P15 Electromagnetism Knowledge Organiser (Triple)

Magnetic poles	•The region of a magnet where the magnetic field is strongest •A magnet has a north pole and a south pole •Like poles repel and unlike poles attract
Permanent magnetism	•Permanent magnets produce their own magnetic field •Permanent magnets are made using steel as steel doesn't lose its magnetism easily once it has been magnetised.
Induced magnetism	•When a material temporarily becomes a magnet when placed in a magnetic field. •Always causes a force of attraction •An induced magnet loses its magnetism when removed from a magnetic field
Magnetic field	•The region around a magnet where a magnet or a magnetic material experiences a force •Field lines always go from the N pole to the S pole. •To find the field around a bar magnet, use iron filings or a plotting compass. •The further you go away from the magnet, the weaker the field. •The field is strongest at the poles of the magnet •The Earth has a magnetic field similar in shape to a bar magnet's field. A compass contains a small bar magnet that lines up with the field and so points in the same direction as it.
Magnetic fields of electric currents	•When current flows in a wire, a magnetic field is set up around the wire. •The field is made up of concentric circles with the wire in the centre. •Higher current = stronger field •The field gets weaker further away from the wire. •The direction of the field depends on the direction of the current. •Use the Right Hand Grip rule to find the direction of the current. Your thumb points in the direction of the current (positive palm, negative nail) and your fingers will curl around in the direction of the current.

Solenoids	•A coil of wire that has a much stronger magnetic field than a straight wire. •When current flows through a solenoid, a magnetic field is set up. •The field is uniform inside the coils as all of the lines are parallel and gets weaker as the distance from the solenoid increases. It is also strongest inside the coils. • At the N pole of the solenoid the current flows anti-clockwise and at the S pole it flows clockwise •To increase the strength of the field, increase the current or increase the number of coils. •If the current is reversed the field also reverses.
Electromagnet	•A coil of wire (a solenoid) wrapped around an iron core •Iron is used because it loses its magnetism easily when the current is switched off
Electromagnets in Devices	•A scrapyard crane uses an electromagnet to lift scrap metal. When current passes through the electromagnet, a magnetic field is induced so the steel bodies of vehicles are attracted to it. When the current is turned off, the magnetic field isn't there anymore and so the crane drops the metal. •In a circuit breaker, an electromagnet is in series with a switch held closed by a spring. When a large enough current passes through the circuit a strong enough magnetic field to pull the switch open is induced and so the circuit breaks. •An electric bell uses an iron armature and an electromagnet to operate a make and break switch. When the circuit is connected, the armature is pulled towards the electromagnet, opening the switch. The electromagnet is also switched off and so releases the armature, starting the cycle again. •A relay switch is a safety device that allows a circuit with a small current to switch on another much higher current one.

P15 Electromagnetism Knowledge Organiser (Triple)

The motor effect	•When a force acts on a current carrying wire in a magnetic field. •This happens because the permanent magnetic field of the magnet interacts with the induced magnetic field around the current carrying wire . •Fleming's Left Hand Rule tells us the direction of the force: Thu**m**b = **m**otion, **fi**rst finger = direction of the **fi**eld and se**c**ond finger = direction of the **c**urrent. •Increase Force by increasing the current or using a stronger magnet. •The force is greatest when the wire is perpendicular to the magnetic field and zero when it is parallel to the field. •**F= BIl** allows us to calculate the size of the force. F is the force in N, B is the magnetic flux density in T (Tesla), I is the current in A and l is the length of wire in m.
Electric Motor	•This is a coil of current carrying wire that spins in a permanent magnetic field because the permanent and induced fields interact. •It spins because a force acts in opposite directions on each side of the coil due to the motor effect. •A split-ring commutator reverses the current direction every half turn.
The Generator Effect	•When a conductor crosses magnetic field lines, a potential difference is induced across the conductor. This is electromagnetic induction. •If the conductor is part of a circuit, a current will flow as a result of the induced potential difference. This is the generator effect. •If the conductor crosses the field lines at 90°, then the maximum p.d. is induced. If the conductor crosses the field lines parallel to them, no p.d. is induced. •The faster the conductor moves, the bigger the induced p.d. •The p.d. is only induced while the conductor is moving •The direction of the induced current will always oppose the change that caused it.

AC Generator	•An AC generator (or alternator) is a coil of wire spinning in a uniform magnetic field •Because the magnet spins and therefore changes direction, an alternating p.d. is generated. •When connected to an oscilloscope, the p.d gives a waveform in the shape of a sine wave. •The induced p.d is maximum when the sides of the coil cross directly through the magnetic field lines •The induced p.d. is zero when the sides of the coil move parallel to the field lines. •A dynamo uses a split ring commutator to reconnect the coil the opposite way round every half turn. This means that a direct current is generated.
Transformers	•Transformers increase or decrease the size of an alternating p.d. •Step-up transformers increase the p.d •Step-down transformers decrease the p.d. •In a transformer, there are two coils of wire connected to an iron core. •Iron is used because it is easily magnetised and demagnetised •When an alternating current flows in the primary coil, a magnetic field is induced in the core. The magnetic field is also alternating and so constantly changes direction. •The alternating magnetic field in the core causes an alternating current to be induced in the secondary coil.
Using Transformers	•Transformers are used in the National Grid to make power transmission more efficient by having a high grid p.d to reduce the current needed. •The transformer equation can help us to work out the number of coils or the p.d in either the primary or secondary coil: $\frac{V_p}{V_s} = \frac{N_p}{N_s}$ •In a step up transformer, N_s is greater than N_p so V_s is greater than V_p •If a transformer is 100% efficient, then $V_p \times I_p = V_s \times I_s$