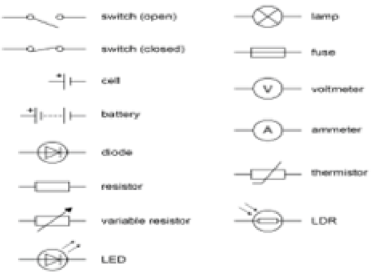
P4: Electric Circuits Knowledge Organiser (Physics)

Current, I

•The flow of charge per second
•Measured in Amperes, A
•The charges that flow in a circuit are free electrons.
•Electrons are pushed away from the negative terminal of the power supply and are pulled back towards the positive terminal.

Circuit Symbols *(You need to know what each of these components does as well as the symbol)*



Potential Difference, V

•The work done (or energy transferred) per unit of charge that passes through a component
•Measured in Volts, V

Resistance, R

•How easy or hard it is for electrons and therefore current to flow in a material.
•Measured in Ohms, Ω
•Filament lamp: higher temp, higher R
•Diode: forward resistance low, reverse resistance high
•Thermistor: R decreases as temp increases
•LDR: R decreases as light intensity increases

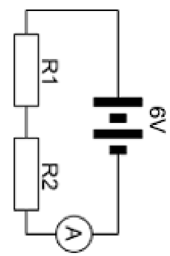
Ohm's Law

•The current through a resistor at a constant temperature is directly proportional to the p.d. across it.
•An Ohmic conductor gives a I-V graph that has a straight line through the origin.

I-V Graph / I-V Characteristic

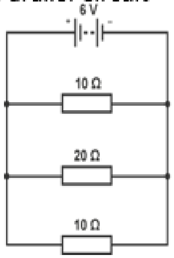
A graph of current against p.d. for a component
You need to know the I-V graphs for a resistor at constant temperature, a filament bulb and a diode (see right)

Series Circuit

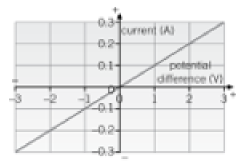


•A circuit where there is only one loop and one path for the current to take
•I is the same in each component
•Total p.d. is shared between components
•R is the sum of all the resistances of the components added together → $R_{total} = R_1 + R_2$
•Adding more resistors in series increases the total R as there is less I flowing in each resistor and the total p.d. stays the same.

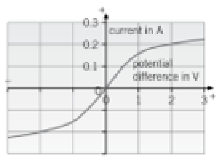
Parallel Circuit



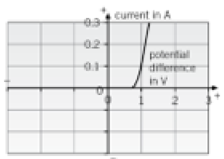
•A circuit where there are two or more loops and therefore multiple paths the current can take.
•Total I is equal to the current in each component
•p.d. across each component is the same
•Less current passes through resistors with bigger R
•The total R or two or more components in parallel is less than the resistor with the smallest R
•As we add more resistors in parallel, total R decreases as total I increases and total p.d. across them is doesn't change



Resistor at constant temp



Filament bulb



Diode

Key Equations To Learn	
Current, I	Current = Charge ÷Time I = Q ÷ t
Potential Difference, V	Potential difference = Energy ÷ Charge V = E ÷ t
Potential Difference, V	Potential difference = Current x Resistance V = I x R

Year 10 – Physics / P4

P4: Electric Circuits Knowledge Organiser (Physics)

Electrical charge	•Atoms are made up of a positively charged nucleus, surrounded by negatively charged electrons arranged in energy levels. •Normally an atom has the same number of protons and electrons so has no overall charge •If electrons are removed from an atom, it becomes positively charged •If electrons are added to an atom, it becomes negatively charged •A charged atom is called an ion.
Charging insulators	•Some insulating materials become charged when rubbed as electrons are transferred due to friction. •To become positively charged, an insulating material loses electrons when rubbed •To become negatively charged, an insulating material gains electrons when rubbed
Electric field	•A charged object has an electric field around itself. This is an area where the object will exert a force on another charged object. •The force is a non-contact force •Like charges repel •Unlike (opposite) charges attract

Key Equations To Learn	
Current, I	Current = Charge ÷Time $I = Q \div t$
Potential Difference, V	Potential difference = Energy ÷ Charge $V = E \div t$
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P4: Electric Circuits Knowledge Organiser (Trilogy)

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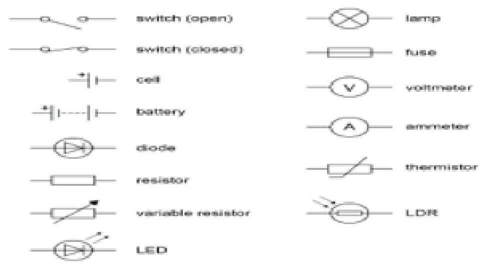
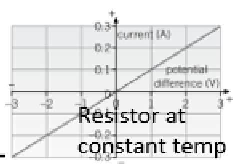
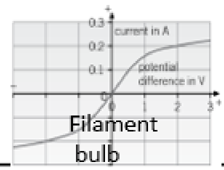
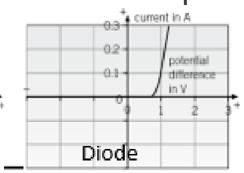
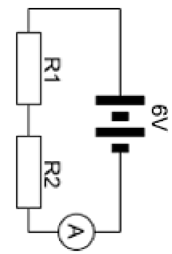
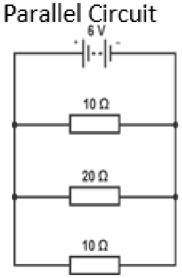
Circuit Symbols *(You need to know what each of these components does as well as the symbol)*	
Potential Difference, V	
Resistance, R	•How easy or hard it is for electrons and therefore current to flow in a material. •Measured in Ohms, Ω •Filament lamp: higher temp, higher R •Diode: forward resistance low, reverse resistance high •Thermistor: R decreases as temp increases •LDR: R decreases as light intensity increases
Ohm's Law	•The current through a resistor at a constant temperature is directly proportional to the p.d. across it. •An Ohmic conductor gives a I-V graph that has a straight line through the origin.
I-V Graph / I-V Characteristic	A graph of current against p.d. for a component. Resistor at constant temp Filament bulb Diode

Series Circuit 	•A circuit where there is only one loop and one path for the current to take •I is the same in each component •Total p.d. is shared between components •R is the sum of all the resistances of the components added together → $R_{total} = R_1 + R_2$ •Adding more resistors in series increases the total R as there is less I flowing in each resistor and the total p.d. stays the same.
Parallel Circuit 	•A circuit where there are two or more loops and therefore multiple paths the current can take. •Total I is equal to the current in each component •p.d. across each component is the same •Less current passes through resistors with bigger R •The total R or two or more components in parallel is less than the resistor with the smallest R •As we add more resistors in parallel, total R decreases as total I increases and total p.d. across them is doesn't change

Key Equations To Learn	
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Potential Difference, V	Potential difference = Energy ÷ Charge V = E ÷ t
Potential Difference, V	Potential difference = Current x Resistance V = I x R

Year 10 – Physics / P4 Trilogy

P5: Electricity In The Home Knowledge Organiser

Direct current , d.c.	•Current that flows in one direction only in a circuit. •Current from a battery is usually d.c.
Alternating current, a.c.	•Current that repeatedly flows in one direction then the other (reverses) •Mains electricity is a.c. • Mains a.c. has a frequency of 50 cycles per second or 50 Hz. •Frequency of an a.c. supply = 1 ÷ the time taken for one cycle
Live wire	•The brown wire in a plug •In mains electricity, it carries a p.d. that alternates between -325V and +325V
Neutral wire	•The blue wire in a plug •Carries 0V p.d.
Earth wire	•The green and yellow striped wire in a plug •Connected to the longest pin •Stops the metal case of an appliance becoming live
Fuse	•Melts if too much current passes through it which breaks the circuit •A safety device •Can be 3A, 5A or 13A depending on the appliance •To decide what fuse to use, divide the power of the appliance by the p.d.
Power, P	•The energy in Joules transferred to a device per second •Measured in Watts, W •Can be calculated in many different ways! →
Charge, Q	•The electrons that flow in a circuit •Measured in Coulombs, C •Charge flow through a resistor causes it to become hotter because the electrons collide with the ions in the resistor. The ions gain KE and so vibrate faster. This increases their thermal energy store.

Electrical work	•The battery does work in a circuit to make the electrons move. •The work done by the battery is equal to the energy transferred to the resistor
Oscilloscope	•A device that shows how an alternating p.d. changes with time. •The Y-gain control changes how tall the waves are •The time base control changes how many waves fit on the screen. •The peak p.d. is the difference in volts between the highest and the middle level of the waves. If the p.d. of an a.c. Supply is higher, the waves (peak p.d.) get higher.

Key Equations To Learn	
Energy, E	Energy = Charge x Potential Difference $E = Q \times V$
Charge, Q	Charge = Current x Time $Q = I \times t$
Power, P	Power = Energy ÷ Time $P = E \div t$
Power, P	Power = Current x Potential Difference $P = I \times V$
Power, P	Power = Current^2 x Resistance $P = I^2 \times R$

P6 Molecules and Matter Knowledge Organiser

Density, ρ	•The mass per unit of volume of a substance •Measured in kg/m³ •Dense materials are heavy for their size, i.e. Lead •To calculate the density, you need to measure the mass and the volume
Measuring volume	• For a regular object (like a cube), measure the dimensions using the right tool and use them to calculate the volume (e.g. l x w x h) •For an irregular object (like a stone), find out the volume of water it displaces using a Eureka can and measuring cylinder
Solid	•Particles are held next to each other in fixed positions •Particles have the lowest energy •Fixed shape and volume •Doesn't flow •Much higher density than a gas
Liquid	•Particles move around randomly and are in contact with each other •Particles have more energy than a solid •Fixed volume •Takes shape of container •Flows •Much higher density than a gas
Gas	•Particles move randomly, rapidly and are far apart •Particles have the highest energy •Volume can change as it spreads out to fill container •Flows •Low density
Melting point	•The temperature a pure substance melts at •A substance will solidify at the same temperature
Boiling point	•The temperature a pure substance boils at •A substance will condense at the same temperature •Boling happens throughout all of a liquid and only happens at the boiling point.
Evaporation	•Happens at the surface of a liquid below the boiling point

Internal Energy	•The energy stored by the particles of a substance •The particles have energy due to their individual motion and positions •Internal energy = KE due to individual motion relative to each other + PE due to their positions relative to each other •Higher temperature = higher internal energy •This is because the KE increases when temp increases •The PE of a substance increases if it melts or boils
Latent heat	•The energy needed for a substance to change state without changing the temperature
Specific Latent Heat of Fusion, L_f	•The energy needed to melt 1kg of a substance without changing the temperature •Measured in J/kg •E = mass x Specific Latent Heat of fusion •This is the same amount of energy if the substance is going from a liquid to a solid. •The particles need energy to break free from each other and this energy is the latent heat of fusion
Specific Latent Heat of Vaporisation, L_v	•The energy needed to boil 1kg of a substance without changing its temperature •Measured in J/kg •E mass x Specific Latent Heat of Vaporisation
Gas pressure	•This is caused by the particles of a gas colliding randomly with the walls of the container •In a sealed container, pressure increases if temperature increases because the particles move faster because they have more KE and so and hit the surfaces with more force and more times per second •Smoke particles move unpredictably because gas particles collide with them (Brownian motion)

Key Equations To Learn	
Density, ρ	Density = mass ÷ volume ρ = m ÷ V

P7 Radioactivity Knowledge Organiser (F)

Radioactive decay	•The nuclei of atoms contain protons and neutrons •Radioactive nuclei are unstable due to the balance of protons and neutrons. They decay (break down) by releasing nuclear radiation to become stable. •A random process- we can't predict or change how it happens.
Nuclear radiation	•Radiation released when radioactive substances decay •There are three kinds: alpha (α), beta (β) and gamma (γ) •The three types of nuclear radiation have different properties
Discovering the nucleus	•Rutherford fired α particles at gold foil. Most went straight through, some were deflected slightly and a few were deflected by more than 90^0 •Alpha particles are positively charged so something positively charged in the gold atoms must have been deflecting them. •Rutherford concluded that most of the mass of an atom must be located in the centre in a positively charged nucleus. •The plum pudding model of the atom said that the atom was a positively charged sphere with electrons dotted around inside it. Rutherford's discoveries showed that this couldn't be correct.
Atomic number, Z	•The number of protons in the nucleus of an atom. •Sometimes called the proton number •Usually the smaller number next to the element symbol in the periodic table
Mass number, A	•The number of protons + the number of neutrons in the nucleus of an atom •Usually the bigger number next to the element symbol in the periodic table •No of neutrons in a nucleus = Mass number – Proton number
Isotope	•Atoms of the same element with the same number of protons but a different number of neutrons •Same atomic number, different mass number

Alpha radiation	•A helium nucleus. •An alpha particle has a mass of 4 and a charge of +2. •When a nucleus decays and emits an alpha particle, the mass number of the original nucleus goes down by 4 and the atomic number goes down by 2. •The decay equation for alpha decay is •Alpha radiation is the most ionising nuclear radiation •Stopped by paper/skin (least penetrating) •Range of a few cm in air
Beta radiation	•A fast moving electron •Negatively charged •Zero (or negligible) mass •When a nucleus decays and emits a beta particle, the mass number stays the same but the proton number increases by 1 as a neutron changes into a proton. •The decay equation for beta decay is •Beta radiation is less ionising that alpha but more ionising than gamma •It is stopped by thin aluminium (second least penetrating) •Range of around a metre in air
Gamma radiation	•A wave of electromagnetic radiation •No charge as it is a wave •No mass as it is a wave •When a nucleus decays and emits a gamma wave, the mass number and atomic number stay the same. •Gamma radiation is the least ionising nuclear radiation •Mostly absorbed by thick lead •Unlimited range in air
Half life	•The average time taken for count rate of a radioactive isotope (or the number of radioactive nuclei) to fall by half. •Half life can be found using a decay curve graph . Find half the initial count rate on the y-axis, draw across to the curve then draw down and read the time off the x-axis.

P7 Radioactivity Knowledge Organiser (H)

Radioactive decay	•The nuclei of atoms contain protons and neutrons •Radioactive nuclei are unstable due to the balance of protons and neutrons. They decay (break down) by releasing nuclear radiation to become stable. •A random process- we can't predict or change how it happens.
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Alpha radiation	•A helium nucleus. •An alpha particle has a mass of 4 and a charge of +2. •When a nucleus decays and emits an alpha particle, the mass number of the original nucleus goes down by 4 and the atomic number goes down by 2. •The decay equation for alpha decay is •Alpha radiation is the most ionising nuclear radiation •Stopped by paper/skin (least penetrating) •Range of a few cm in air
Beta radiation	•A fast moving electron •Negatively charged •Zero (or negligible) mass •When a nucleus decays and emits a beta particle, the mass number stays the same but the proton number increases by 1 as a neutron changes into a proton. •The decay equation for beta decay is •Beta radiation is less ionising that alpha but more ionising than gamma •It is stopped by thin aluminium (second least penetrating) •Range of around a metre in air
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Half life	•The average time taken for count rate of a radioactive isotope (or the number of radioactive nuclei) to fall by half. •Half life can be found using a decay curve graph . Find half the initial count rate on the y-axis, draw across to the curve then draw down and read the time off the x-axis. •Count rate after n half-lives = initial count rate ÷ 2^n

P7 Radioactivity Knowledge Organiser (Triple)

Radioactive decay	•The nuclei of atoms contain protons and neutrons •Radioactive nuclei are unstable due to the balance of protons and neutrons. They decay (break down) by releasing nuclear radiation to become stable. •A random process- we can't predict or change how it happens.
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Radioactive Tracers	•Trace the flow of a substance through an organ •The tracer emits gamma radiation as these are penetrating enough to be detected outside the body. •Radioactive iodine is used to check if the kidneys are working properly. •Radioactive iodine is used because it has a half life of eight days, it emits gamma radiation and it decays into a stable isotope.
Gamma camera	•This images internal organs •The patient is injected with an isotope that emits gamma radiation. The isotope is absorbed by the organs and detected by the gamma camera. •The isotope used needs to have a half-life long enough to allow the image to be taken but must have a short half-life so that it decays quickly.
Gamma beam	•This is a narrow beam of gamma radiation used to destroy tumours without surgery •The gamma radiation is emitted by a radioactive isotope of cobalt
Radioactive implants	•A tiny rod or seed of a radioactive isotope is implanted in a tumour to kill cancerous cells. •The isotope is a beta or gamma emitter. •The half life needs to be long enough so that the cancer cells get irradiated but short enough that the isotope decays soon after treatment is finished.
Nuclear fission	•When the nucleus of an atom splits apart into two smaller nuclei and two or three neutrons. Energy is also released.
Induced fission	•This is when a nucleus absorbs a neutron, causing is to become unstable. •The nucleus breaks down into two smaller nuclei and two or three neutrons are released •Nuclear reactors use the fission of Uranium-235 or Plutonium-239
Spontaneous fission	•When a fission happens to a nucleus without it absorbing a neutron first •Rare!

Chain reaction	•When the neutrons released from fission collide with other nuclei, causing them to undergo fission. •Each fission event causes further fission events..
Nuclear reactor	•Uses the chain reaction of fission to release energy from Uranium-235 or Plutonium-239 •The nuclear energy released heats water in a heat exchanger. •The reactor core has the fuel rods, control rods and water at high pressure. The fission neutrons collide with the water molecules, slowing them down. The water acts as a moderator. •Control rods are used to stop the reaction from going out of control •The control rods absorb neutrons so that on average only one neutron from each fission event goes on to cause more fission.
Nuclear fusion	•When two nuclei are forced together to produce a single, larger nucleus. •Energy is released as some of the mass of the small nuclei is converted into energy •The nuclei need to be moving very fast for fusion to occur. •Nuclear fusion happens in stars
Background radiation	•Natural sources: rocks and cosmic rays •Man-made sources: nuclear fallout and nuclear accidents •Varies due to location •Radon gas causes a lot of the background radiation in the air. It seeps into houses through the ground. It is an alpha source.

P8 Forces in Action Knowledge Organiser (F)	
Vectors and scalars	•A vector is a quantity that has magnitude (size) and direction, e.g. , weight, forces, acceleration, momentum, displacement •Vectors can be represented using arrows that show the size and direction of the quantity •A scalar quantity has only size and no direction, e.g. Temperature, energy, distance, mass, time
Forces and Newton's Third Law	•Force is measured in Newtons, N •Forces can change the shape or motion of an object. A force can also act to change the state of rest of an object (i.e make it start moving!) •Newton's Third Law says that when two objects interact, they exert equal and opposite forces on each other
Resultant force	•A single force that has the same effect as all the forces acting on an object •To find the resultant force when two forces act on an object along the same line, add them together if they act in the same direction or work out the difference if they act in opposite directions.
Newton's First Law	•If the forces acting on an object are balanced, the resultant force acting on it will be zero and it will move at the same speed in the same direction, or remain stationery if at rest.
Centre of mass	•This is the point where the mass of an object is thought of as being concentrated •In uniform objects, i.e. a ruler, the centre of mass is at the midpoint •If an object is freely suspended, it will come to rest with the CoM directly underneath where it is suspended from. This is a way to find the centre of mass of a non-uniform object.

P8 Forces in Action Knowledge Organiser (H)

Vectors and scalars	•A vector is a quantity that has magnitude (size) and direction, e.g. , weight, forces, acceleration, momentum, displacement •Vectors can be represented using arrows that show the size and direction of the quantity •A scalar quantity has only size and no direction, e.g. Temperature, energy, distance, mass, time
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Resultant force	•A single force that has the same effect as all the forces acting on an object •To find the resultant force when two forces act on an object along the same line, add them together if they act in the same direction or work out the difference if they act in opposite directions. •We can use a free body force diagram to show the forces acting on an object and therefore work out the resultant force.
Newton's First Law	•If the forces acting on an object are balanced, the resultant force acting on it will be zero and it will move at the same speed in the same direction, or remain stationery if at rest.
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Parallelogram of forces	•A scale diagram of two force vectors used to find the resultant of two forces that don't act on the same line. •The resultant force will be the diagonal of the parallelogram that starts where the two force arrows start.
Resolving forces	•When we know the resultant force, we can split it back up into the two forces that are acting at $90^0$to each other to give that resultant force. •Turn the force arrow into a rectangle. The force arrow forms the diagonal of the rectangle like a vector. The long and short sides are therefore the forces that add up to give the vector. We can use trigonometry or ratios to find the size of each side. •If an object is in equilibrium, the resultant force acting is zero. Objects at rest are in equilibrium.