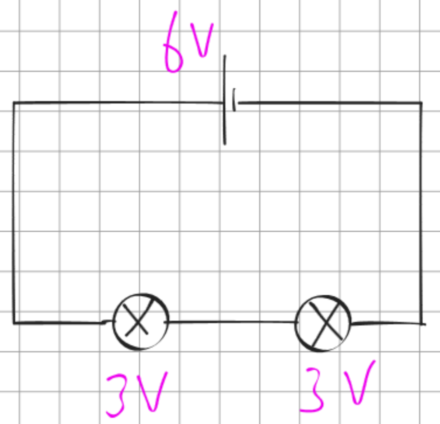
By applying the current law we can see that in a circuit with multiple loops the current SPLITS at a junction, and then COMBINES again at the next.

The total current in the branches adds up to the current through the power supply.

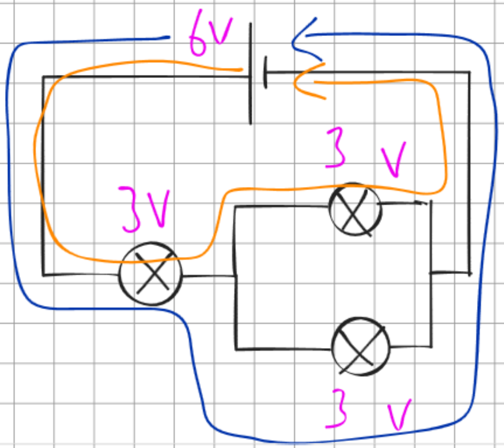


The 'voltage' law: the sum of the potential difference across every component in a loop adds up to the voltage of the power supply

energy takers = energy givers

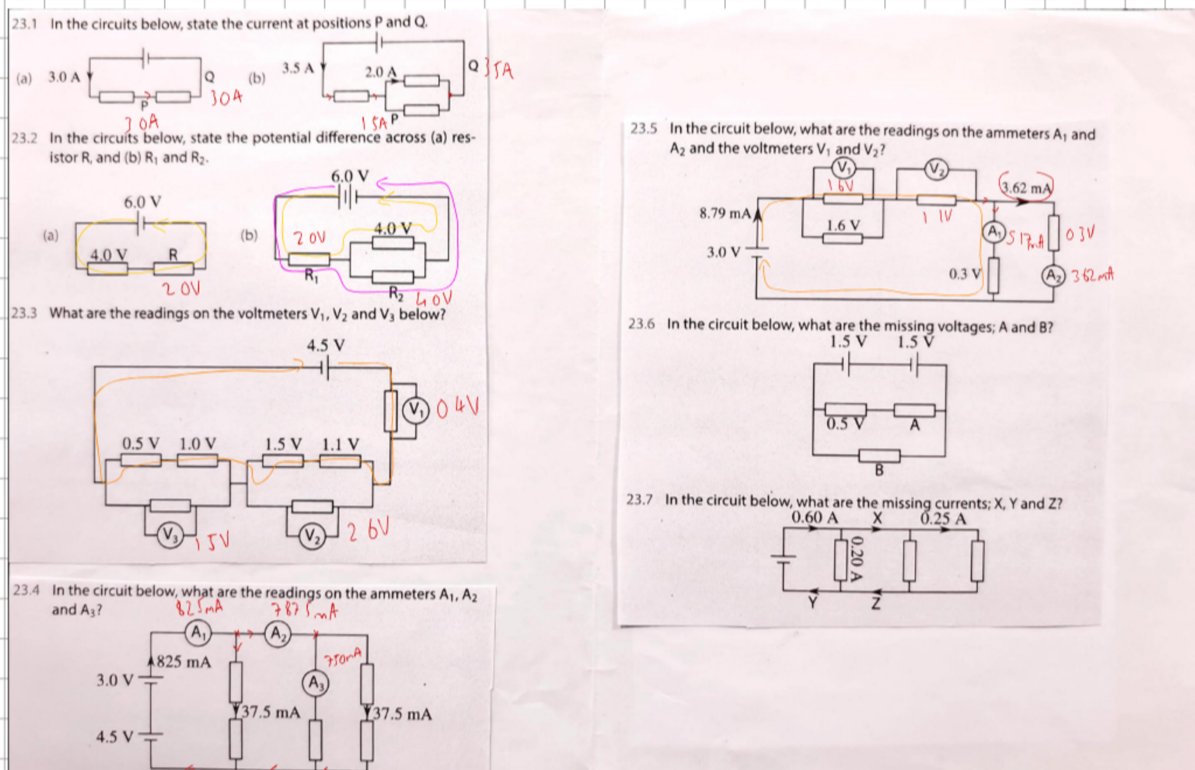


In a simple circuit with one loop the voltage of the power supply is 'shared' between the components (the resistance of each component decides the size of the share of the voltage it has).



In circuit with components in parallel, the total voltage across each branch is always the same.

Here we can see the total p.d. across each loop adds up to 6 V.



23.1 In the circuits below, state the current at positions P and Q.

23.2 In the circuits below, state the potential difference across (a) resistor R, and (b) R_1 and R_2.

23.3 What are the readings on the voltmeters V_1, V_2 and V_3 below?

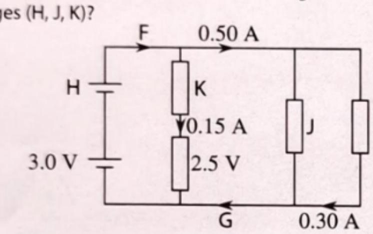
23.4 In the circuit below, what are the readings on the ammeters A_1, A_2 and A_3?

23.5 In the circuit below, what are the readings on the ammeters A_1 and A_2 and the voltmeters V_1 and V_2?

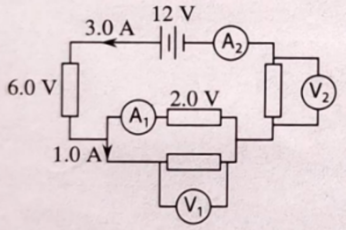
23.6 In the circuit below, what are the missing voltages; A and B?

23.7 In the circuit below, what are the missing currents; X, Y and Z?

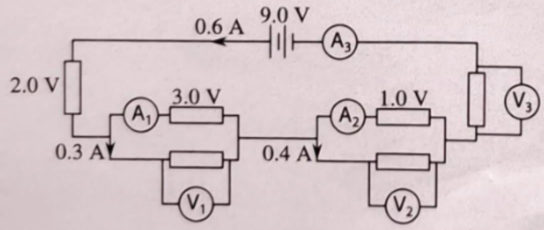
23.8 In the circuit below, what are the missing currents (F and G) and voltages (H, J, K)?



23.9 What are the readings on A_1 and A_2, and on V_1 and V_2 below?



23.10 What are the readings on A_1, A_2 and A_3, and on V_1, V_2 and V_3 below?



Circuit Analysis   5th June

We have several tools and rules we can use to find unknown values in any circuit i.e. currents, potential differences and resistances.

When shown a circuit with some missing information we can try the following things/use the following rules to solve any problem:

1. Can I use the current law to find any missing currents?
2. Can I use the voltage law to find any missing p.d.s?
3. Can I use V = IR to find anything? Check if there are any components where I know 2 out of V, I and R.

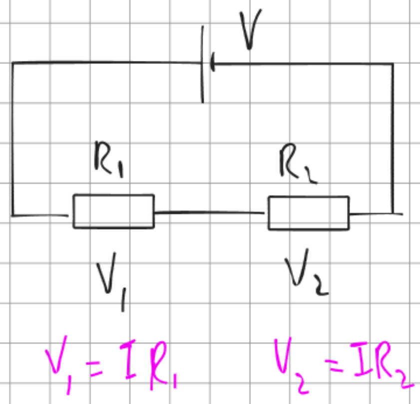
Don't forget:

In a series circuit, the total resistance is the sum of the resistance of each component.

If we use V = IR, with V as the voltage of the power supply and I as the current through the power supply, then R represents the TOTAL RESISTANCE of the circuit.

Different Resistors & Sensor Circuits

11th June



In a simple series circuit like this the current is the same through both resistors (and the power supply).

The voltage of the power supply is shared between the two resistors.

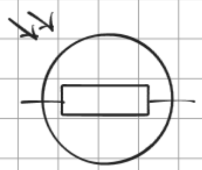
The size of the share depends on the resistance.

The ratio of the voltages of the resistors is the same as the ratio of their resistances.

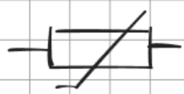
e.g. If the resistances are equal, their share of the supply voltages will be equal.

If one has double the resistance of the other, it will get twice the share of the supply voltage.

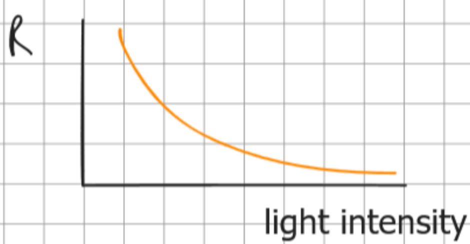
LDR



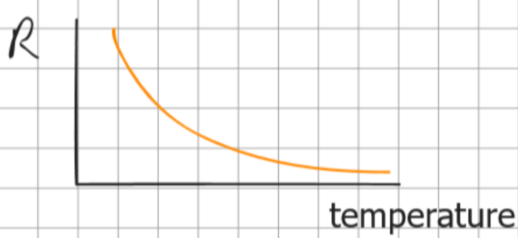
Thermistor



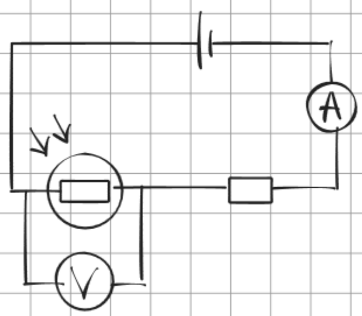
The resistance of an LDR DECREASES as light intensity INCREASES and vice versa.



The resistance of a Thermistor DECREASES as its temperature INCREASES.



Below is an example of a sensor circuit where voltages and currents change when the light intensity changes.



As the light intensity increases...

- Resistance of LDR decreases
- Total resistance of circuit decreases
- Current in circuit (reading on ammeter) increases
- Resistance of LDR is now a smaller share of the total resistance, so it gets a smaller share of the total voltage from the power supply
- The reading on the voltmeter goes down