Paper 2 Equations recall

work done (J) = Force (N) x Distance (m)

GPE (J) = mass (kg) x gravitational field strength (N/kg) x height (m)

KE = $\frac{1}{2}$ x mass (kg) x velocity (m/s)^2

Power = $\frac{\text{Workdone (J)}}{\text{Time taken (s)}}$

Efficiency = $\frac{\text{useful energy output (J)}}{\text{total energy input (J)}}$

Density (Kg/m^3) = mass (Kg) ÷ Volume (m^3)

Force (N) = spring constant (N/m) x extension (m)

Help with units:

- All distances and lengths are in metres (m)
- Time is always seconds (s)
- All types of energy are in Joules (J)
- Speed and velocity are always metres per second (m/s)
- All types of forces are in newtons (N)

If a number is given with units different to these above you will need to convert them

Changing the Subject Remember to do the opposite function if you want something to "move to the other side". Opposite functions include:
Multiply and Divide — Squared and Square root — Add and subtract

Paper 2 Equations recall

Energy transferred (J) = Charge moved (C) x Potential difference (V)

Charge (C) = current (A) x time (S)

Potential difference (V) = current (A) x resistance (Ω)

Power (W) = current (A) x potential difference (V)

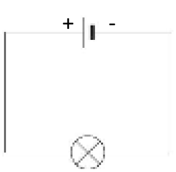
Power (W) = current^2 (A^2) x resistance (Ω)

Remember the power = energy ÷ time can still be used!

Base Units
Energy = Joules (J)
Charge = Coulombs (C)
Potential difference = volts (V)
Current = Amps (A)
Resistance = Ohms (Ω)
Power = Watts (W)

x 1000	x 1000	x 10	x 100		÷ 1000	÷ 1000	÷ 1000
nano (n)	**micro (µ)**	**Mili (m)**	**Centi (c)**	**Base Unit**	**kilo (k)**	**mega (M)**	**Giga (G)**
÷ 1000	÷ 1000	÷ 10	÷ 100		x 1000	x 1000	x 1000

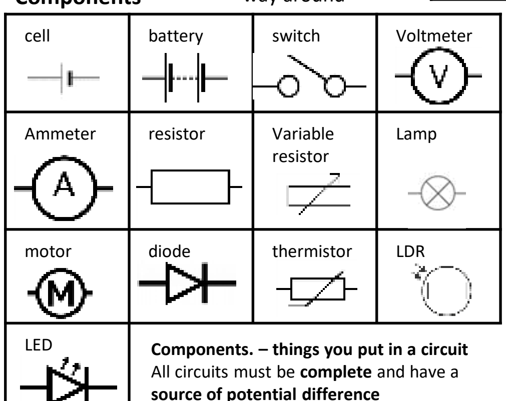
Basics of electricity



1. Lines must be straight
2. Must always be no gaps
3. Right angles
4. Always a cell
5. All cells drawn same way around

Subatomic particle	Relative mass	Relative charge	Position in atom
Proton	1	+1	Nucleus
Neutron	1	0	Nucleus
Electron	0	-1	shells

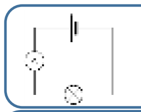
Components



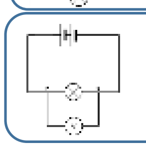
Components. – things you put in a circuit
All circuits must be **complete** and have a **source of potential difference**

Series circuit = one loop, no junctions

Parallel circuit = more than one loop, junctions



Ammeters measure current (A) and must always be connected in series



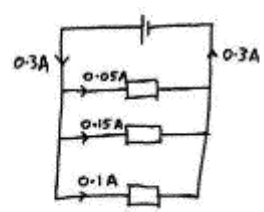
Voltmeters measure potential difference (V) and must always be connected in parallel. Junction must be before an after component measured

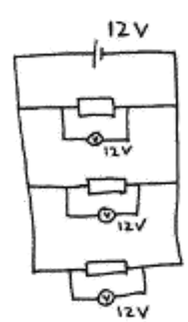
Calculations and terms

Current is the **rate of flow of charge**
In metals the charges are electrons

Potential difference is the **energy transferred** per charge
Measured in volts (volts are joules transferred per coulomb)

Current:
Is always the same at beginning and end
Splits at junctions
Same at any point on a loop





Voltage:
Never splits a junctions
Voltage of each component of loop adds up to voltage of source

Resistance
Voltage = current x resistance

So resistance of component = voltage across it (measured in parallel) x current at any ammeter on it's loop.

Energy transfers and systems.

Topic 8 card 1

The energy stores a system can have are:
- -Kinetic
- -Thermal
- -Chemical
- -GPE
- -Elastic potential
- -Magnetic
- -Nuclear

When there is a energy change in a closed systems (when nothing can enter of leave) there is no net change in energy. This means that the total energy before the transfer will be the same as the total energy after.

There are 4 different types of energy transfer. Mechanically, Electrically, by heating and by radiation.

Mechanically – a force moving an object.
Electrically – a current doing work in a circuit.
By hearting – heat transferring from a hotter object to a colder one.
By radiation – energy transferred by waves

GPE of apple	Mechanically →	Kinetic of apple
	Mechanically →	thermal of apple

From energy store (mains)	Electrically →	Kinetic of hair dryer
	Electrically →	thermal of hairdryer

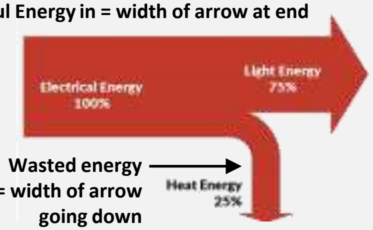
Energy and work done.

Topic 8 card 2

Sankey diagrams show that no energy is lost in a closed system. The total energy in (beginning of the arrow) must add up to total energy out (ends of the arrows).

Useful Energy in = width of arrow at end

Energy in = width of arrow at start



Wasted energy = width of arrow going down

Work done (J or Nm) = Force (N) x distance moved(m)

Work done = energy transferred. This means work done in equal to the energy required to move an object a distance.

Example. Calculate the work done completed by the weight lifter. Answer 2m x 25N = 50J

As work done is equal to energy transferred you can also use the following equations to say the GPE gained by the bar must = the KE it would gain if it was dropped (as all the energy would be transferred).

To work out work done you will therefore need to know the force and distance moved.

ΔGPE(J) =Mass(Kg) x gravity (Kg/N) x Δ height(m)
KE(J) = ½ x mass (kg) x velocity^2(m/s)

Efficiency

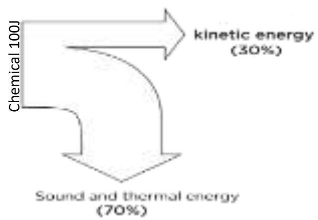
Topic 8 card 3

In all energy transfers energy is dissipated to energy stores which are not useful. Mechanical energy transfers become wasteful as movement causes energy to be transferred as heat. We say it is **dissipated to the surroundings as heat.**

Kinetic in engine	Mechanically →	Kinetic of wheels		
	Mechanically →	Thermal of wheels	Heating →	thermal of air

$$\text{efficiency} = \frac{\text{useful energy}}{\text{total energy supplied}}$$

Example Q = work out the efficiency of the car engine using the Sankey diagram on the left. Answer = 30/100 = 0.3



REMEMBER: energy loss can be reduced through ***lubrication*** *(which reduces friction)*

Power

$$\text{Power (W)} = \frac{\text{work done(J)}}{\text{time taken (s)}}$$

Power is the rate at which energy is transferred (or work is done).

1 Watt = 1 Joule per second.

Something that has a high power can transfer a lot of energy in a short time. (in cars this means they accelerate quickly)

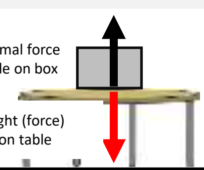
Forces and their effects

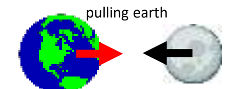
Topic 9 card 1

Scalar quantities - have a magnitude (size) only eg distance, speed, mass, temp, and time.
Vectors Quantities - have a magnitude and direction eg force, velocity, displacement, acceleration and momentum.

Forces can be either **Contact** (need to touch eg friction) or **non contact** (eg gravity or magnetism)

When **two objects interact** they always make a **pair of forces** which can be shown as **vector arrows**





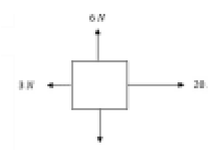
Hint: *friction or normal force arrows must start where objects touch*

H

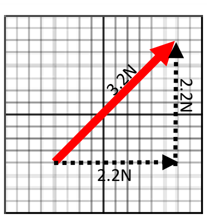
Must show all the forces on one object only.

Must show all the forces on that object

Size of arrows must be proportional to size of force



Resultant force must have size and direction



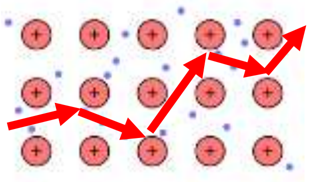
Remember any diagonal force can be turned into it's "up and down" components by a scale drawing of a right angle triangle

Resistance

If there is an electric **current in a resistor (or a wire)** there is always **energy transfer** which **heats** the resistor
This is because current does work against resistance

H

Low resistance wires are made of special materials or super cooled to reduce collisions



This is because
1. Current is the flow of electrons in a metal
2. As they flow they collide with metal ions
3. This releases heat

$$\text{Resistance }(\Omega) = \frac{\text{Voltage (V)}}{\text{Current (A)}}$$

This heat is dissipated to the surrounds as heat – can be useful or waste full

Connect resistors in series and their resistance adds up
because current is same but adds up the total resistance is the sum of each resistor
Connect in parallel and resistance **gets lower**
Because the current divides across each resistor so the total = sum of 1/number of resistors

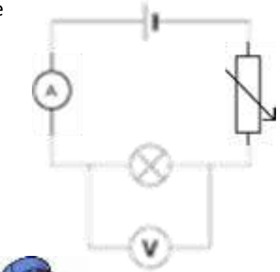
Resistance not useful as heat from wires Is wasted energy

Resistance useful as heat from wires cooks bread

Changing the current

A variable resistor can be used to change the current in a circuit
Increasing the resistance decreases the current

To test how the current changes with increased voltage
1) Set up the circuit (on right) and add set the variable resistor to max to get a low Current
2) Record the voltage on the voltmeter And the current on the Ammeter
3) Write your results in a headed table including units
4) Decrease the resistance to increase the current
5) Record readings again and repeat increasing the current each time

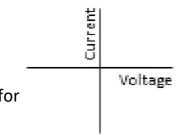


Extra steps for testing some devices

LED: keep variable resistor low & increase light levels

Thermistor: keep variable resistor low & increase temperature **in an OIL BATH**

Diode: switch the direction of source of potential difference circuit and repeat



You will produce different graphs for each type of component

KEY CONTROL: switch off circuit and allow to cool between each test to control temperature

Power ratings & energy transfer

You are given an equation for working out energy transferred by a device
Work done (energy transferred) = current x voltage x time

The **power rating of a device** is the total input energy divided by time
Measured in watts power = Joules ÷ time ***(includes waste energy)***
Remember you have three equations you could need for electrical power depending on what information you are given

Efficiency = useful energy ÷ input energy – tells you how much / little is wasted as a percentage

Remember
The higher the power rating the more energy is transferred electrically to the device.

The higher the efficiency the more of the energy is transferred into useful forms

Power rating = total amount transferred

Efficiency = % that's useful

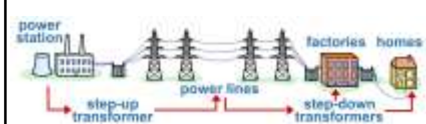
Mains power

1) Are source of alternating voltage (+ / - terminals flip with a **frequency of 50Hz**)
2) **Always supply 230V**
3) produce **alternating current**
4) Movement of charges changes direction
5) Transfer energy electrically

Batteries & cells

1) store chemical energy
2) Are source of **direct voltage** (+ / - ends stay in one place)
3) produce **direct current**
4) Charges flow in **one direction**
5) Transfer energy electrically

National Grid and Safety



Voltages need to be high in power lines
Reduces energy lost as heat (because current is low

Voltages need to be low into homes
Because high voltages are dangerous

Step up transformers make voltage go up for power lines

Step down transformers make voltage go down for homes

$$V_p \times I_p = V_s \times V_s$$

Given and need to use.
Little p means 1st coil (primary), Little s means 2nd coil (secondary)
Always have one unknown

E =Earth wire
Should be 0V
Connects case to ground in case live wire touches casing so can remove charges

N = Neutral wire
Should be 0V
Carries current back to the mains – completes circuit

L = Live wire
Should be 230V
Transfers energy electrically to the device

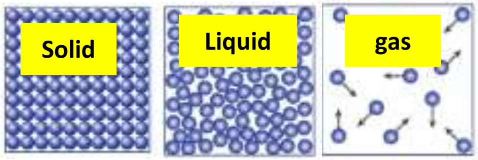
Fuses
connect to live wire. Melts and breaks circuit if surge of current

Circuit breaker
connects to live wire. Flicks open if surge. Quicker and can be reset

Both connect to live wire as higher voltage is dangerous.
If touches another wire can short circuit and cause high current (fire risk)
If touches person can cause a shock

Particle model and density

Topic 14 card 1



Solid	Liquid	Gas
Arrangement: Close together, regular pattern	**Arrangement:** Close together, random arrangement	**Arrangement:** far apart, random arrangement
Movement: Vibrate around a fixed point	**Movement:** move over each other	**Movement:** quick, in all directions
Relative energy: lowest	**Relative energy:** medium	**Relative energy:** high

Density is the amount of mass in a certain volume

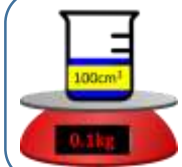
$$\text{Density } (kg/m^3) = \frac{\text{mass (kg)}}{\text{Volume (m}^3\text{)}}$$

Solids: ,most dense as most particles per volume as closely packed and regular

Gases: least dense as few particles per volume as particles are far apart

To work it out we need to measure both mass and volume

Measuring the Density of a liquid



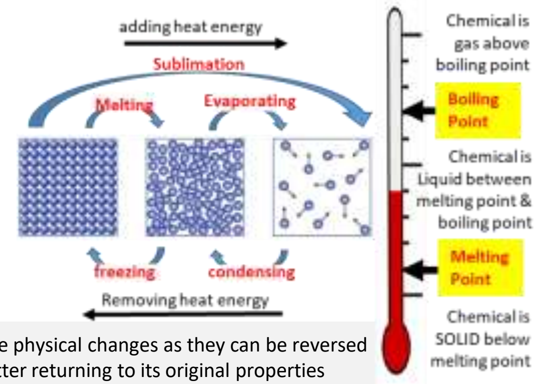
1) Measure volume with a measuring cylinder
2) Zero balance with beaker on it
3) pour in liquid and measure mass in Kg
4) divide mass by volume

Measuring the Density of a solid

1) Measure the mass of solid and covert to Kg *(g → kg ÷ 1000)*
2a) Fill a displacement can (sometimes called eureka can) to spout with water
2b) slowly lower solid in until water has stopped flowing out of spout.
3) Collect liquid as flows out in measuring cylinder and record volume

Changes of state

Topic 14 card 2

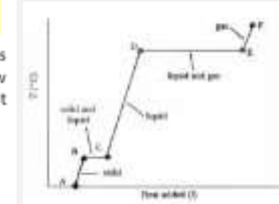


These are physical changes as they can be reversed with matter returning to its original properties

If you **heat** a material it will gradually **increase the energy stored** in it.

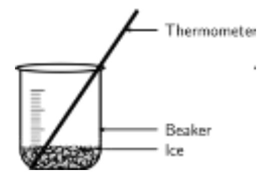
As you heat it a solid's particles **gain kinetic energy** (vibrate more) making the temperature rise.

OR can break the attractions between particles **causing a change of state** (i.e. melting)



Getting a Temperature time graph for ice
1) Set up the equipment on right
2) warm gently
3) record the temperature every 30 seconds
4) continue until water is boiling
5) plot graph

Temperature should stay constant during melting and boiling and rise between



Insulation can reduce unwanted heat loss (energy transfer). This can **be putting a lid on** or **wrapping insulating** material around a beaker

Latent and specific heat

Topic 14 card 3

Different materials can absorb different amounts of energy before they get.
Sand needs less energy to heat up then water (which is why sandy beaches are hot to stand on

You will be given both of these equations on the back of your exam paper

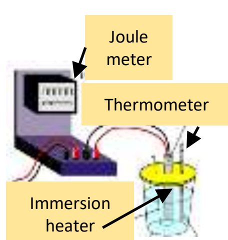
Energy change (J) = mass (Kg) x **c** x ΔT	Energy change (J) = mass (Kg) x **L**
C = Specific heat capacity is the amount of joules of energy needed to raise the temperature of one kg of material by one degree	**L = Specific latent heat** is the amount of joules of energy needed to melt or evaporate one kg of material

Remember ΔT is the change (or difference) if you are given two temperatures

Compare specific and latent heat:

Specific heat tells you about energy needed for a material changing temperature

Latent heat tells you how much energy must be absorbed at the boiling point (Latent vaporisation) or melting point (latent heat of fusion) to change state (per Kg)



Measuring the specific heat capacity of water

1) Set up the equipment as shown after weighing mass of water
2) Record the start temperature and heat until raises by 25 degrees
3) record joules used on meter
4) Rearrange equation to

$$c = \frac{\text{energy used (J)}}{\text{mass (kg) x } \Delta\text{T}}$$

Kelvin and pressure

Topic 14 card 4

Even Ice has lots of heat energy in it at 0ºC.
Heat energy is the kinetic energy of the particles in the solid vibrating

0º Celsius is the temperature Ice melts (and 100 º Celsius when it boils) but the scale can be confusing because -273 ºC is the temperature where there is no heat energy at all

-273 Celsius is called absolute zero.
It is when particles do not have the energy to vibrate

In physics we use a different temperature scale called degrees kelvin.
0 degrees kelvin is set at absolute zero

Degrees kelvin = degrees Celsius - 273

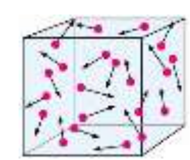
Degrees Celsius = degrees Kelvin + 273

Pressure of a gas

Pressure is caused by gas particles moving around and **colliding** with the insides of their container

Air particles colliding into the outside of objects is called atmospheric pressure.
Pressure is measured in Pascals (Pa)

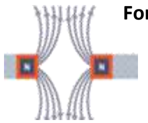
The more gas particles inside a volume the higher the pressure



Increasing the temperature of a gas in a fixed container
Makes particles move with a **faster velocity**
Increasing **the frequency of collisions** with the container
So an increase in temperature increases the pressure

Higher only H

Topic 12 & 13



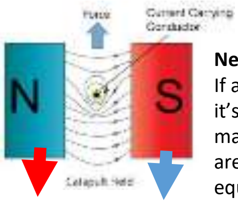
Forces of attraction or repulsion are because of the **interaction** of magnetic fields

Fleming's left hand rule

Index finger: points from north to south

Middle finger: points in direction current flows

Thumb points: direction force pushes wire



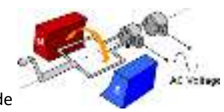
Newton's third law

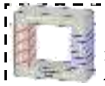
If a wire is pushed up by it's interaction with a magnetic field the magnets are pushed down by an equal but opposite force

A current can induce a magnetic field &
A magnetic field can induce a current

To induce a potential difference a magnetic field needs to be moving a wire through the magnet of the magnet along the wire. Size of p.d. increased by:

- Speed of movement
- Strength of magnet
- Number of times wire looped inside magnet
- Area of coil of wire inside





TRANSFORMERS

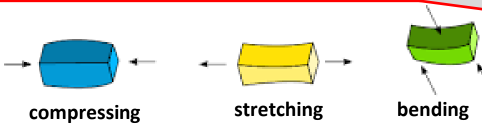
1) First coil has alternating voltage & current
2) Alternating current induces a fluctuating magnetic field in Iron core
3) Fluctuating magnetic field induces a alternating voltage in second coil.
4) Difference in number of coils changes size of p.d

Use: Force – B (T) x I (A) x l (m)
B = magnetic flux density. I = current & l = length of wire in field will tell you the size of the force

Springs

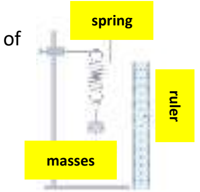
Topic 15

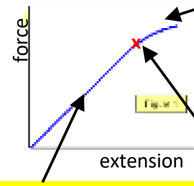
Stretching, bending or compressing an elastic material needs more than one force



The equation for measuring the **"linear elastic distortion"** or the stretching of a spring is
Force (N) = spring constant (N/m) x extension (m) *The spring constant is given the letter **k***

<u>Investigating extension</u>
1) Record the starting length of spring in mm
2) Add the first mass (1N) to the spring
3) measure new length
4) **new length – original = extension**
5) repeat adding 1N of force at a time
6) plot a graph with extension on the x axis and force on the y axis





Non-linear (inelastic stretching)
Force is no longer proportional to extension
Can not return to original length

Linear (elastic stretching)
Force is proportional to extension (so K is constant)
Can return to original length

Elastic limit :
where graph stops being directly proportional

You are given an equation for working out the energy transferred when stretching a spring which you need to use
Energy (J) = ½ x spring constant (N/m) x extension^2 (m)