8.05: Electricity 1

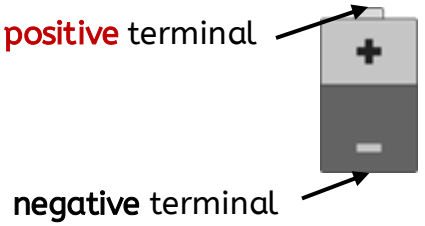
Electric Circuits

- A complete conducting loop
- Components connected into circuit by two electrical contact points
- With an energy source

Circuit Symbols

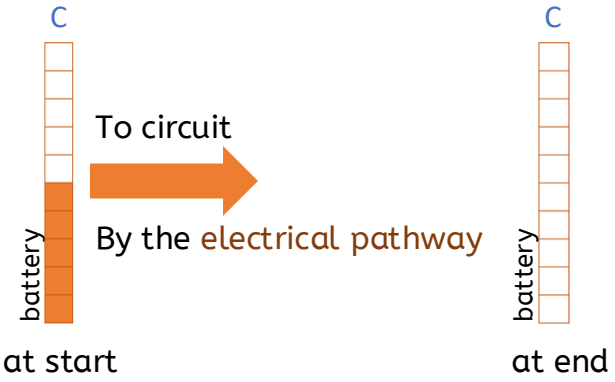
component	symbol
wire	
switch (open)	
cell (battery)	
bulb	
motor	M
buzzer	

Batteries



- An energy source for circuits
- Two terminals
- Chemical reaction of reactants inside when terminals connected in a circuit

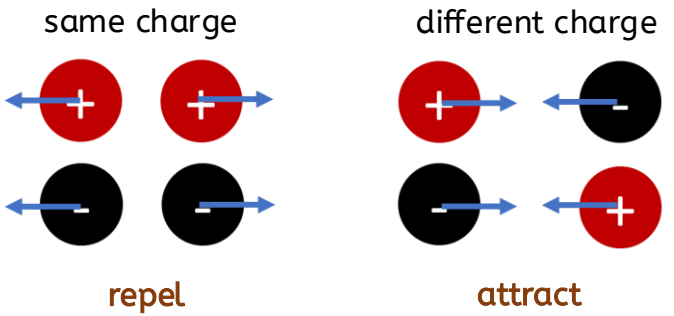
- Batteries run down when the circuit is working



Electrostatic Force

- All electrical effects are caused by an electrostatic force
- Acts between charged objects
- Electrical charge is a property of some objects

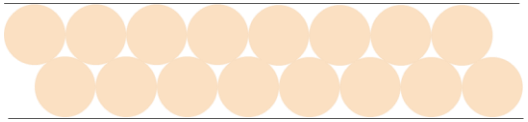
Effects of Electrostatic Force



8.05: Electricity 1

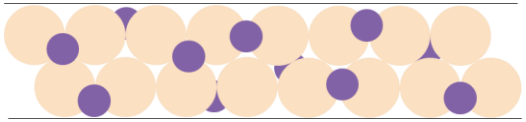
Electrical Conductors

poor electrical conductor



Particles with no separation, fixed in position, vibrating

good electrical conductor



Also has freely moving charged particles of the same type

In a Working Circuit

- Particles carrying same charge
- Electrostatic forces exerted
- Repel

- One charged particle caused to move
- Repels nearby charged particle
- Net movement of all charged particles
- At the same time

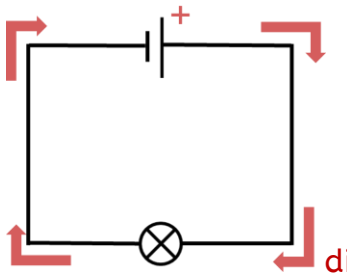
Electric Current

- Rate of flow of charge, measured in amps (A)

These particles carry a total of 1 C of charge.

If all pass this point in one second, the size of the current is 1 A.

$$\text{current (A)} = \frac{\text{charge flow (C)}}{\text{time taken (s)}}$$



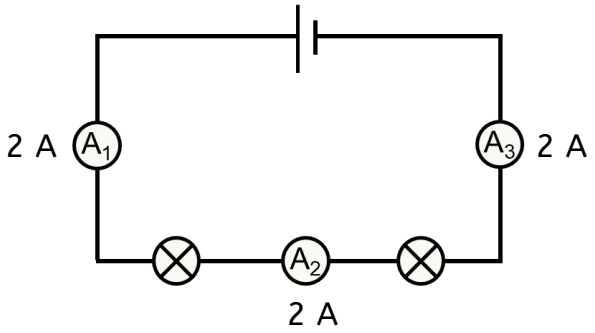
Current flows 'from positive to negative'

direction of conventional current

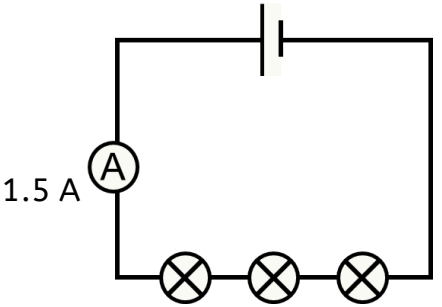
8.05: Electricity 1

Electric current is

- a quantity
- **the same size** in all parts of a series circuit



Changing Number of Components

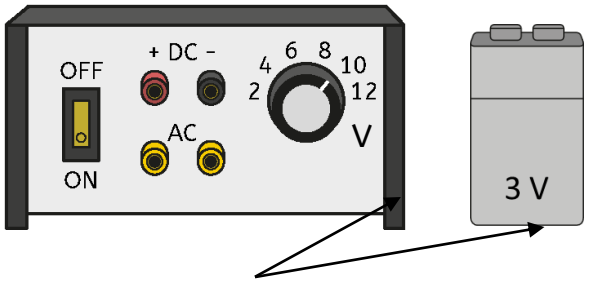


More components

- Each component resists flow of charged particles
- Harder for current to flow
- Current decreases

Voltage

- an electrical push



All energy sources for circuits have a **voltage**.

Changing Voltage

electrostatic force on charged particle by battery

greater electrostatic force on charge particle by battery

- A **higher voltage** of battery provides a **greater push** on the current.

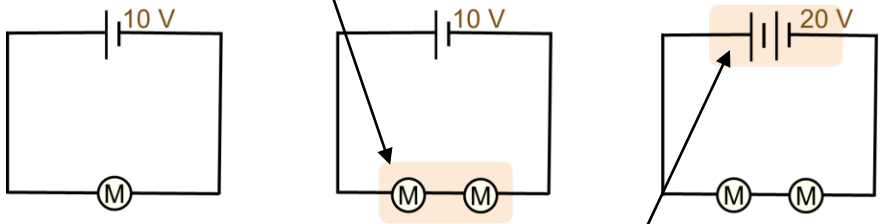
8.05: Electricity 1

	 buzzer	 bulb	 motor
increasing voltage of energy source	gets louder	gets brighter	gets faster
increasing number of devices	each gets quieter	each gets dimmer	each gets slower

Changing Number of Components

More components:

- harder to push current through the circuit
- decreases current

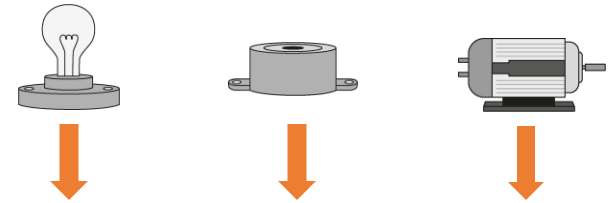


Increase voltage:

- though harder to push current
- battery pushes harder
- increases current again

Energy Transfer in Circuits

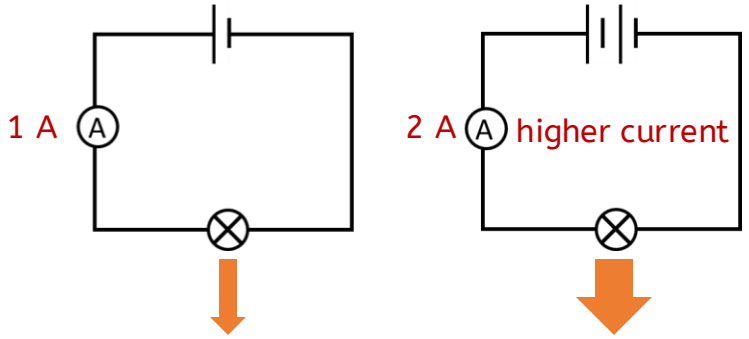
charged particles/ current by electrical pathway



by radiation pathway

by mechanical pathway

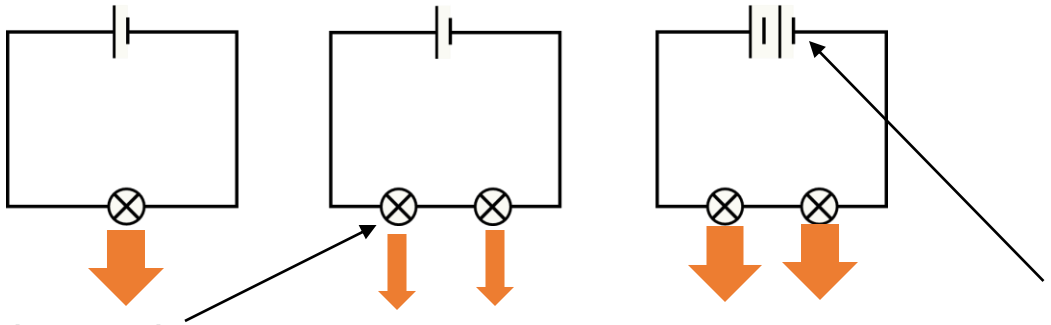
Changing Voltage



bulb working harder brighter

8.05: Electricity 1

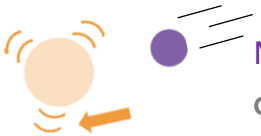
Changing Number of Components



- Harder to push current through two components
- Current decreases
- Less energy transferred each second

- More energy needed to push current with same effect
- Increase voltage

Dissipated Energy



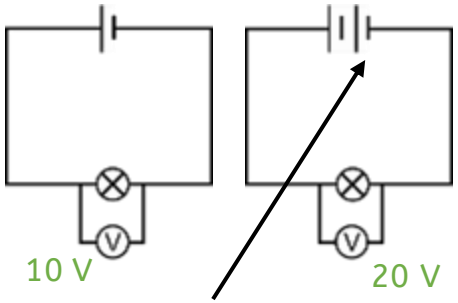
Moving charged particles collide with fixed particles

Energy transfers to particles of circuit

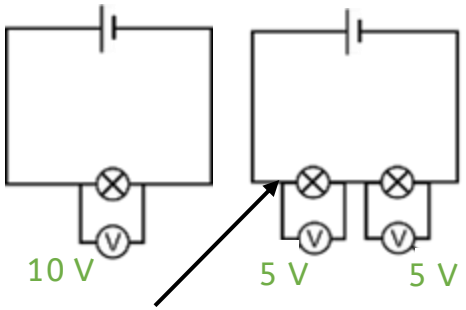
Fixed particles vibrate more
Components get hotter

- Thermal store of surroundings increases

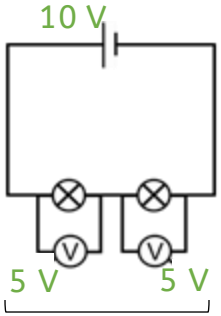
Voltage Across Components



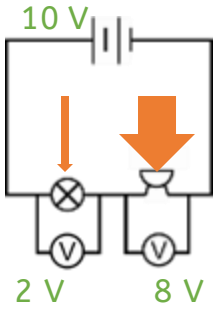
If supply voltage increases, voltage across each bulb increases



If number of bulbs increases, voltage across each bulbs decreases



The sum of the voltages across components equals the supply voltage



Current is same through both components.

Greater voltage across buzzer

More energy transferred at buzzer

It must be harder to push current through buzzer than bulb

8.05: Electricity 1

Comparing Terms

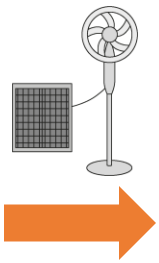
electricity — The flow of charged particles

current	voltage	energy transfer
The rate of flow of one coulomb of charge	The 'electrical push' on the current	The effect of how hard it is for the current to be pushed between two points

Power

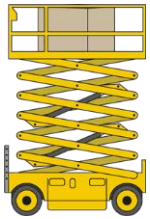
- rate of energy transfer by an object, measured in watts (W)

More Powerful



a higher current is flowing

greater rate of energy transfer



30 seconds

a force moves the box in less time

greater rate of energy transfer

$$\text{power (W)} = \frac{\text{energy transferred (J)}}{\text{time taken (s)}}$$

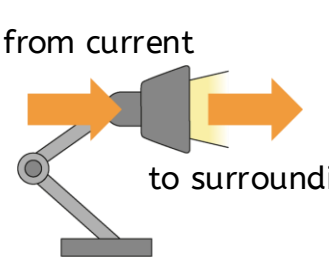
Domestic Appliances

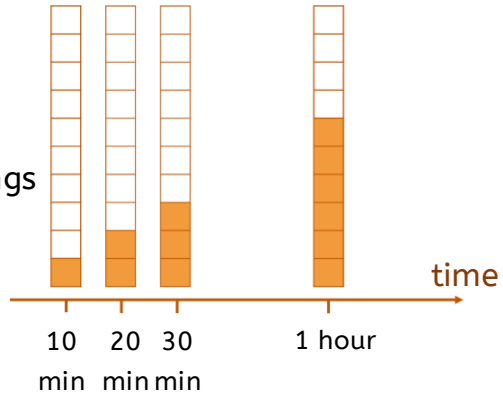
Lower power appliance → less energy each second

Higher power appliance → more energy each second

- Work faster, work harder or go further
- Appliances that heat need to be most powerful

Working Over Time





8.05: Electricity 1

Costs of Electricity

Electricity companies supply households

Households are charged:

- for the number of domestic electrical units supplied
- a standing charge

cost (p) = number of units (kWh) x price per unit (p)

Air Fryer
Model: AF100UK JM1
220-240V ~ 50-60Hz 1550W

One unit = one kWh

energy supplied (kWh) = power (kW) × time (h)

- If power is in watts, it is converted to **kilowatts**
- If time used for is in seconds, it is converted to **hours**

Sources of Electricity

- Electricity is a **secondary source** of energy
- The UK electricity supplies originate from primary sources

fossil fuels (coal, oil and natural gas)

nuclear fuel

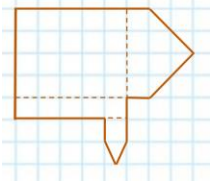
renewables (wind, solar etc.)

raw resources

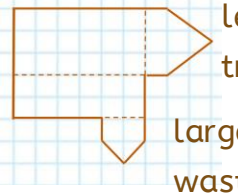
- There are disadvantages to using any source
- **Using less electricity** (or any energy source) saves money and is better for the environment

Efficiency

More efficient



Less efficient



less energy transferred usefully

larger proportion wasted

More efficient appliances cost less and cause less environmental damage - only if they are not used more.

8.05: Electricity 1

Validity

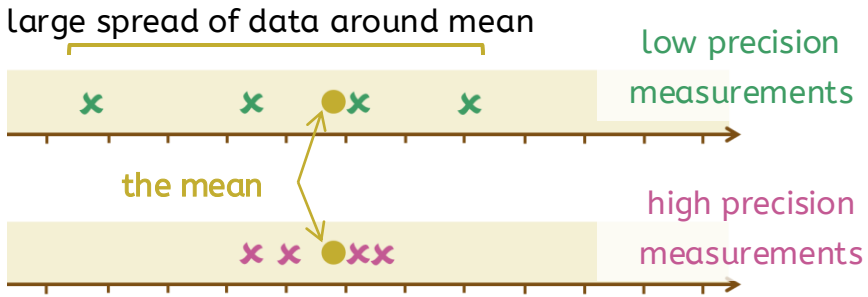
valid data

- represents the real situation and is trustworthy

- with low measurement error
- that is accurate
- that is precise
- that is repeatable
- that is reproducible

Precision

Measurements are precise if there is little spread around the mean.



Developing the Method

Researchers plan to collect valid data:

- select apparatus and techniques known to give accurate and precise data
- measure over appropriate range, with systematic intervals
- often **trial** experiments to finalise the method

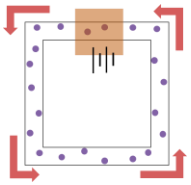
Interpreting Data

Researchers ensure all data is included in their report before publication:

- Collected data, including control variable data
- Processed data, for example, means and calculated results

Electric Circuit Model

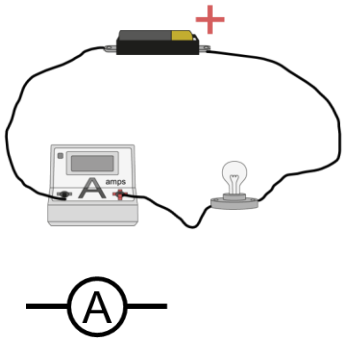
- Charged particles are all part of the circuit; no charged particles are lost from it
- The energy source provides an 'electrical push' on the nearby charged particles
- Their movement affects others and so on
- All charged particles start to move at the same time, drifting at the same rate, in the same direction



8.05: Electricity 1

Selecting Apparatus and Techniques

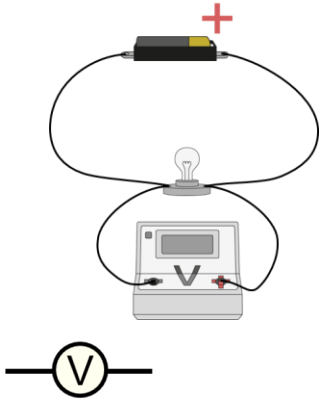
Measuring Current



An **ammeter** measures the size of the **electric current** flowing in a part of a circuit.

Connect **in series** to components.

Measuring Voltage



A **voltmeter** measures the **voltage**, the **push** exerted **on the current** to **transfer energy to the component**.

Connect **across** the two contact points of a component.

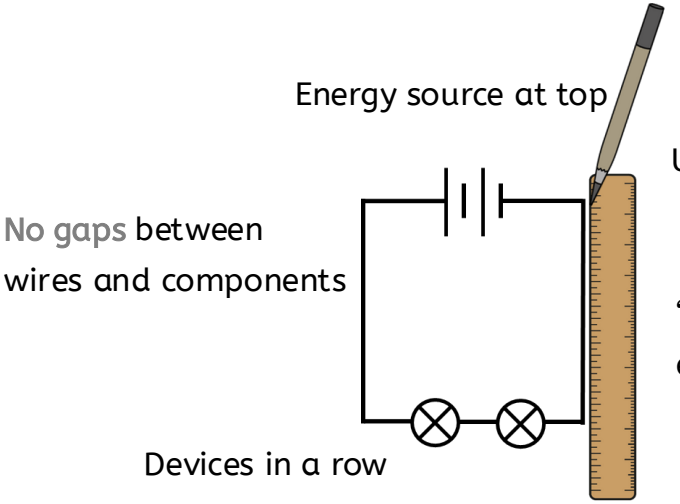
Circuit Set-Up

Series circuits are set up, so that there is

- A single, complete conducting loop
- With one component following another

Circuit Diagrams

- Represent real circuits.
- Simplify connections between components.



8.05: Electricity 1

Applications of Science on Industry

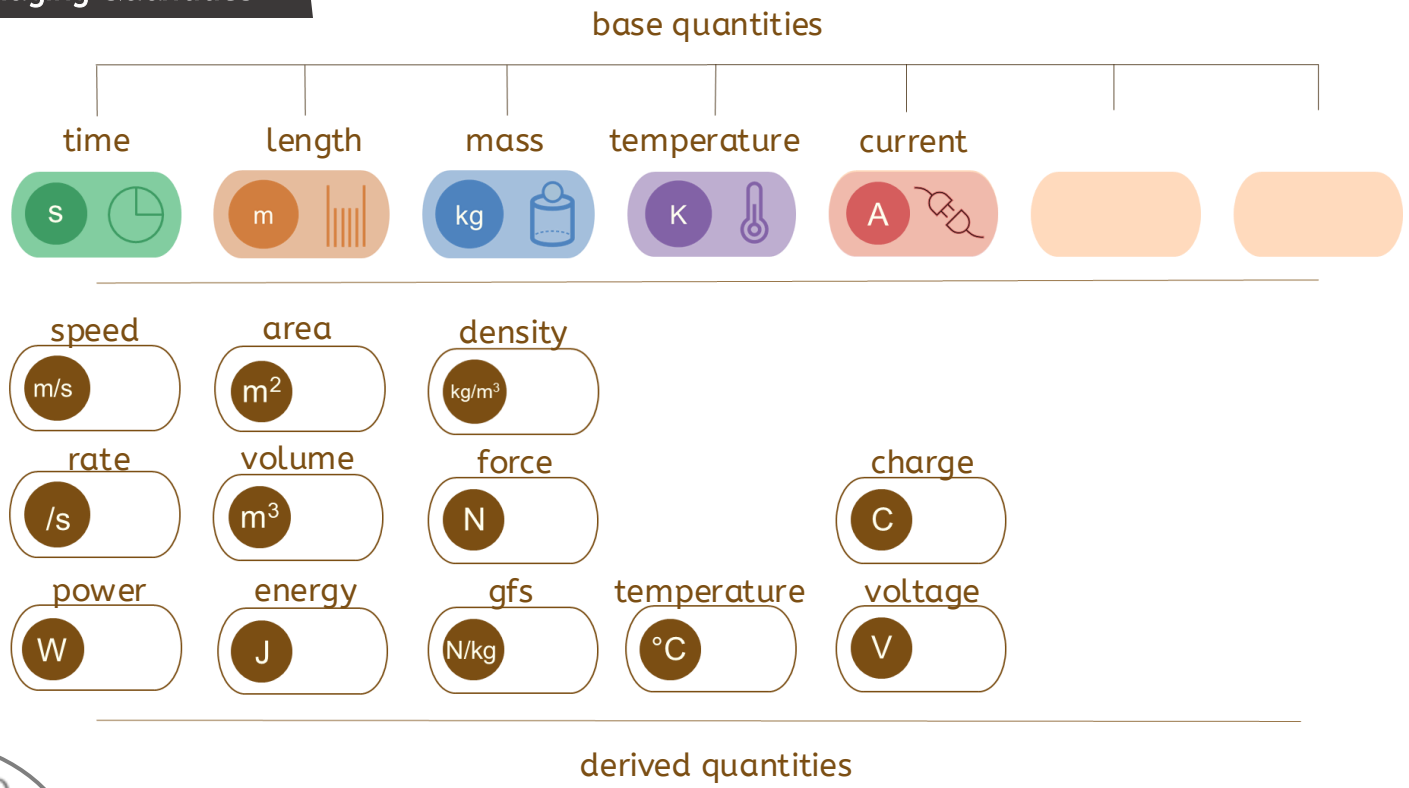
Mechanical engineers use scientific knowledge to design solutions to our energy needs:

Electrified Transport

- Cars
- Buses
- Trains
- Trams
- Lorries

Less air pollution
Less greenhouse gases
More demand for electricity
More demand for (new) raw materials

Managing Quantities



Converting Quantities

1000 W = 1 kW

÷ 1000

60 min = 1 h

÷ 60