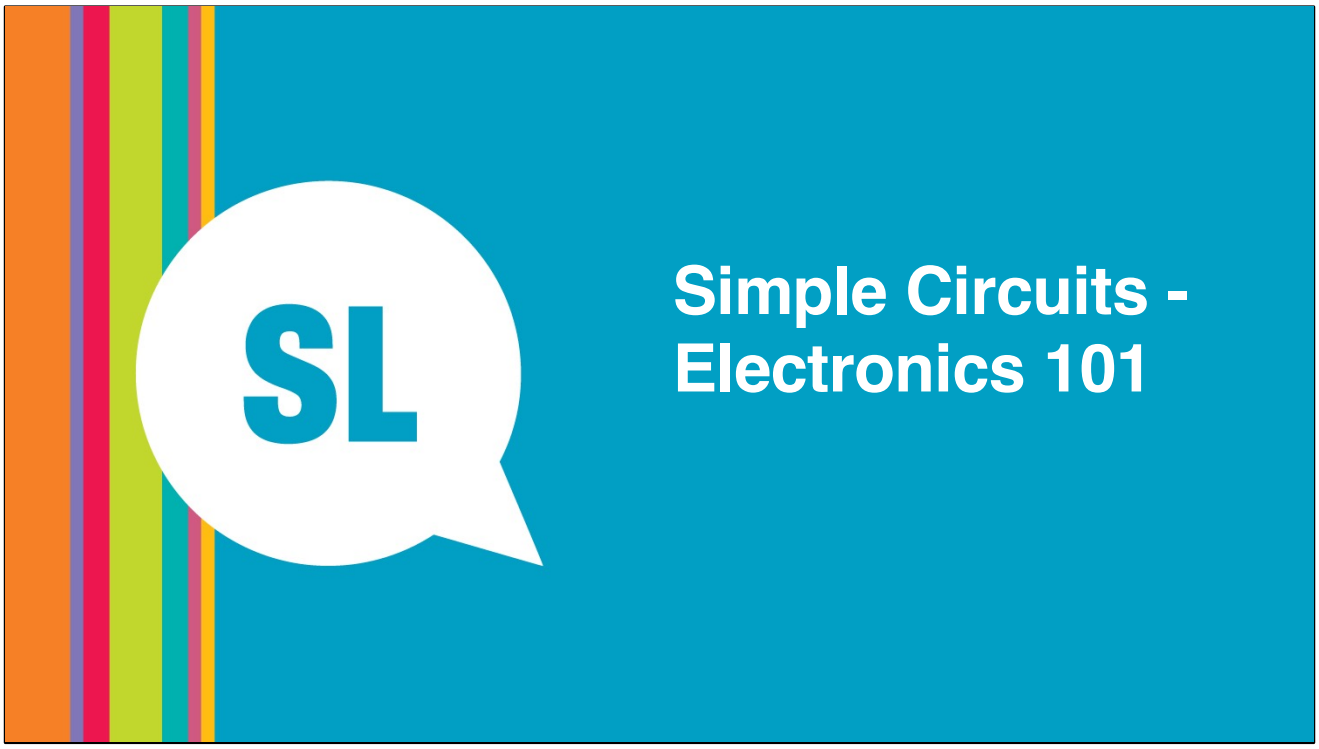


Before session:

Materials:

- Per participant:

Acknowledgement of Country

We acknowledge Aboriginal and Torres Strait Islander peoples and their continuing connection to land and as custodians of stories for millennia. We respectfully acknowledge the land on which we all meet today, and pay our respects to elders past, present and emerging.

Intros!

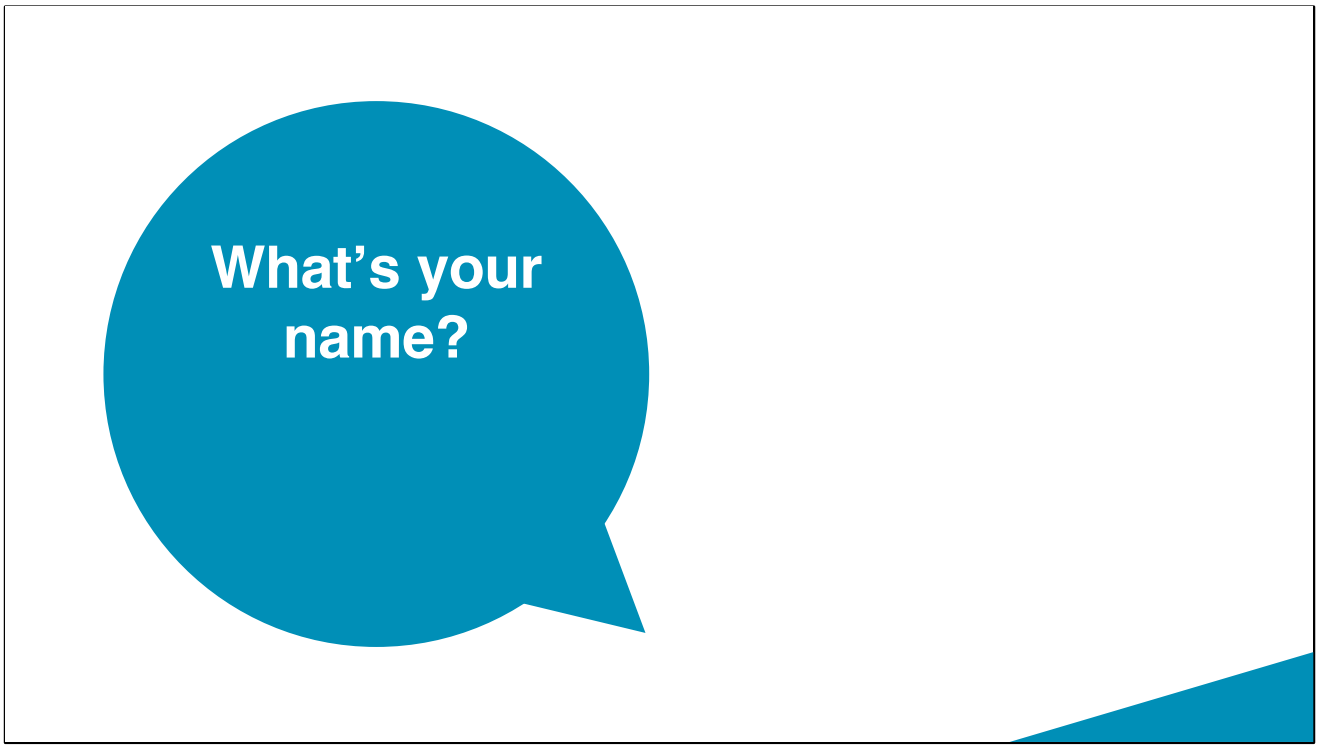
Intro Activity - Favourite Invention

•Whats your name?
•Why did you sign up for today?
•Whats your Favourite Invention?

The Transistor

experts to estimate that 13 sextillion transistors were manufactured from their invention in 1947 to today (that 13 followed by either 21 or 32 zeros). In 2014, this was 2.9 sextillion. This shows just how quickly we are producing them and putting them into service how many transistors are there in the world?

A transistor is a semiconductor device with at least three terminals for connection to an electric circuit. In the common case, the third terminal controls the flow of current between the other two terminals. wikipedia


What's your name?

Why do you want to know about electronics?

What's your name?

Why do you want to know about electronics?

The Transistor

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A transistor is a semiconductor device with at least three terminals for connection to an electric circuit. In the common case, the third terminal controls the flow of current between the other two terminals. [wikipedia]

Session Overview

1. Intro - Why this workshop

Session overview only

Session Overview

2. How does electricity flow in a circuit
    a) Current
    b) Voltage
    c) Resistance
    d) Ohms Law
    e) Common Components & an intro to the multimeter.

Session overview only

Session Overview

3. What's the difference between the words **Electric** & **Electronics**
4. What are the basic electronics components and the key concepts we need to know to bend current and voltage to our whims.

Session overview only

Part 1
Why an electronics 101?

How does electricity work??? Its easy you go over and turn it on at the switch on the wall

Intro to electricity

In lots of situations, especially in workshops, you'll get asked if you know how something works, before quickly moving to the next bit.

And electricity is one of these classic things that a *hand wavey* assumption is made that you'll know how it works and we don't really stop to make sure we all really understand it.

Today we're going to stop and try and make sure that we all have the basic understanding of
•how Electricity flows in a circuit,
•how some common components work and
•how we can make use the effects for our own devilish ends.

•IF WE CAN WE'LL WORK OUR WAY THRU THE BASICS AND UP AND INCLUDING TRASNSITORS

First time I delivered some of this content (a couple of month ago) I was reflecting

on how people get their head around complex concepts and I came across ELI5
We are going to guided by ELI5 concept to make sure we all understand. Explain Like I'm 5 is a bit of a movement on the web, started on reddit (and other message board style social media) and things like youtube where people take commonly asked questions like “How does Electric circuit work?” and answer these questions in a way that a lay person would understand - using a Five year old intelligence as a rough filter of the assumed understanding or experience of the world as a starting point for the explanation.

Often the ELI5 explanation (or the best ones i think) make use of observations a five year old would use. You'll see what I mean when we get to it.)

Learning styles – learning thru mental models, by seeing relationships and consequences, by measuring
Learning by doing - resourcing our intuitions with experience
Learning together - by discussing, explaining

BECAUSE THIS IS WORKSHOP IS A BIT OF A FIRST REALLY INTERESTED IN HEARING YOUR FEEDBACK – TOO MUCH, NOT ENOUGH

But first a safety message

Electricity can kill.

Never mess with anything that uses mains power – anything you plug into the wall.

If in doubt check before you disassemble any electrical appliance or equipment.

If there's only one thing that you learn today it would be great to think you are confident about what's safe and legal and what's not.

A helpful way to look at it electrical safety is IEC (int Electrotechnical Commision) definition of High Voltage, Low Voltage and Extra Low Voltage

Be confident in your Electrical Safety

International Electrotechnical Commission Definitic

Voltage range	AC voltage (V)	DC voltage (V)
High voltage (HV)	> 1000	> 1500
Low voltage (LV)	≤ 1000	≤ 1500
Extra Low voltage (ELV)	≤ 50	≤ 120

In Queensland its illegal for anyone to undertake unlicenced work on any electrical equipment over the ELV threshold.

Questions?

High Voltage is over 1000V AC and 1500DC and can arc thru the air

Low voltage is anything under this and can result in an electric shock

Extra Low Voltage is anything under 50VAC or 120VDC and is consider low risk

In Australia you need to be certified to work on anything over Extra Low Voltage.

TODAY WE'LL BE WORKING ON 9 VOLT DC CIRCUITS ☺

References

www.legislation.qld.gov.au/view/html/inforce/current/act-2002-042#sec.14
www.legislation.qld.gov.au/view/html/inforce/current/act-2002-042#sec.55
https://www.legislation.qld.gov.au/view/html/inforce/current/act-2002-042#sch.2

ACDC ???

- **AC** stands for Alternating Current – it's the type of electricity that we have in our houses.

Instead of just ramping up to 240 V the current reverse 50 time a second from 240 V+ to 240V- and back again.

The symbol for AC is ~

But don't worry about this too much because as I said before… you should be playing Alternating Current

ACDC ???

- **DC** stands for Direct Current – it's the type of energy used in cars and electronics.

DC gets used in Electronics and while consumer electronics plug into the wall the power pack that that you power these with generally steps this voltage down and flattens it out.

The symbol for AC is 

Part 2
How does electricity flow in a circuit

Current

- An electric current is a stream of charged particles, such as electrons or ions, moving through a circuit.
- This current flows from (+) positive to the (–) negative
- Current is measured in Amps (**I**)

*One ampere is equal to 6.241509074×1018 electrons worth of charge moving past a point **per second**.

Generally we talk about this current flowing from the positively Charged side of the circuit to the negatively charged side*

Current is measured in Amps (named after Andre Marie Ampere and represented by the letter **I**)

*nb: theres a big caveat here- electrons “actually” have been discovered flow from

negative to positive (only recently actually)… but the convention has remained - Current flows Positive to negative, active to neutral, positive to ground.

Practical activity: Calc batt & LED

Voltage

Voltage, the electric pressure or difference in potential that causes this current to flow (conventionally from positive to negative*).

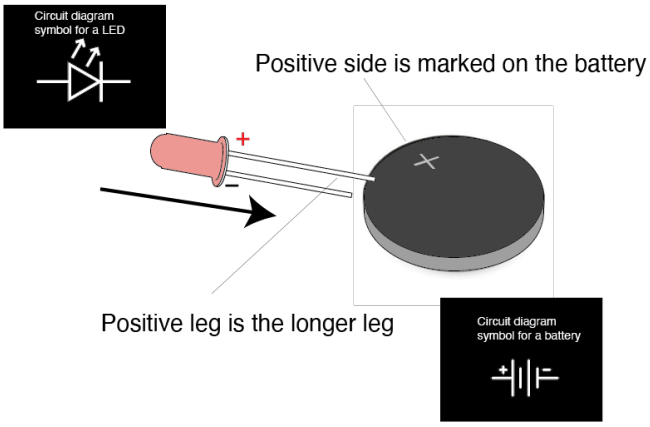
This potential is measured in Volts (**V**)

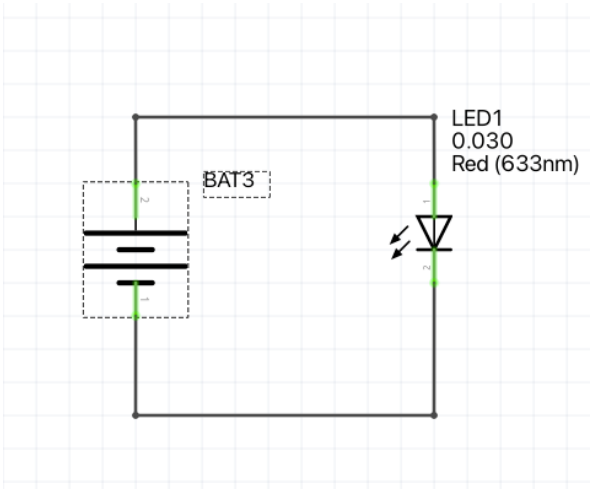
This potential is measured in Volts (named after Alessandro Volta represented by the letter **V**)

Practical activity: 9v Battery & LED PLUS a resistor

Hands on activity #1

lets get the juice flowing





LED and and a calc battery

- Battery has a Pos and Neg side
- LED is a special Diode – Diode are one way gate has a pos and neg too

- When the right way round the Voltage of pushes electrons down the led which tickle the semi conductor which emits photons and then continue around to complete the circuit.
- If theres a break in the circuit the electrons – current can flow
- If the LED is around the wrong way the elctrons get caught at the led and the circuit wont flow

Current and Voltage analogies

- Hydro-Electro Analogy – the drain-pipe theory

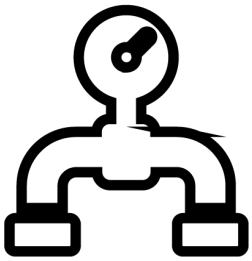
There are a couple of analogies that commonly get used to describe how this happens that are intuitive to us because we see and in these things in our daily observations. The first one is the " Hydraulic – Electro analogy" and, the other is the "Earth gravity analogy" (marble run) of electrical potential.
Its good to look at both of these analogies because they both have strengths and limitations.

Practical activity: 9v Battery & LED PLUS a resistor

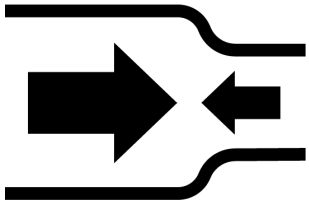
Hydraulic analogy
The drain-pipe theory

Current
Flow

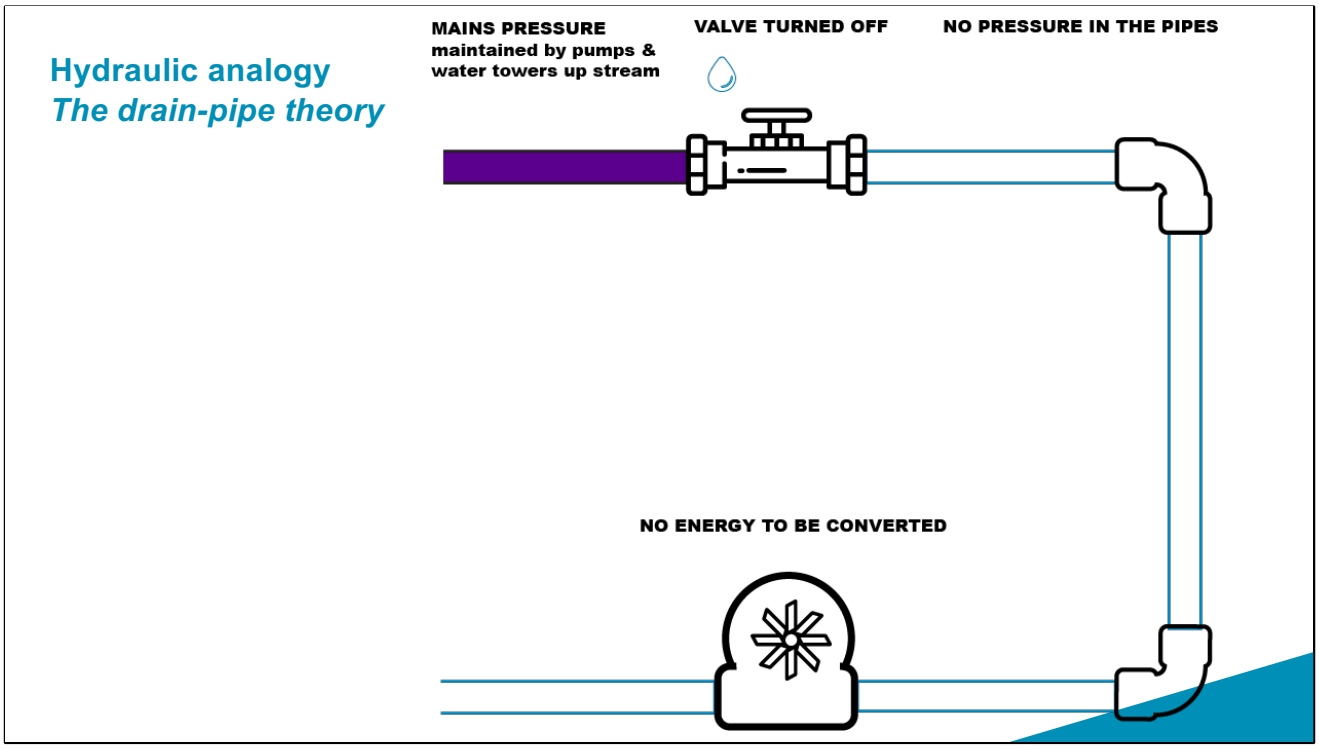
Voltage
Pressure



Resistance
opposition

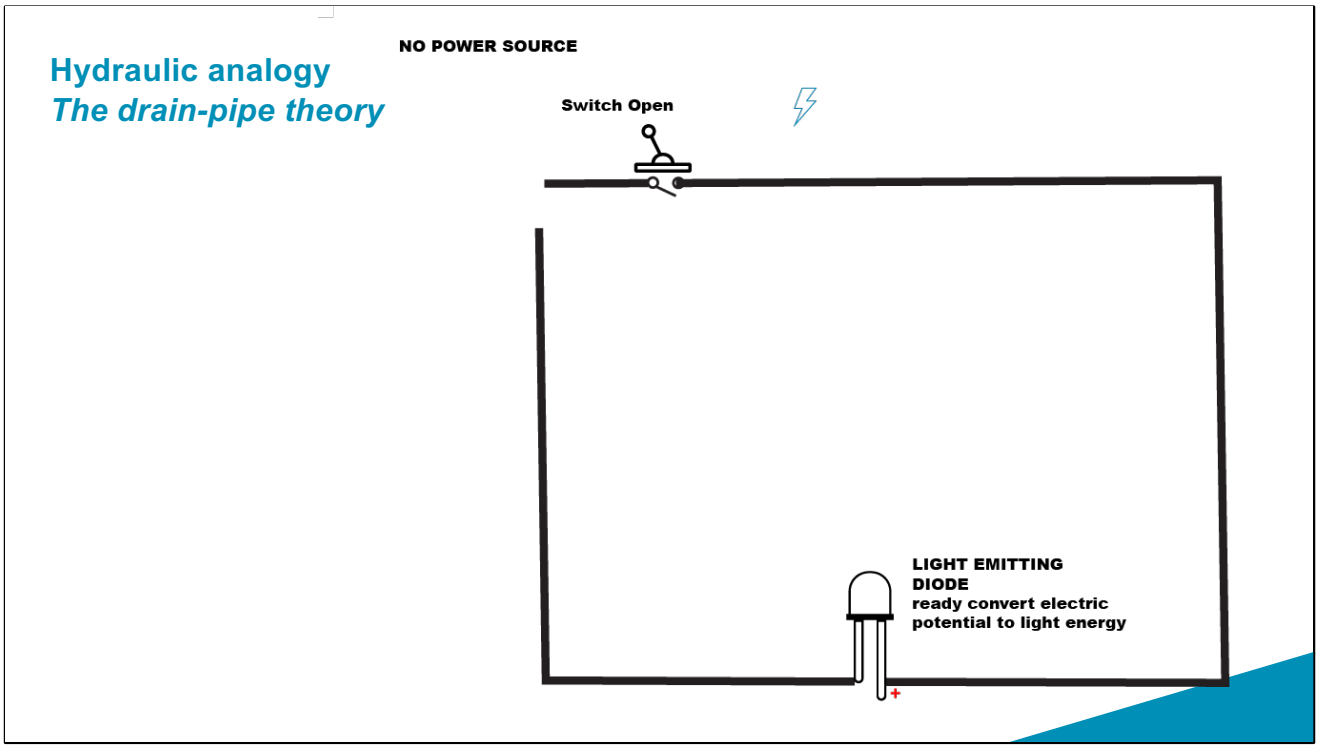


Hydraulic analogy
The drain-pipe theory



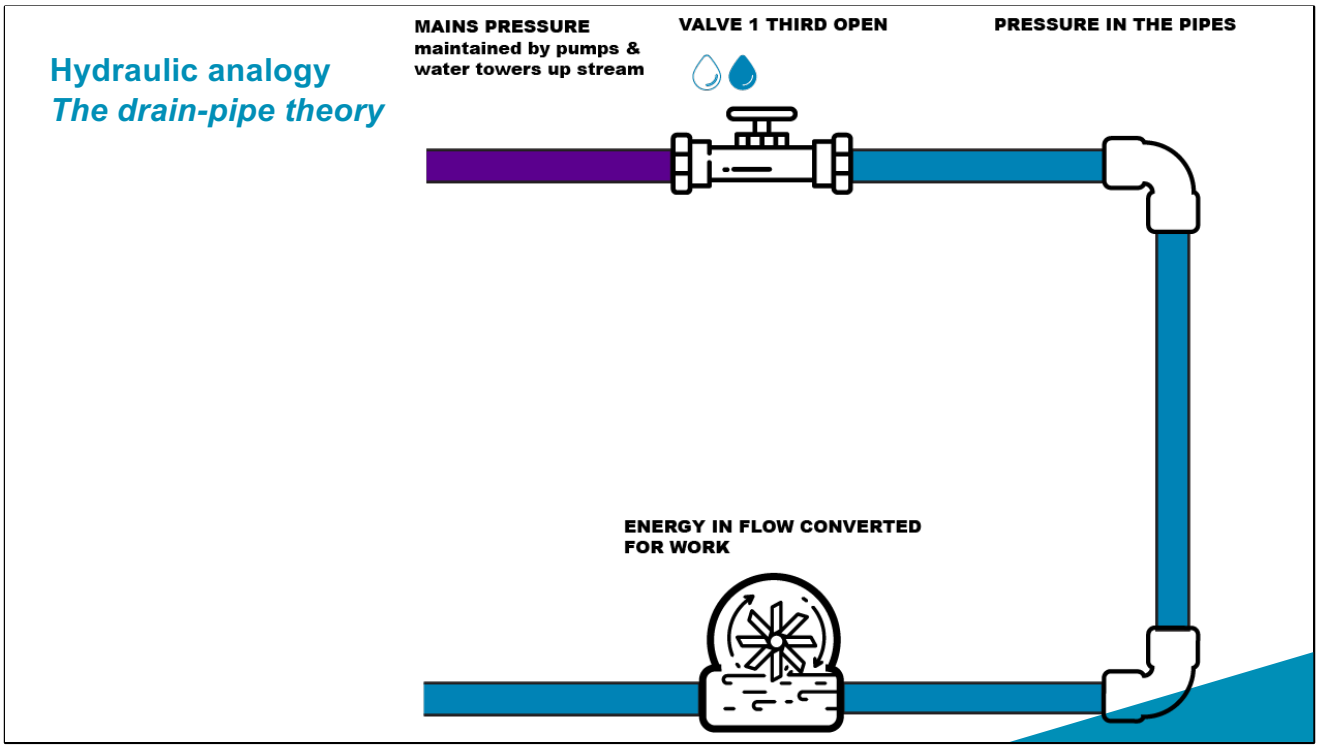
Valve is off now water getting to the water wheel

Hydraulic analogy
The drain-pipe theory



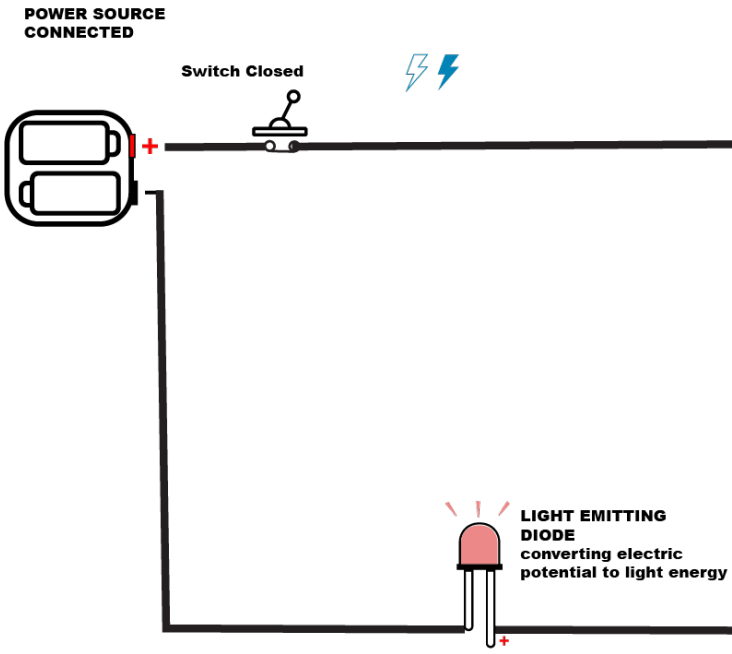
Theres no voltage sorce

Hydraulic analogy
The drain-pipe theory



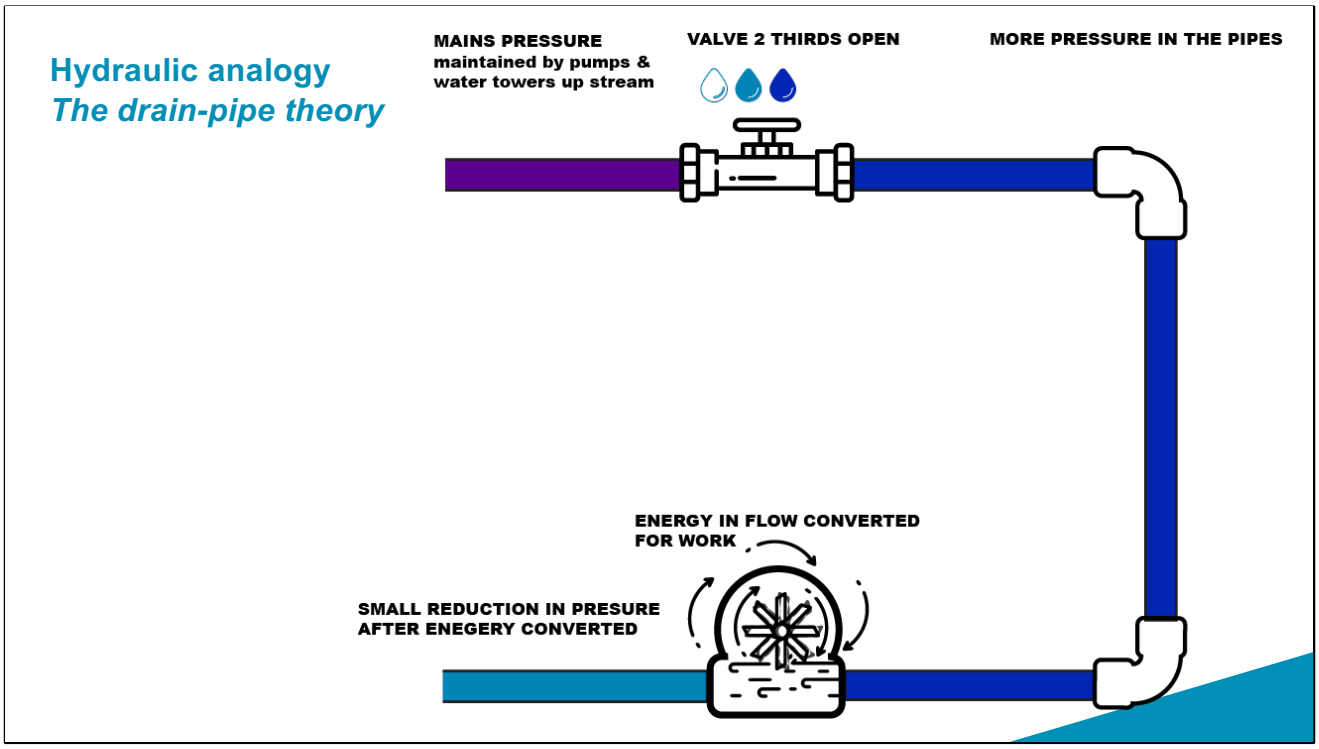
What happens if we turn on the valve

Hydraulic analogy
The drain-pipe theory



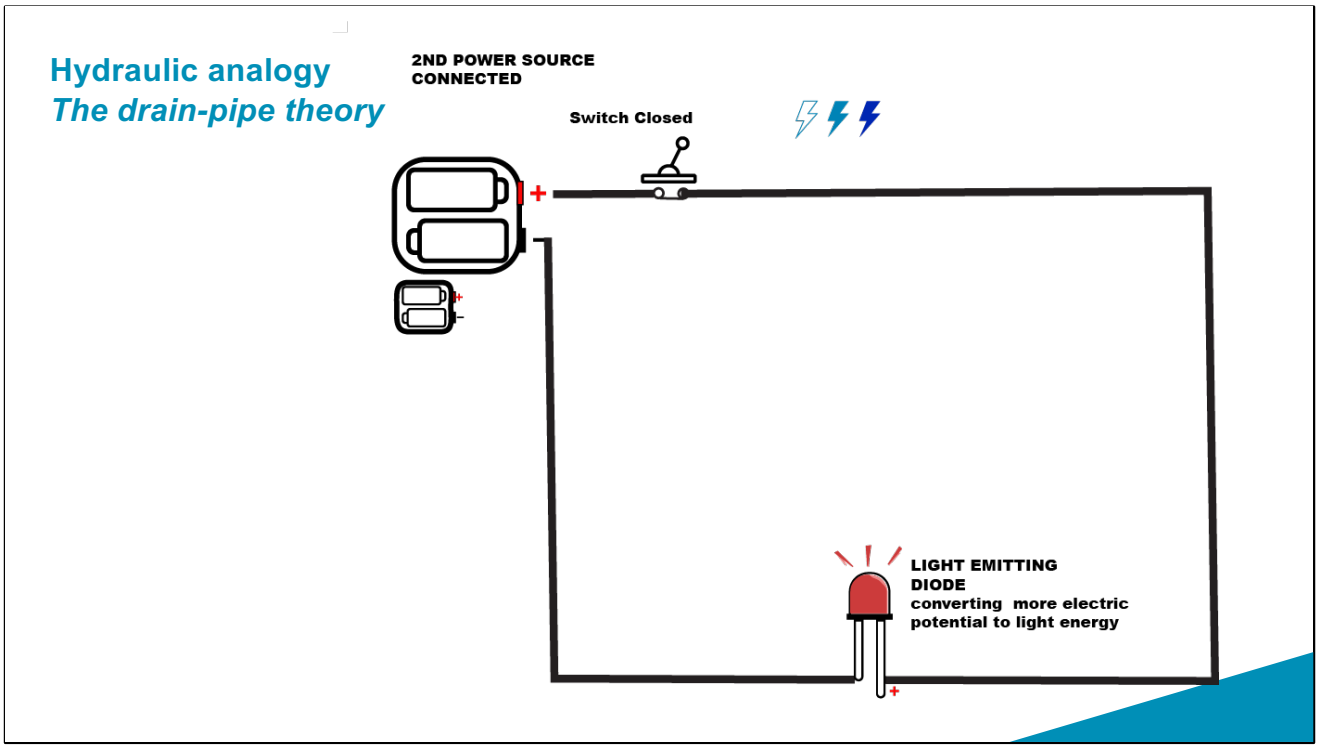
What happens if apply a voltage and close the switch

Hydraulic analogy
The drain-pipe theory



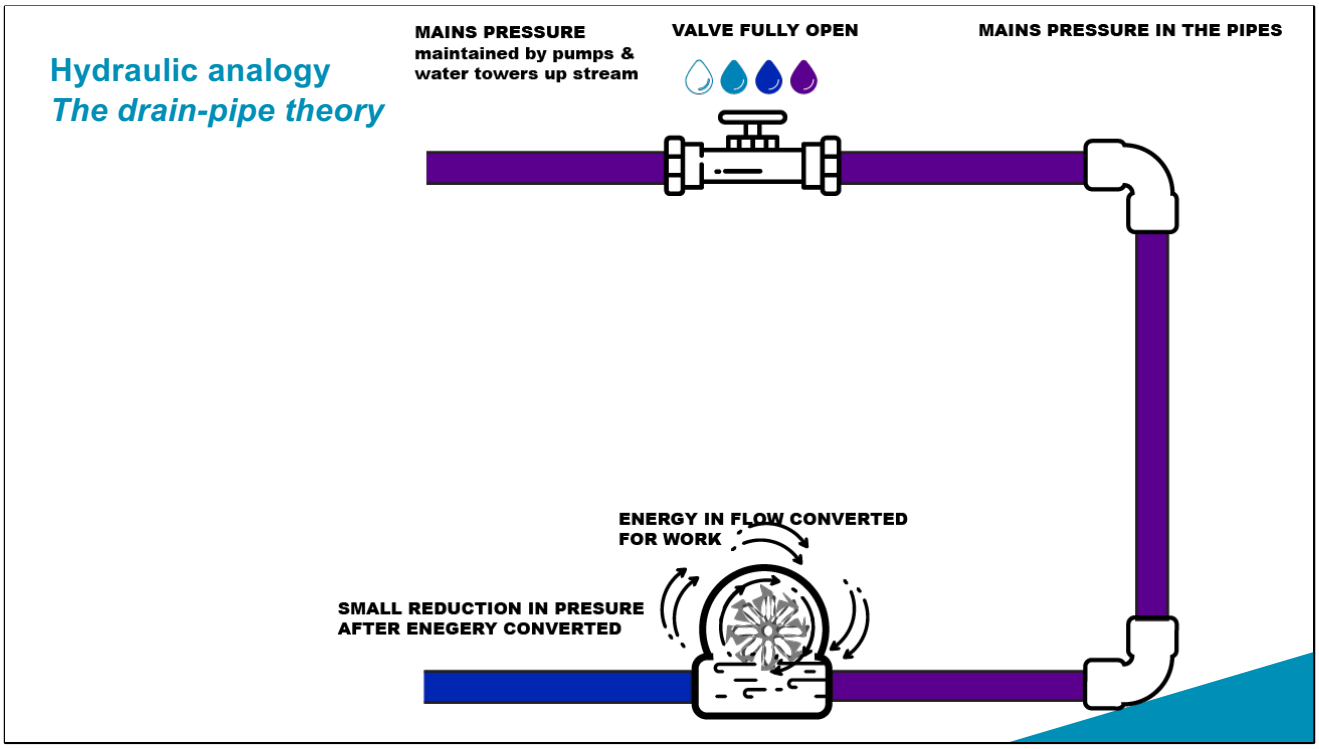
What if we turn the valve on a little more?

Hydraulic analogy
The drain-pipe theory



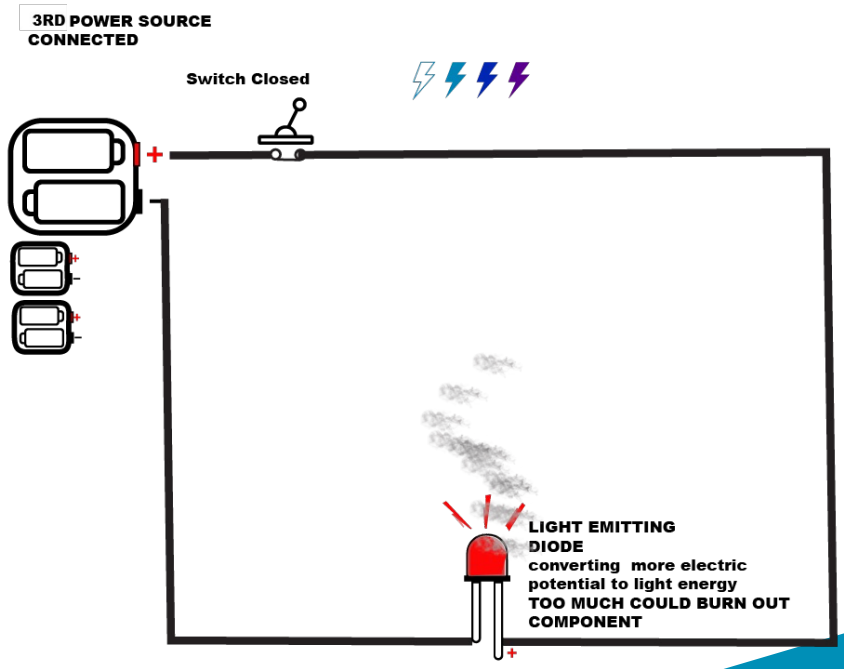
What if we add more voltage

Hydraulic analogy
The drain-pipe theory



What if we increase the potential even more?

Hydraulic analogy
The drain-pipe theory



Maybe its too much

Resistance

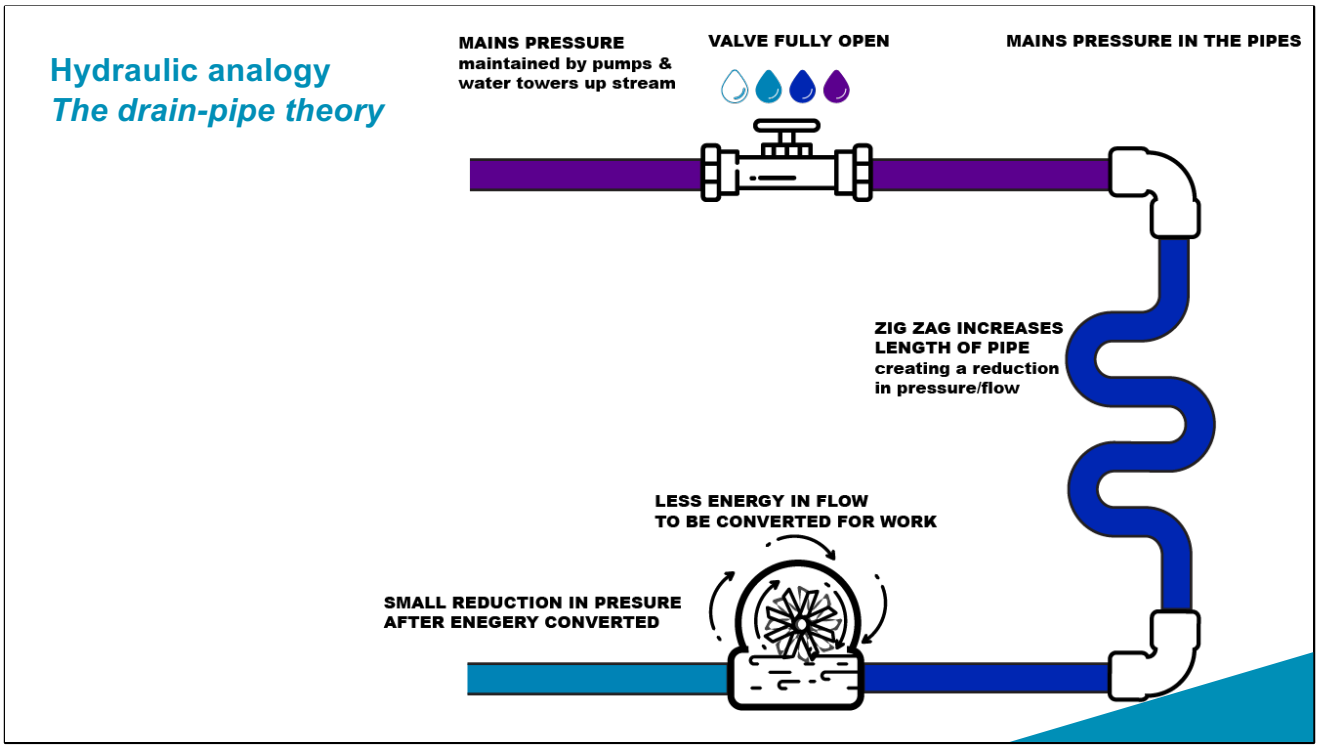
Resistance is the measure of its opposition to the flow of electric current.

Resistance is measured in Ohms (**Ω**)

Resistance is measured in Ohms (named after Georg Ohm and represented by the last letter of the Greek alphabet, Omega **Ω**)

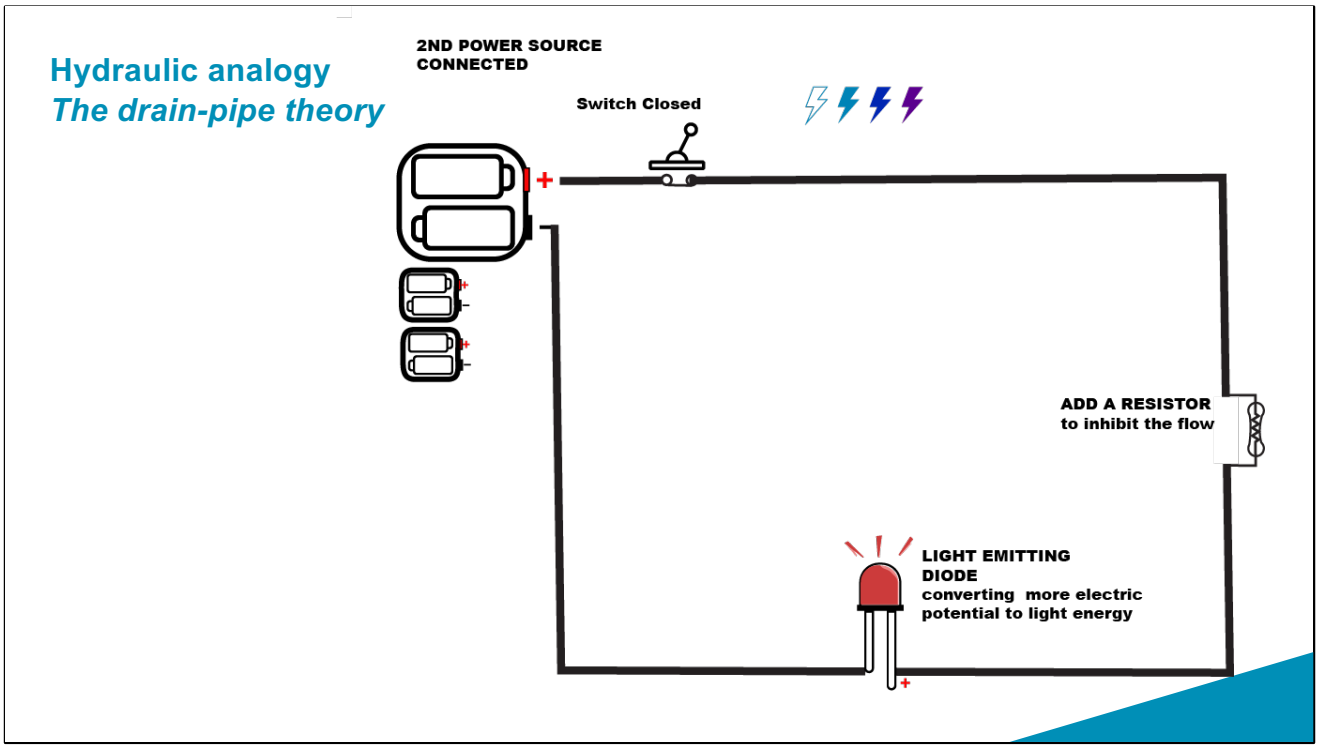
9v Battery & LED PLUS a potentiometer

Hydraulic analogy
The drain-pipe theory



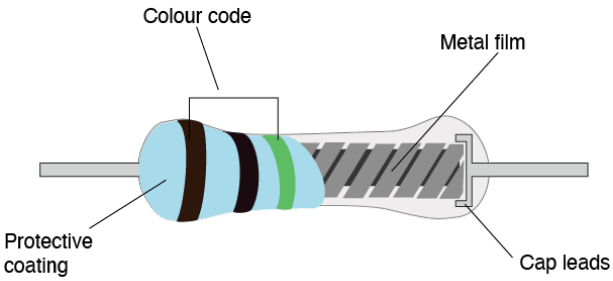
What if we add a longer length of pipe to the system

Hydraulic analogy
The drain-pipe theory

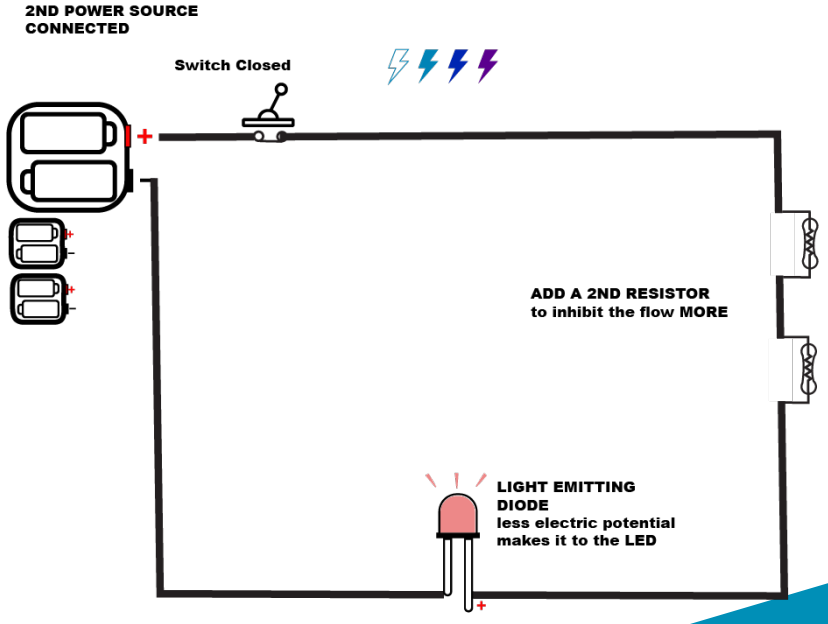


What happens if we turn on the valve

Resistor

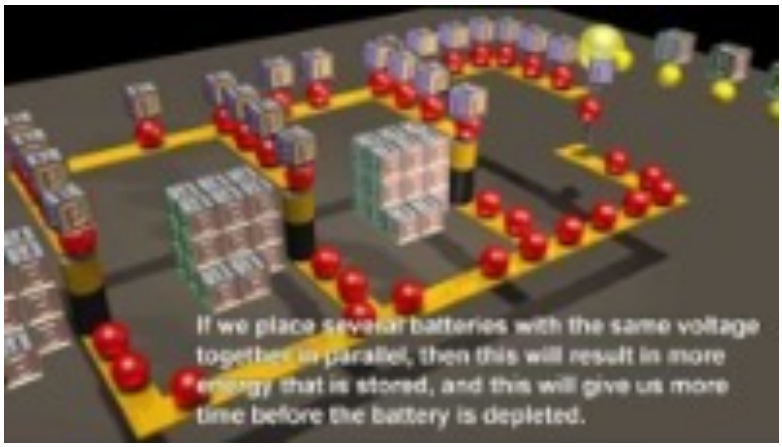


Hydraulic analogy
The drain-pipe theory



Current and Voltage analogies

- Earth gravity analogy – Marble race



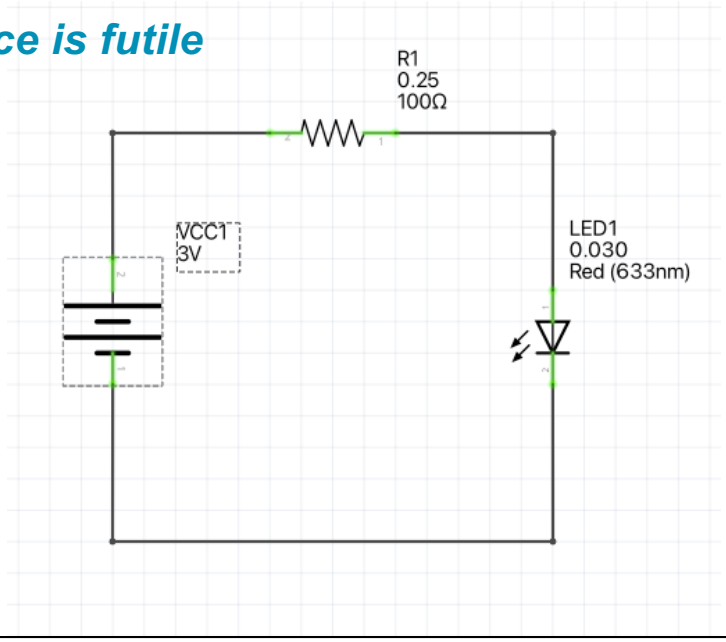
Physics Videos by Eugene Khutoryansky

analogy" (marble run) of electrical potential.
Its good to look at both of these analogies because they both have strengths and limitations.

Practical activity: 9v Battery & LED PLUS a resistor

Hands on activity # 2

resistance is futile

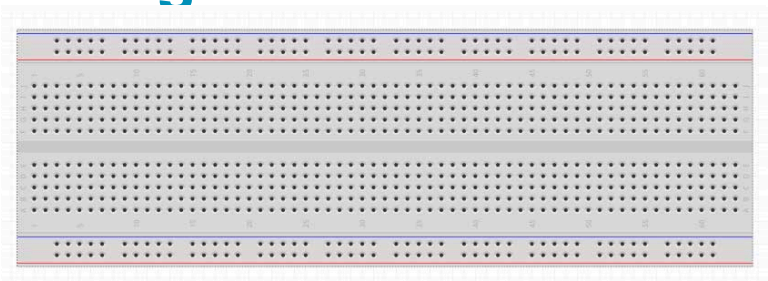


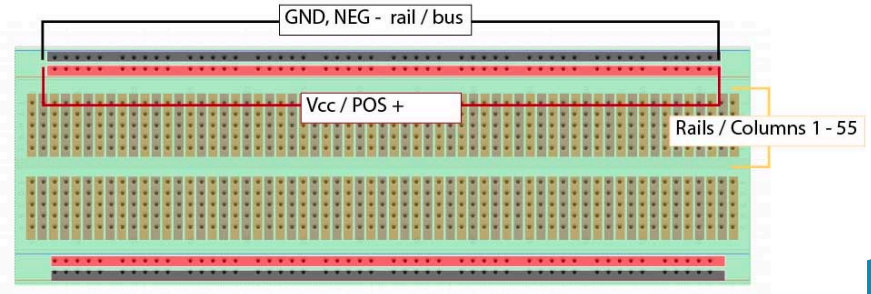
LED and and a calc battery

- Battery has a Pos and Neg side
- LED is a Diode – one way gate has a pos and neg too

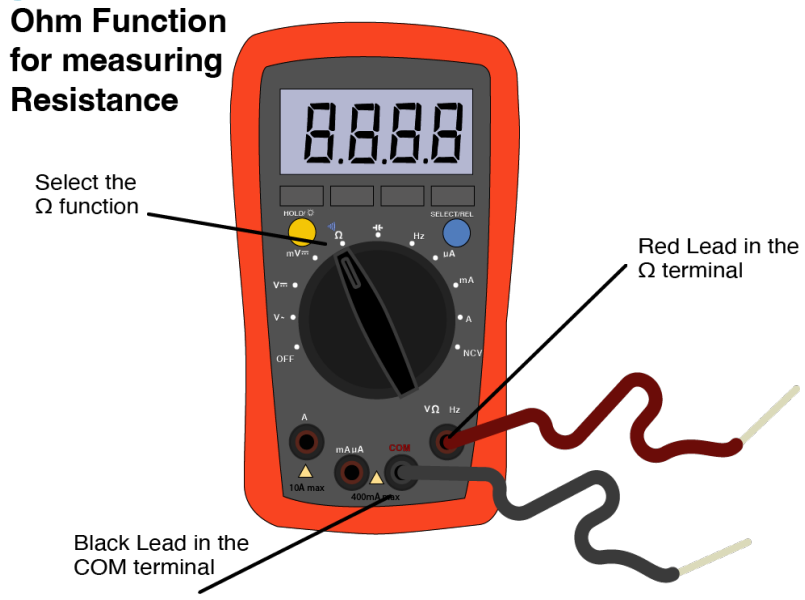
- When the right way round the Voltage of pushes electrons down the led which tickle the semi conductor which emits photons and then continue around to complete the circuit.
- If theres a break in the circuit the electrons – current can flow
- If the LED is around the wrong way the elctrons get caught at the led and the circuit wont flow

Using a breadboard





Using a Multimeter



Another way of getting you head around this stuff is to use a measuring tool.

Multimeters are tool we use for fault finding and checking stuff is working as we go

There's 2 main types Digital and analogue but these are pretty rare these days

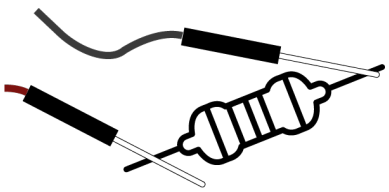
Theres a whole variety of digital ones too.
The main thing to know is whether its manual or auto ranging.,

The ones we'll be using today are auto ranging
So that's where we'll start

Although these measure all sort of things the three things we'll be looking at are what we've cover so far
Voltage, Resitance and Current

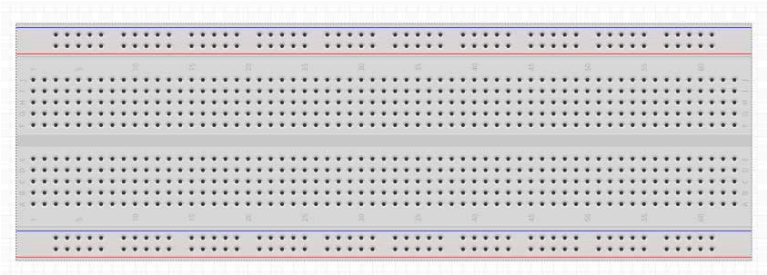
Using a Multimeter

Resistance (Ohms - Ω)



Lets try the multimeter Out on a couple of resistors.

We can also use the multimeter to work out which holes are connected on the breadboard.



1. Place red cable in the **V Ω -|)- Hz** terminal and the black in the common
2. Select for **Ω** Resistance

3. Connect the the leads leads to either side of the component or section of circuit you would like to measure.

NB

- When taking a resistance reading we are actually applying a small current to the component (section of a circuit) and measuring the voltage drop. So it needs to be isolated to get an accurate reading. (if its not isolate the current can travel back thru a parallel circuit and give a false reading.

Continuity

Continuity is a little like the resistance setting only it doesn't give you a value just a yes no to let you know theres path or complete circuit for current to flow.
The meter will read *OL.* MEANING LOOP OR OPEN CIRCUIT OR A *READING* AND WILL *BEEP.*

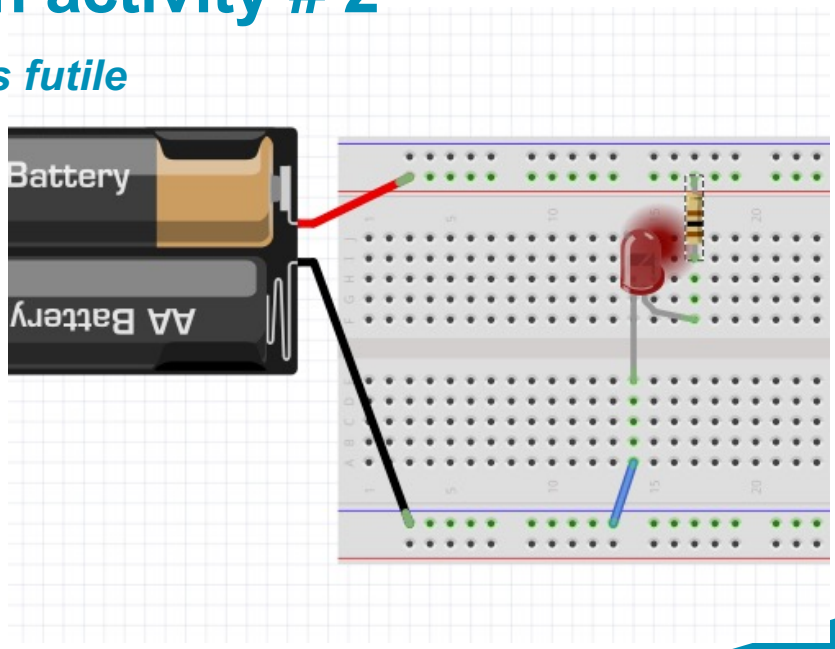
TO TEST FOR CONTINUITY ONLY

1. SET UP YOU LEADS AND SELECTOR THE SAME AS ABOVE AND HIT THE BLUE BUTTON TO SELECT THE ALTERNATE MODE

Hands on activity # 2

resistance is futile

It should look something like this



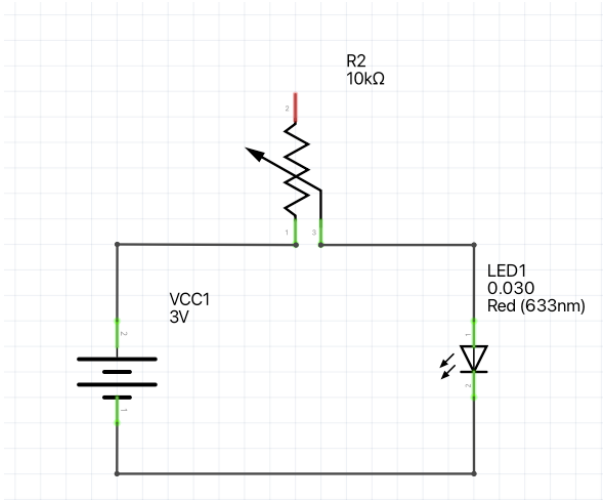
LED and a pair of batteries that produce 3V

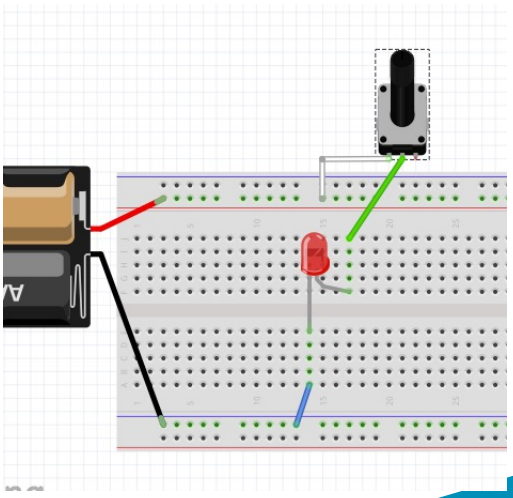
- Battery has a Pos and Neg side
- LED is a Diode – one way gate has a pos and neg too

- When the right way round the Voltage of pushes electrons down the led which tickle the semi conductor which emits photons and then continue around to complete the circuit.
- If theres a break in the circuit the electrons – current can flow
- If the LED is around the wrong way the elctrons get caught at the led and the circuit wont flow

Hands on activity # 2

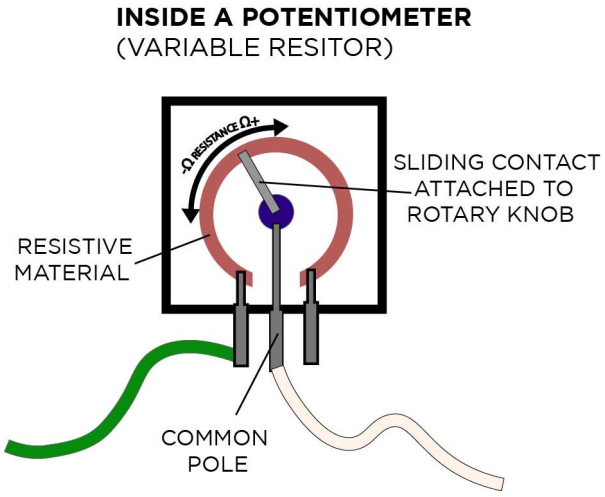
resistance is futile





Ok lets swap the normal resistor out for a potentiometer

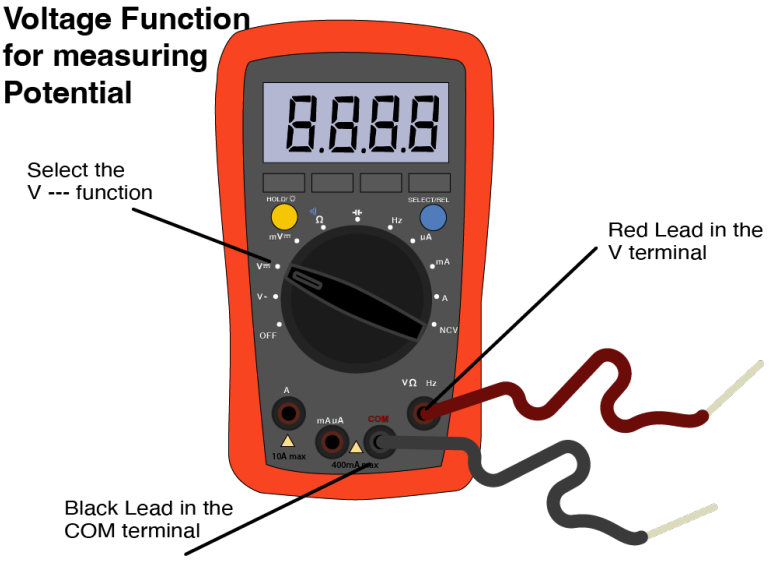
Potentiomenter



Whats a Potentiometer?

Fritzing

Using a Multimeter



First thing to workout before you can measure anything is whether your dealing with a Direct Current (DC) or Alternating Current (AC)

Should be DC cause we genrerally **should not** be playing with AC.

We're luck cause these meters default to DC

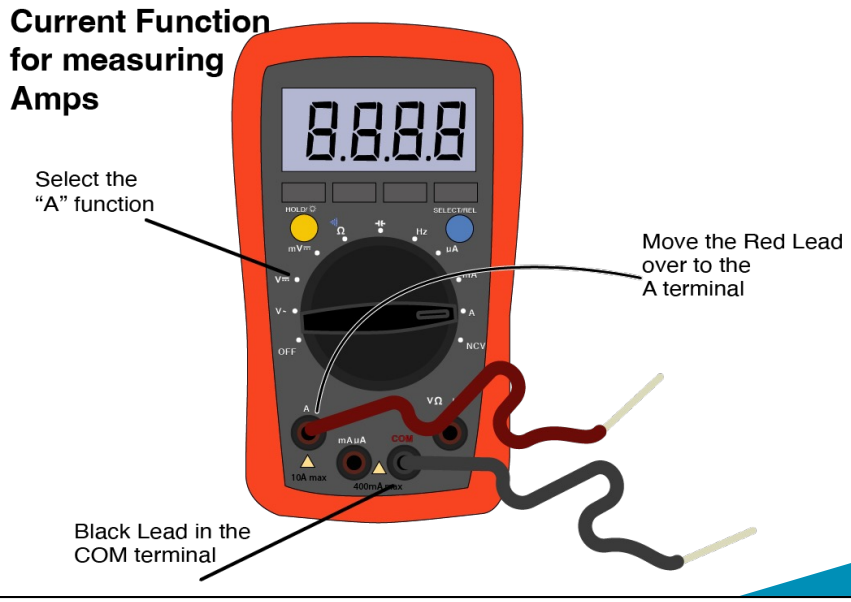
1. Place red cable in the V Ω -|)- Hz terminal and the black in the common
2. Select V--- for DC Voltage

3. Connect the red lead to the positive (+) and back lead to the negative (-) component or section of circuit you would like to measure.

NB

- Remember you are measuring the difference in voltage (potential , pressure… so measuring at the same point you get zero (no difference in voltage)
- If you get a negative Voltage – you have the leads around the wrong way

Using a Multimeter



!!CURRENT CAN DAMAGE YOUR METER!!

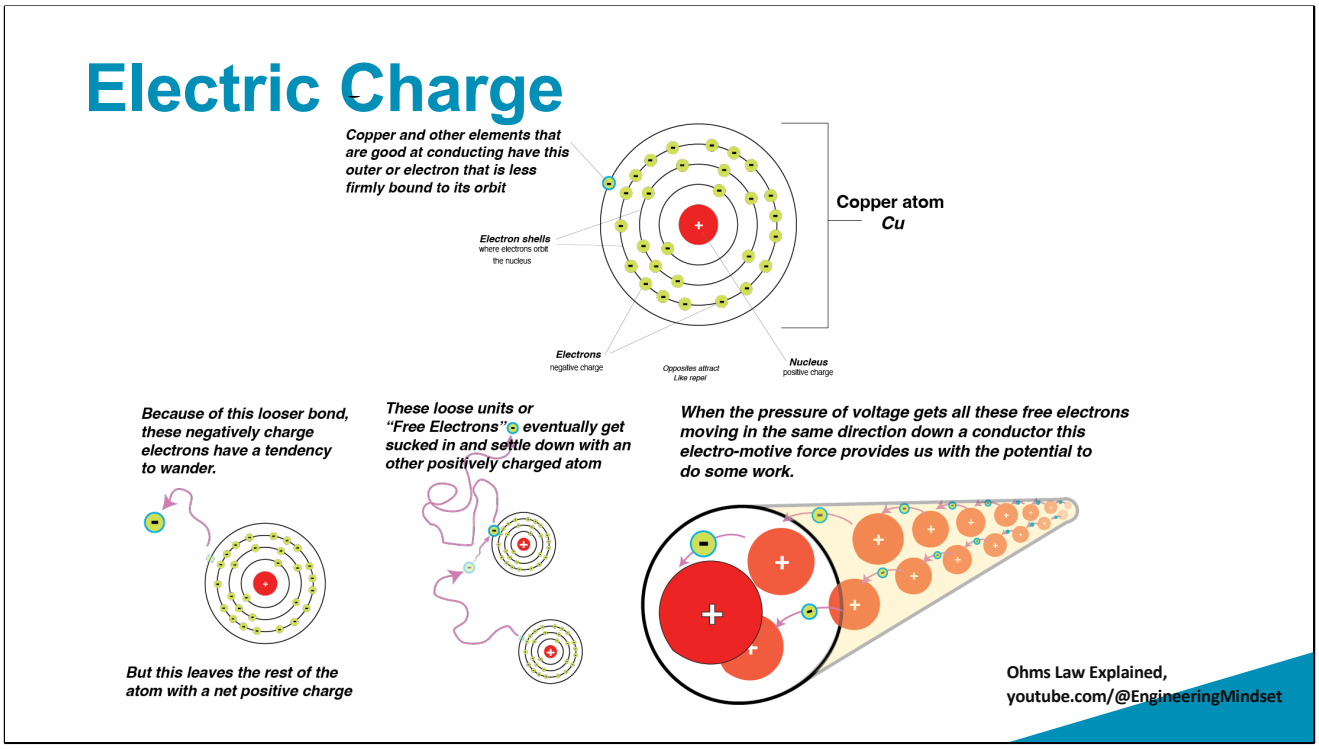
The mA (milliAmp) µA (microamp) terminal is only designed to measure up to a maximum value of 400mA Try to measure anything over this and you'll blow the fuse.
If you don't know what reading you are likely to get select the **A** and work your way back if need be.

If you don't know the

1. Place the black in the common and the red cable in the **A** or **mA µA** terminal.
2. Select for A---, mA---, or µA---

3. **Amperage readings need to always taken in series. Taking a reading in parallel to the load provides a shorter path for the current to to flow and will giveyou a false reading and could damage your meter.**
4. Remember you are measuring the difference in voltage (potential , pressure… so measuring at the same point you get zero (no difference in voltage

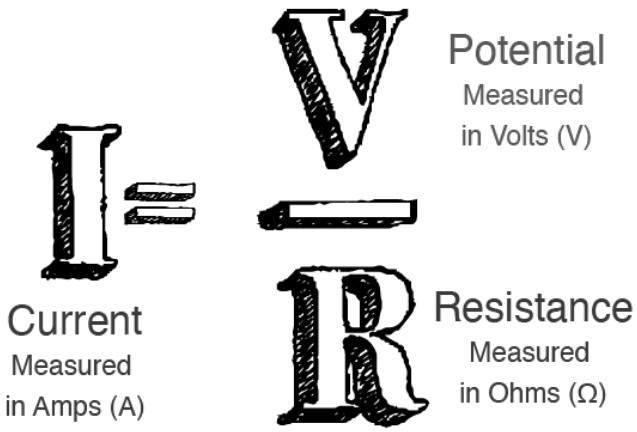
Electric Charge



Copper is a favourite material for making conductors
Its relatively cheap, easy to find and produce and it got great conductivity characteristics.

If this is what a conductor does… whats a semiconductor do?

Ohms Law

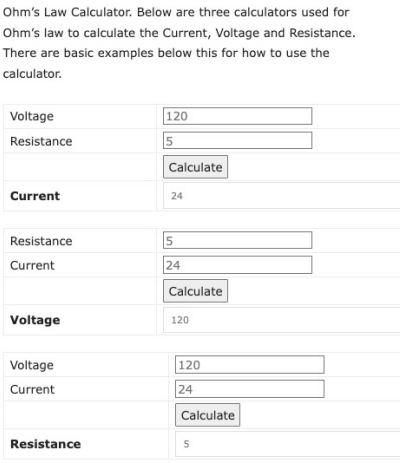


Ohms Law is the interlinked relationship of Voltage, Current and Resistance.

It's a powerful tool and while it looks like maths when you play with it enough you come to unstand it on a intuitive level …. Im told ;)

Ohms Law

theengineeringmindset.com/ohms-law-calculator



Befor we go any further with this remember you never have to worry about doing maths

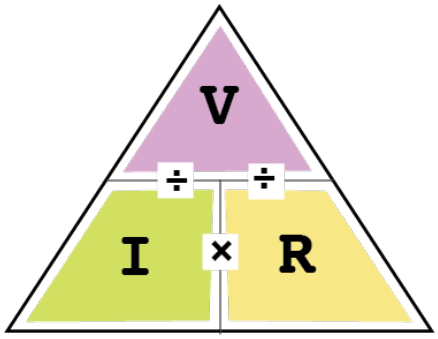
Cause theres an app for that

Ohms Law

Ohms Law Triangle

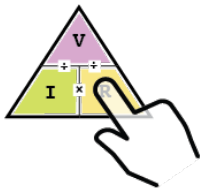
Don't have a memory for formulas?

just remeber VIR in the ▲



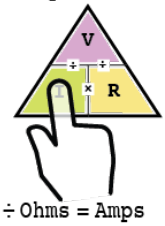
Cover the one you don't know and plug in the numbers

R?



Volts ÷ Amps = Ohms

I?



Volts ÷ Ohms = Amps

V?

Amps × Ohms = Volts

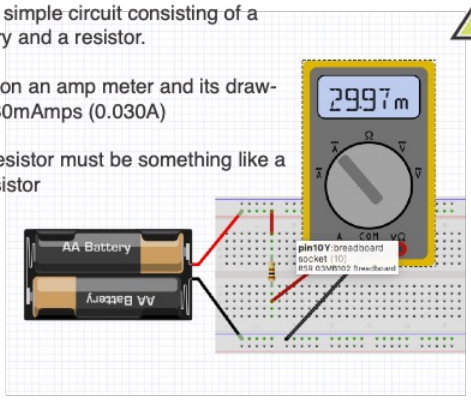
Ohms Law

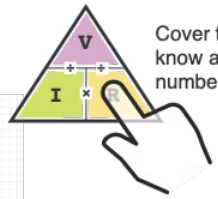
Have a voltage and current reading but want to know the resistance in the circuit?

We have a simple circuit consisting of a 3volt battery and a resistor.

If we put it on an amp meter and its drawing about 30mAmps (0.030A)

Then the resistor must be something like a ???? Ω resistor





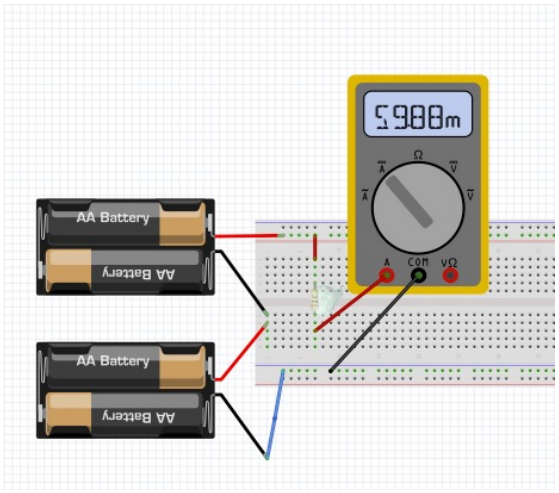
Cover the one you don't know and plug in the numbers

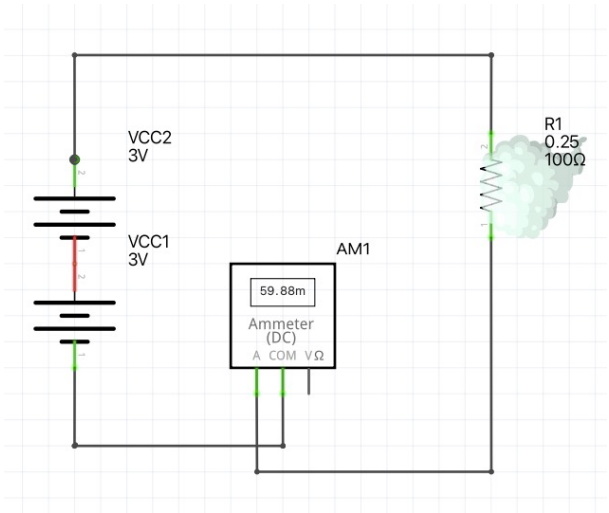
Volts ÷ Amps = Ohms

3 Volts ÷ 0.03 Amps =

100Ω

Ohms Law

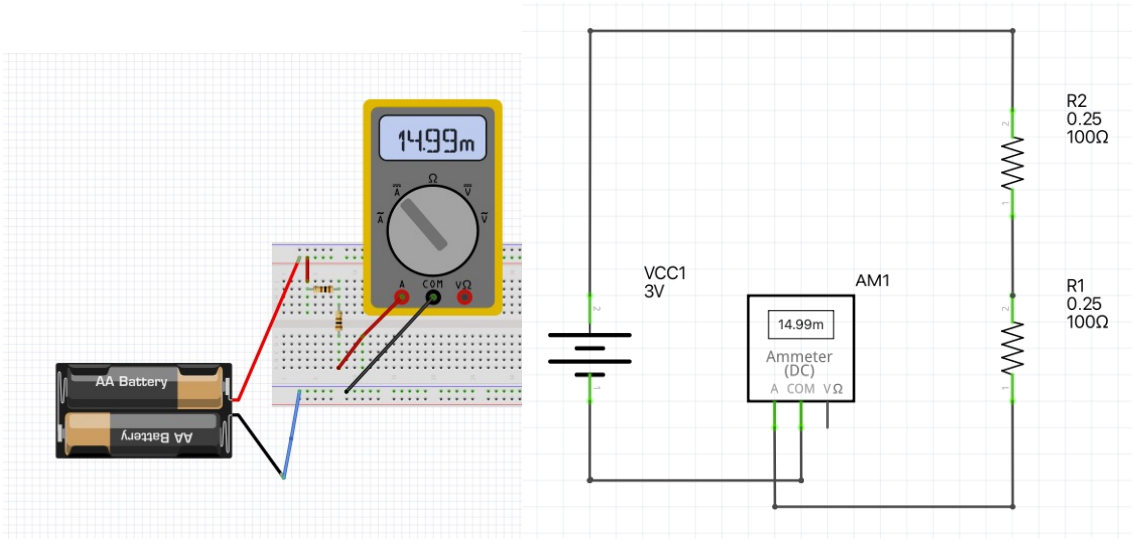




Now that we have this in hand “or kinda” we can do some experiments

What if we double the voltage by adding double the batteries we double the amps

Ohms Law



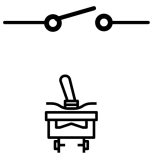
What if we double the resistance by adding doubling the 100 Ohm resistors

we halve the amps

Common components summarised

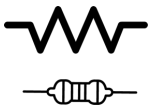
Switch

mechanical break in a circuit that stops the flow of current.



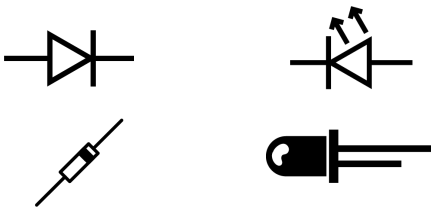
Resistors

Inhibits the flow of current



Diodes (LED)

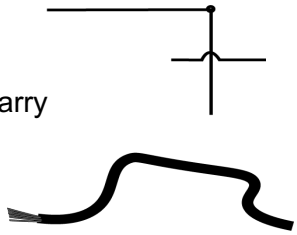
One-way gate



Common components summarised

Conductors (wires)

These are wires or other strips of metal designed to carry current and are often surrounded by insulation

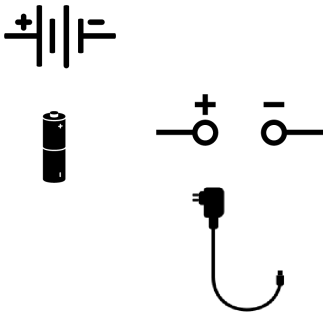


Supply Voltage

Usually a battery

or

power supplies designed for powering DC circuits



Bread board

What's the difference between the words Electric & Electronics

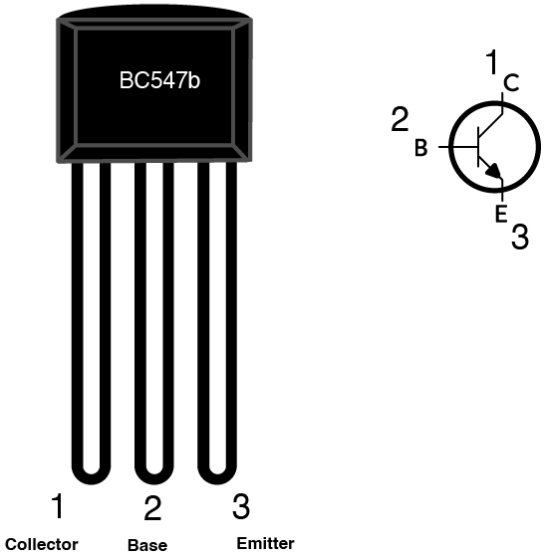
Electrical installations use the above and of course some more advanced concepts like AC, transdformers, induction to do grunt work

Where as Electronics use semiconductors another electromagnetic effects to sense and respond according to our designs.

One more component

Transistor

BC547b Bipolar NPN Resistor



A Transistor is a semiconductor that can be used as a switch (turn on or off) or vary the current in one subcircuit in response to the inputs of a parallel sub circuit.

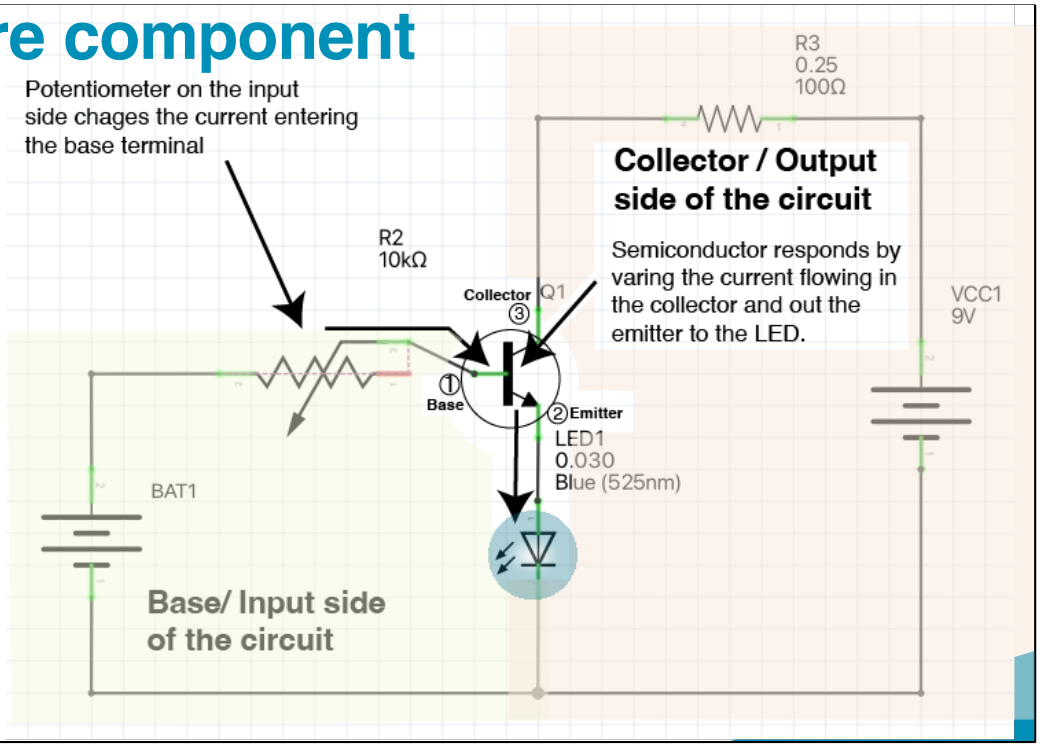
It allows us to design circuits that will automatic and remotely change their output based on a voltage inducing input somewhere else.

Today we are going to be using a fairly common sort of Transistor its a Bipolar

Bipolar Transistors are current regulating devices that control the amount of current flowing through them from the Emitter to the Collector terminals in proportion to the amount of biasing voltage applied to their base terminal, thus acting like a current-controlled switch. As a small current flowing into the base terminal controls a much larger collector current forming the basis of transistor action.

One more component

Transistor



The Transistor sits at the centre of 2 sub-circuits,

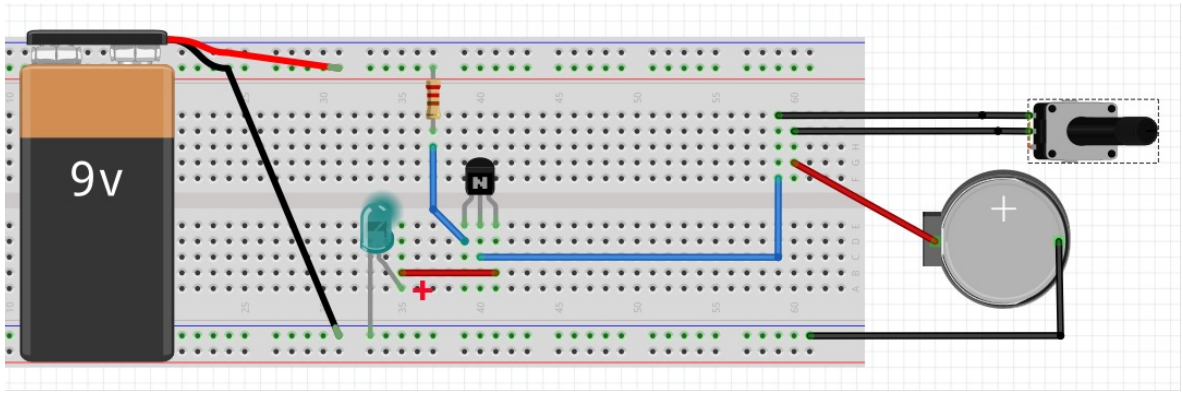
1. the input or base circuit side and
2. The output or emitter side of the circuit

- At the minimum base voltage threshold or “Cutoff” the semiconductor begins to allow current to flow from the collector out of the emitter. Below this threshold the transistor is “Fully-Off”
- At the maximum base voltage threshold or “Saturation” the semiconductor is “Fully-On”
- The spectrum between these thresholds is the “Active Region”.

- Amplify

- Gain

Lets put this together



Where to go from here?

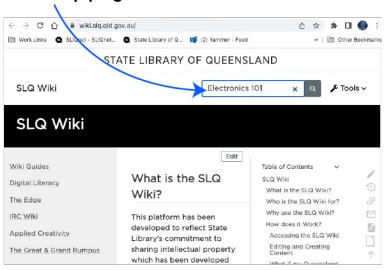
SLQwiki –

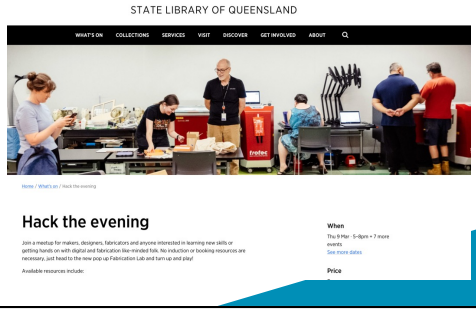
- This presentation and a pile of other useful info is on the wiki

Hack the Evening

- Come back and work on your own designs,
- Get signed off on theElectronics bench induction.
- Talk to people about their projects.

Go to the Wiki and search “electronics 101”
wiki.slq.qld.gov.au





Where to go from here?

Arduino Workshops –

- We run Arduino based project workshops and coding workshops 2 or 3 times a year. Keep an eye on the enews for bookings

Instructables projects–

https://www.instructables.com/circuits/projects

Where to go from here?

Videos –

Electricity videos by Eugene Khutoryansky

Great visual explanations for key concepts

ElectroBOOM

Entertaining experiments demonstrating key concepts for you…
so you don't have to blow anything up at home.

Please don't try at home

Where to go from here?

Videos –

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More excellent visual explanations for key concepts