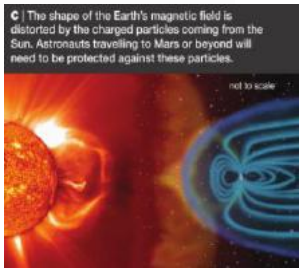
Year 8 Autumn Term – 9J: Forces fields and Electromagnets

Section A: Key Vocabulary	
Keyword	**Definition**
attract	Two things pulling towards each other are said to attract.
force field	The volume around something where a non-contact force can affect things. Examples are electric, magnetic, and gravitational fields.
magnetic field	The space around a magnet where it can affect magnetic materials or other magnets.
repel	To push away.
electric field	The space around an object with a charge of static electricity where it can affect other objects.
electric current	A flow of electrons around a circuit.
resistance	A way of saying how difficult it is for electricity to flow through something.
decimal place	The position of a digit to the right of the decimal point in a number. The number of decimal places in a number is the number of digits after the decimal point.
significant figure	The first significant figure in a number is the digit with the highest place value, the second significant figure has the second highest place value and so on.
relay	A switch that is turned on and off without a person touching it. One type of relay uses a small current to make an electromagnet close the contacts in a circuit that carries a much larger current.

Section B: Content

Force fields

The space around a magnet where it can attract magnetic materials is called a **magnetic field**. A bar magnet has two ends, called the north pole and the south pole. Two north poles or two south poles will repel each other. A north pole and a south pole will attract each other.

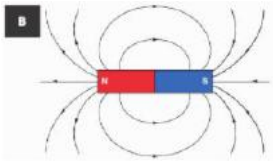


C | The shape of the Earth's magnetic field is distorted by the charged particles coming from the Sun. Astronauts travelling to Mars or beyond will need to be protected against these particles.

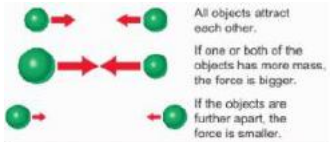
not to scale

The Earth's magnetic field helps to protect it from charged particles emitted by the Sun. However, the shape of this field is altered by the Sun.

Force fields



You can find the shape of a magnetic field using iron filings or small compasses. The arrows show the direction a north pole would move. The field is strongest where the lines are closest together.



D | The force of gravity between two masses depends on the strength of their gravitational fields, and on how far apart they are.

Any object that has **mass** has a **gravitational field** around it. When two objects are in each other's gravitational field, they attract each other.

The **gravitational field strength** (g) of the Earth is approximately 10 N/kg. This means that the force of attraction between the Earth and a 1 kg mass is 10 N. We call this force the **weight** of the object:

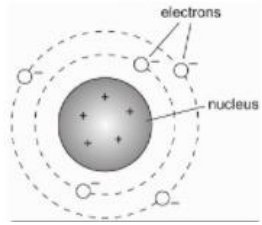
weight (N) = mass (kg) x g (N/kg)

Section C: Content

Static electricity

People sometimes get small shocks when touching metal railings, doorknobs or car doors. Shocks like this are caused by **static electricity**. A charge of static electricity can build up when two different materials rub together. Sparks caused by static electricity can cause fires or damage electronic equipment.

Atoms consist of a central **nucleus** with small particles called **electrons** moving around it. The nucleus has a **positive charge** and each electron has a **negative charge**. The total positive and negative charges in an atom are usually the same, so they balance each other and the atom has no overall charge.



C | The effect of rubbing two different insulating materials with a cloth. The charges stay where they are when they have been transferred.

Static electricity

Two charged objects can attract or repel each other. If the charges are the same (two positively charged objects, or two negatively charged ones) they will repel each other. If the two objects have opposite charges they will attract each other.

Positive and negative charges can become separated when a conducting material (such as metal) is rubbed. However, the charge spreads out over the whole of the metal object, so we do not usually notice the charge.

E | This person has a charge of static electricity.

F | Electric field around a negative charge. The arrows show the direction in which a positive charge would move.

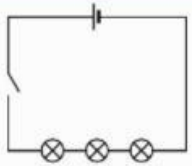
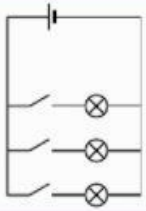
The space around a charged object where it has an effect is an **electric field**. The field is strongest close to the object. Diagram F shows one way of representing the electric field around the end of a rod with a negative charge.

Year 8 Autumn Term – 9J: Forces fields and Electromagnets

Section D: Content

Current Electricity

B | Circuits can be series circuits or parallel circuits.

Series circuits	Parallel circuits
	
The current is the same everywhere in the circuit.	The current through the cell splits up when it comes to a junction.
All the bulbs go off when the switch is opened.	Each bulb can be controlled individually.
If you add more bulbs in series, the current in the circuit is reduced and the bulbs are dimmer.	If you add more bulbs in parallel, the bulbs all stay at the original brightness. The current through each bulb stays the same.

Measuring electricity

We use an **ammeter** connected in series to measure the current flowing through a circuit. The units for current are **amperes** (A).

The **voltage** across a cell is a measure of the energy provided by the cell. We measure voltage using a **voltmeter** connected in parallel to a component; we say that a voltmeter is connected *across* a component. The units for voltage are **volts** (V).

D | A 'multimeter' can be used to measure different quantities. Here it is being used as a voltmeter. The probes are being used to measure the voltage across a component on the circuit board.

The voltage across a component is a measure of the energy transferred by that component. In circuit C the bulb is transferring more energy than the motor, because the voltage across it is higher. The voltages across all the components add up to the voltage across the cell.

In a parallel circuit, the voltage across each branch of the circuit is the same as the voltage provided by the cell. In circuit E both bulbs have a voltage of 3 V across them.

Section E: Content

Resistance

The size of the current flowing in a circuit depends on the voltage of the cell or power pack, and on how easy it is for current to flow through the components in the circuit.

The **resistance** of a component is a way of saying how easy or difficult it is for current to flow through it. The current in a circuit can be controlled by changing the resistance of the components. Resistance can be added to a circuit using components called **resistors**.

The resistance of a wire depends on how long it is, how thick it is and on the metal it is made from.

- Longer wires have a higher resistance than shorter wires.
- Thin wires have a higher resistance than thick wires.

All metals conduct electricity, but some metals conduct it better than others. Copper, silver, gold and aluminium are the best conductors.

Insulating materials have very high resistances.

B | This electric fence will give a small shock to anyone touching the wire.

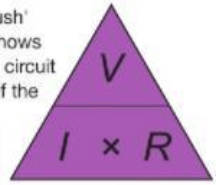
Calculating Resistance

The units for measuring resistance are **ohms**, and the symbol is the Greek letter omega (Ω).

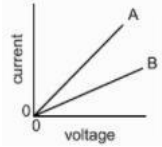
Voltage, resistance and current are related by this formula:

voltage (V) = current (A) × resistance (Ω)

The voltage of a cell is what helps to 'push' charges around a circuit. This formula shows that the voltage you need to supply to a circuit increases if you need a large current or if the circuit has a high resistance.



The resistance of a component is the ratio of the voltage (potential difference) across it to the current flowing through it. A graph of current against voltage is a straight line.



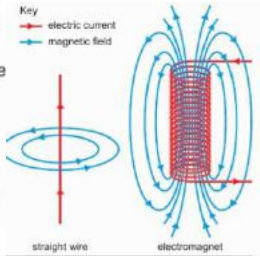
F | Current–voltage graph for two resistors. The graph shows that current is directly proportional to voltage.

Section F: Content

Electromagnets

A wire with an electric current flowing through it has a magnetic field around it. The strength of the field increases if the current increases. The direction of the field changes if the direction of the current changes.

When the wire is wrapped into a coil, the magnetic field is a similar shape to the magnetic field of a bar magnet. The directions of the north and south poles of an electromagnet depend on which way the current is flowing through the wires.

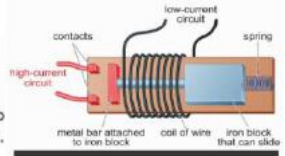


B | The magnetic field around a wire and an electromagnet. There is only a magnetic field while the current is flowing.

You can increase the strength of an electromagnet by:

- increasing the number of coils of wire
- increasing the current in the wire
- using a magnetic material as a 'core' inside the coil of wire.

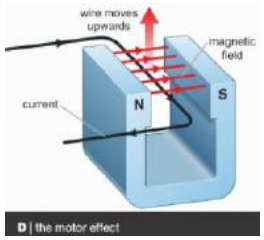
Electromagnets have many uses. **Relays** (as shown in diagram C) can improve safety by using a small current to switch on a circuit that carries a much bigger current. This means that people do not have to touch any part of the circuit carrying the large current.



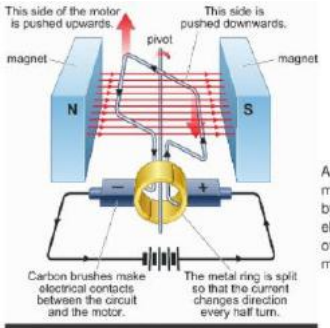
C | an electromagnetic relay

Electric motors

A current flowing through a wire creates a magnetic field around it. If the wire carrying the current is placed in the magnetic field of a magnet, the two magnetic fields affect each other and the wire experiences a force. This is known as the **motor effect**. The direction of the force depends on the directions of the current and the magnetic field. This only happens when the wire cuts across the magnetic field.



D | the motor effect



E | This is a simplified diagram of an electric motor, as a real motor would have a lot more turns of wire on the coil.

An **electric motor** consists of a coil of wire in a magnetic field. The magnetic field can be produced by permanent magnets (as shown in diagram E), or by electromagnets. When a current flows through the coil of wire, the combination of the magnetic field from the magnets and from the coil makes the coil spin.