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NATURAL SCIENCES GRADE 9 TERM 3

Core concepts

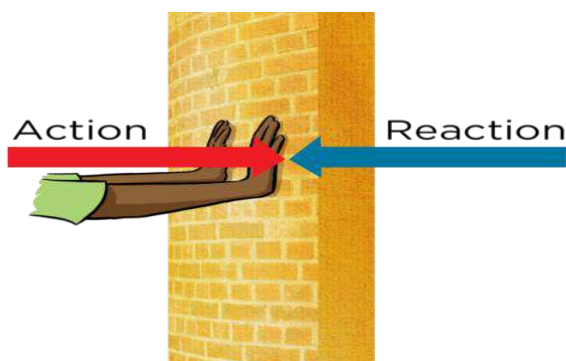
- Types of forces
- Contact forces
- Field forces (non-contact forces)

TOPIC 1: FORCES: [3 WEEKS]

- A **force**: is an **action** that can be described as a **push or a pull** (or **twist**).
- A force has a *size and a direction* & we represent forces by means of *arrows*.
- The *force decreases* as the *distance between objects increases*.

PAIRS OF FORCES

- Forces act in pairs, for example **when a force is applied to an object**, the *object resists the force* eg if you push against a wall, the wall resists as if it is pushing back.
- These 2 forces are known as a **Force pair** and *act in an equal but opposite direction*.
- Whenever one object exerts a force on a second object, the **second object exerts a force back on the first object** eg *when you pushed against a wall, therefore forces act in pairs*.



- Newton called the one force the **action**, and the other force the **reaction**, as shown in the following diagram above.
- We *measure a force* by using an *instrument* called a **Spring balance**. When spring balance is **stretched, gives a reading of the force used to stretch the spring**



Figure 1 Spring balance

- The *strength of a force is measured* with a **Newton meter**, which is similar to a spring balance.

WEIGHT

- **Weight:** is the **force (of gravity)** with which the **earth attracts (pulls down) an object**. It is the **heaviness of an object**.
- The **weight of an object** is **proportional to it's mass**: the **greater the mass, the greater the weight**. Relationship is represented as follows:

$$W = mg$$
 - W represents **weight in Newtons (N)**, m represents **mass in kg**, g represents **gravitational acceleration on earth** which is **9.81 m/s²** rounded as (**10**).

Example calculate the weight of a person who has a mass of 120 kg

a) On earth

b) On the moon where gravitational acceleration (g) is 1.6

SOLUTIONS

$$\begin{aligned} a) \quad W_{\text{earth}} &= mg \\ &= 120 \text{ kg} \times 10 \\ &= 1\,200 \text{ N} \end{aligned}$$

$$b) \quad W_{\text{moon}} = mg$$

$$= 120 \text{ kg} \times 1.6$$

$$= 192 \text{ N}$$

DIFFERENCES BETWEEN MASS AND WEIGHT

MASS	WEIGHT
Mass is a measure of the quantity of matter in an object.	Weight is a measure of the size of force of gravity acting on the mass of an object.
Mass is measured in kilograms (kg)	Weight is measured in Newtons (N).
The <i>mass of an object</i> is the <i>same anywhere in the universe</i> .	The weight of an object is different in different places in the universe.
The mass of an object does not depend on the size of the gravitational force on it.	The weight of an object depends on the size of the gravitational force on it.

- The weight of the same objects would be less on the Moon than on the Earth because, the *force of gravity on the Moon is less than the force of gravity on Earth*.

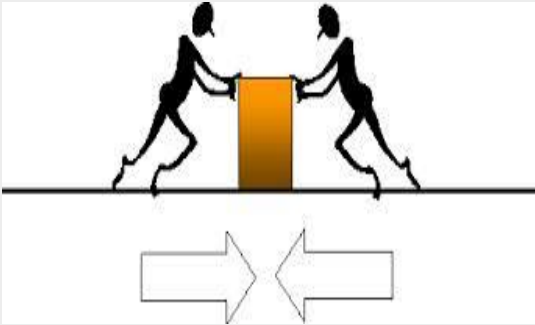
EFFECTS OF FORCES

1. Forces can **change the shape** of an object. This is called *deformation*.
2. Forces can **change the motion** of an object. If an object is stationary, a force can cause the object to start moving. Or, if an object is already moving, a force can cause an object to speed up or slow down.

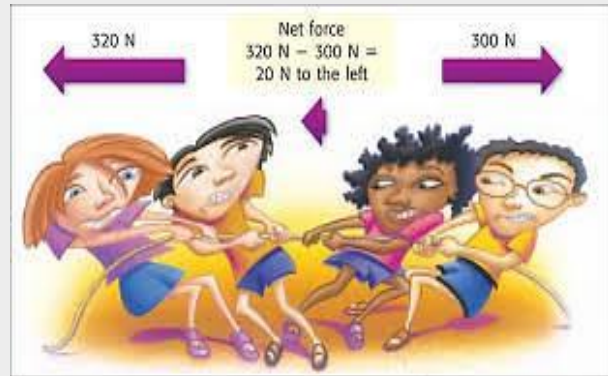
FORCE AND MOTION

- 1) **Equal but opposite** forces = NO movement (stationary) → this is because the forces are **balanced** and the system is in **equilibrium**. Or if the object is already moving, it will continue to move at the same speed in the same direction. *Balanced forces cancel each other*.
- 2) If a **body is at rest** and an unequal force acts upon it, the body will **move** in the direction of the bigger force → forces are **unbalanced**

and a **resultant force** is present, producing a change in speed or direction



VS



- Forces is **measured** in units called **Newtons**.
- There are **2 main types** of forces - *contact forces and non-contact forces*.

CONTACT FORCES

- **Contact forces:** are forces where the bodies that are *exerting a force on each other* are in *direct contact with each other* or *touch each other*. Examples are Tension, compression, torsion, shear, bending and friction.
- 1) **Tension** - is a *pull force*. Tensile forces tend to **stretch an object** because they *act away from each other*
 - 2) **Compression** - is a *push force*. It tends to *compress (squash, flatten) an object* because they *act towards each other*.
 - 3) **Torsion** - *causes twisting of an object* e.g. unscrewing a bottle cap. There are two forces, acting in opposite directions around a common centre.
 - 4) **Shear** - forces *act at right angles to an object* with a tendency to cut or slice an object. A pair of scissors or garden shears tend to cut, since the forces exerted by the blades act at right angles to the object.
 - 5) **Bending** - **2 sets of forces**, one set of tensile force and one set of compressive forces. The tensile forces tend to stretch one side of the object, while the compressive forces tend to compress the opposite side. This results in the bending of the object.

6) Friction- force occurs wherever **2 surfaces meet & one surface slides or tends to slide over another surface.**

- Frictional force always *acts opposite to the direction of motion.*
- The *strength of frictional force is determined by the weight of an object & the roughness/smoothness of a surface.*

▪ **Demonstration:** A boy pulling on a block with a rope

ADVANTAGES OF FRICTION

a) It is used in *brakes to slow down and stop a car.*

b) Friction is also involved in keeping cars from skidding as the tyres experience friction between the tread and the roadway.

c) In *friction of a match against a matchbox causes the match to ignite.*

d) Friction **between our feet and the ground enables us to move forward and prevents us from slipping.**

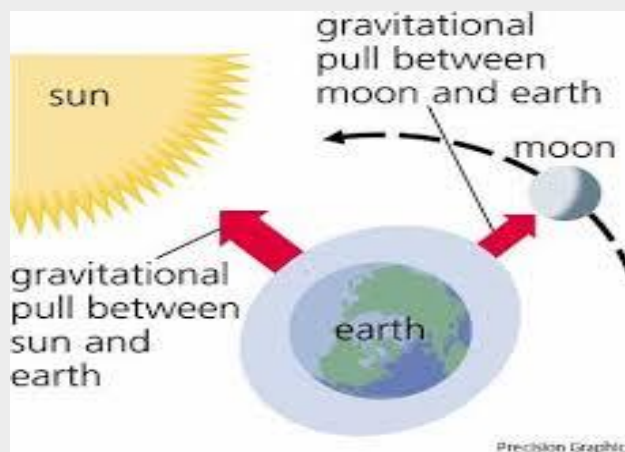
❖ The *main disadvantages* of friction are that it *produces unnecessary heat in machinery*, and that it *slows down the motion of moving objects.*

NON-CONTACT FORCES

- **A non-contact force:** is a force that is *exerted over a distance*. It is also called a *field force*.
- Field forces are the *result of an attracting or repelling force* of one object on another object, *without the objects touching each other*.
- **Examples** of field forces are: *gravitational force, magnetic force, electrostatic force.*
- Use the **magnet and steel pin** to *demonstrate the attraction of the pin by the magnet*. Objects do not have to be touch for the force to take effect.

1. GRAVITATIONAL FORCE

- **Gravitational force:** is a *pulling force* that bodies exert on each other over a distance due to their masses.
- The Earth's gravitational force pulls everything down **towards the centre of the Earth** which is why when you drop an object like a book or an apple, it falls to the ground.
- The **Earth attracts us** because it has such a **large mass** and so we are *attracted downwards towards the centre of the Earth all the time*.
- The **bigger the mass of the objects**, the **greater the force between them**.
- **2 small objects** would have a **very weak gravitational attraction**, while **bigger objects** such as the Moon and the Earth have a much **greater gravitational force**.
- The **second factor** which affects the gravitational force of attraction between objects is the **distance between them** (The **further objects are away from each other**, the **smaller the gravitational force**).
- **All the components in our Universe are held together by a gravitational force.**

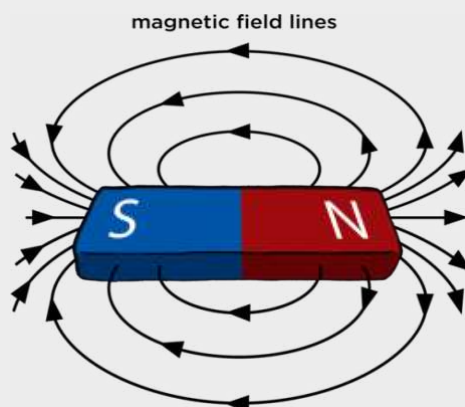
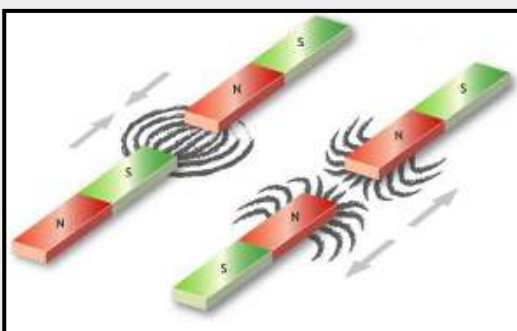


2. MAGNETIC FORCE: (A FIELD FORCE)

- **A magnetic force:** is a force that *2 magnetic materials exert on each other over a distance.*
- **A force of attraction** is a *pulling force* that 2 objects exert on each other.
- **A force of repulsion:** is a *pushing force* that 2 objects exert on each other.
- **A magnetic field:** is an *invisible area of magnetism around a magnet.* A magnet has a magnetic field around it.
- A magnet has *2 magnetic poles*, a north pole (N) and a south pole (S).
- The *magnetic field is strongest near the poles* of a bar magnet.
- Opposite poles attract, like poles repel.
- The magnetic compass can indicate the Earth's magnetic north pole.
- You can **demonstrate the magnetic field and forces of a magnet** by using the *2 bar magnets, metals and non-metals, iron filings and sheet of paper.*

The magnetic field around a horseshoe magnet.

- The pattern you saw with your magnets can be represented by **field lines**. The closer the field lines are drawn together, the **stronger the field being described.**
- The **more field lines that are drawn, the stronger the field.** **The field lines go from the north pole to the south pole.** The following diagram shows the field lines around a bar magnet.



ELECTROSTATIC FORCE: (A FIELD FORCE)

- *Electrostatic force: is the attracting or repelling force between electric charges near one another.*
 - *Charges or charged objects that are placed near one another have “**electric potential energy**” & **exert a force on one another***
 - *Like charges (+ and + or – and -) repel each other, while unlike (opposite) charges (+ and -) attract each other.*
- a) An **atom** consists of a *nucleus* with a *cloud of negatively charged electrons* spinning around it.
 - b) *Inside the nucleus* there are positively charged protons and neutral neutrons.
 - c) The *electronic charge* of substances can be *changed by rubbing 2 substances together*.
 - d) If *electrons are removed* (usually by rubbing one substance against another), then the atom *becomes positively charged*, because there are more protons than electrons in the atom.
 - e) If *electrons are added*, then the atom becomes *negatively charged*, because there are *more electrons than protons in the atom*.
- ❖ **To investigate electrostatic force fields**, use Perspex or glass & rub it with a woollen cloth, it loses electrons and becomes positively charged. If plastic is rubbed with a woollen cloth, it gains electrons and becomes negatively charged.

STATIC ELECTRICITY

- 1) **Static electricity:** is the *build-up of an electric charge* in a certain location. It *stays in one place and does not move*.
- 2) *Electrons that move away* from their atoms *cause static electricity*.
- 3) Two things with opposite charges will attract each other, while things with the same charge will repel each other. **A charged object will also attract something that is neutral.**

LIGHTNING

- **Potential energy:** is energy that is *stored* in a system.
 - *Static electricity* has **potential energy** because it can do work.
 - *Clouds* are made up of **water molecules, ice and air**.
- a) The *movement of the water, ice and air particles* in the clouds cause them to **rub against each other** *causing friction* [resulting in clouds to be charged).
 - b) The **positive charges build up at the top of the cloud** and the **negative charges build up at the bottom of the cloud** (closest to the ground)
 - c) When the **build-up of charge** becomes too large, the **electrons move from the bottom of the cloud to the ground where they are "earthed"**.
 - d) The energy transfer is **massive** and results in extremely bright light, heat and sound.
 - e) A Lightning (**a giant spark** of electricity) can occur *within a cloud* (between the top and bottom of the cloud), *between clouds*, and *between a cloud and the ground* and **causes thunder**.
 - f) A lightning bolt opens up a channel in the air.
 - g) Once the light is gone, the **air expands** into the channel and **creates a sound wave** that we *hear as thunder* (*air moving as a result of electrons moving*).

NB: We see lightning before we hear thunder, because **light travels faster than sound**.

- The *energy in a lightning bolt is very high* and **can cause death**
- Lightning is **extremely dangerous**. If the **electrons move through a person on their way to the ground**, then the **large amounts of energy cause significant damage**. That person can suffer serious injury, even death.

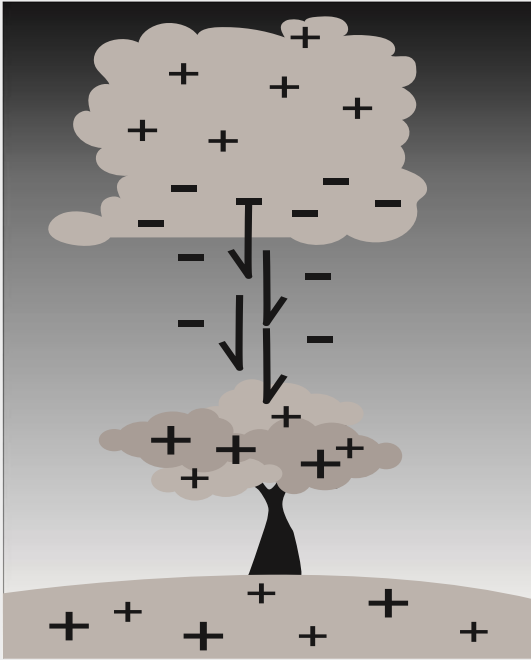


Figure 2 Lightning

SAFETY PRECAUTIONS AGAINST THUNDER

- i. The **safest place to be in a lightning storm is indoors.**
- ii. Stay away from **windows and metal objects.**
- iii. Avoid standing **next to tall objects or metal objects** because if lightning strikes it will usually hit the tallest object in the area.
- iv. If you are travelling in a car during a storm, **stay inside the car until the storm subsides.**
- v. Installing a lightning conductor;
- vi. Staying away from water and tall trees and structures;
- vii. Avoiding swimming, showering and bathing;
- viii. Avoiding using appliances that conduct electricity.

TOPIC 2: ELECTRIC CELLS AS ENERGY SYSTEMS **1 WEEK**

Core concepts

- **Electric cells**
- **Inside the cell**, there are *certain chemicals*, once the *cell is connected to a circuit*, a spontaneous chemical reaction takes place, this *causes electrons to collect at the one terminal* (Negative terminal) of the cell.
- **Electrons** are then *withdrawn from the other terminal* (positive terminal), *chemical energy is converted to electrical energy*.
- When a *cell is connected to an external circuit* the *chemical substances react with each other*. The reaction produces an *electric charge* with *high potential energy*. Positive is red, while negative is black.
- A cell *stores chemical* substances as **potential energy**.
- **Electrical charge**: type of charge; either positive, negative moves from the cell along the conducting wires of the circuit has high **kinetic energy**. **Electrical energy** is a *form of kinetic energy*.
- The *electrical charge with high kinetic energy* moves from the *cell to a resistor* (light bulb) that uses this kinetic energy/ electrical energy *to light up*.

ELECTRIC CURRENT

- 1) **Current** (symbol I).: *flow rate of the electrons* in the circuit. It is *electricity in motion*.
- 2) When **electrons move**, they *carry electrical energy from one place to another*. This is called **current electricity** or an **electric current**.
- 3) Electrical current is *measured* in **amperes (A)** or "amps".
For example, 20A is a bigger current than 5A.
- 4) Current is measured by a **device** called an **ammeter** that is *always connected in series*.
- 5) When *more current flows* through the *light bulb and it will glow brighter*

TOPIC 3: RESISTANCE [1 WEEK]**Core concepts**

- Uses of resistors
- Factors that affect resistance in a circuit
- **Resistance:** *material opposes the flow/ movement of charge* through a substance.
- **Resistors:** are *electrical components* or conductors that help **control/ oppose the flow of current** in a circuit.
- A resistor in a circuit **controls the amount of current** and *provide useful energy transfer like heat or light*
- **Examples** of resistors are **bulbs, rheostats and motors**.
- **High resistance** means there is **less current** available for a given voltage.
- **Rheostat:** resistor in which the **resistance can be manually changed**. Also called a variable resistor
- *In a resistor the resistance is fixed.*
- *Electrical current can flow freely through a conductor in a circuit.*
- *A resistor restricts the movement of an electrical current in a circuit.*
- The **unit of measurement for resistance** is the **ohm**, with the **symbol Ω**

FACTORS THAT AFFECT RESISTANCE IN A CIRCUIT

Length of the conductor	The longer the conductor, the higher the resistance
Thickness of the conductor	The thinner the conductor, the higher the resistance
Temperature of the conductor	The resistance of most metals increases with increasing temperature
Type of material	Some metals, for example copper, are better conductors than other metals, such as nichrome. The higher the conductivity, the lower the resistance.

TOPIC 4: SERIES AND PARALLEL CIRCUITS **2 WEEKS!**

Core concepts

- Series circuits
- Parallel circuits

SERIES CIRCUITS

- A **series circuit**: provides only one pathway for current to flow.
- 1) The **current** is the *same everywhere* along the circuit. That means that *the current flowing through each component in a series circuit is the same*.
 - 2) **Cells** or **resistors** can be connected in series in a circuit.
 - 3) Cells connected in series is called a **battery**.
- ❖ **Example:**



Cells in series

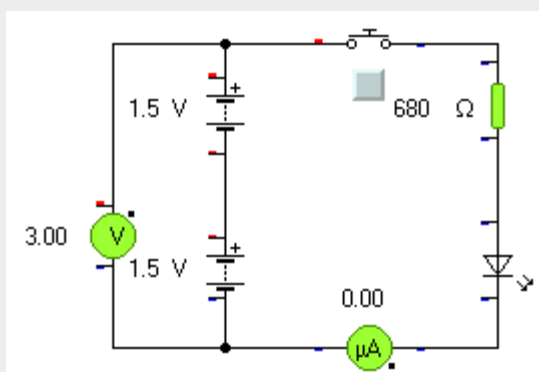


Resistors in series

CELLS IN SERIES

- 1) *Positive pole of one cell is connected to a negative pole of another cell*
- 2) *The total emf (total voltage) of battery is equal (=) to the sum of the emf of individual cells.*

$$\text{Emf (battery)} = 1.5 \text{ V} + 1.5 \text{ V} = 3 \text{ V}.$$



- 3) As we *add cells in series*, the **voltage** in the circuit will *increase*.

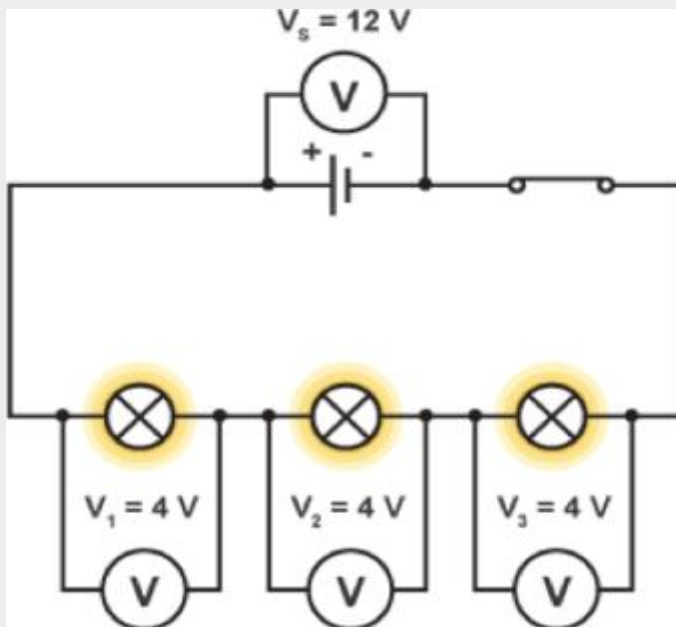
NUMBER OF CELLS	VOLTMETER READING (V)	BRIGHTNESS OF LIGHT BULBS
1	1.5	dim
2	3	brighter
3	4.5	brightest

VOLTAGE/ POTENTIAL DIFFERENCE

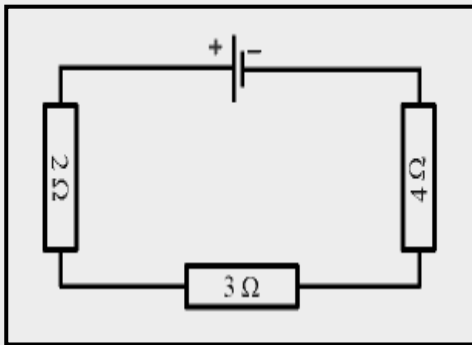
- 1) **Potential difference:** the *difference in electric potential energy* per unit of charge ***between 2 points in a circuit.***
 - **Voltage:** is the *electric force* (Electromotive Force/EMF") *that pushes the free electrons to move from one atom to another.*
 - The emf/ Voltage ***indicates how much energy is stored in the cell & transferred to the charges*** (electrons) as they leave the cell.
- 2) Potential difference/voltage/emf's symbol is **V**, and is measured in **Volts (V)**. **Example** a single cell from a **flashlight** creates an electrical force of 1.5 Volts, **radio battery** creates an electrical force of 9 Volts.
- 3) Potential difference is **measured** with a **Voltmeter** which is ***always connected in parallel*** with the component in the circuit,
 - Voltage is usually ***supplied by a battery or a generator.***
 - A **volt** is the measure of **electric pressure**.
- 4) You can ***measure the voltage across a cell or battery*** using a voltmeter; the ***more cells in series connected, the bigger the voltage.***
- 5) The ***supply voltage is divided (shared) between the components.***

RESISTORS IN SERIES

- 1) Resistors in series *share the total voltage/* potential difference & serve as *Potential dividers*.
- 2) The *ammeter readings are the same anywhere in the series* circuit and it is referred to series resistors as **potential dividers**.
- 3) The *current strength decreases* as the *number of resistors in series increases* & therefore the *total resistance increases*. NB: *The more light bulbs connected in series, the dimmer they glow*.
- 4) The **unit of measure** for resistance is the **ohm (Ω)**.
- 5) The *total voltage across the battery* is *equal* to the *sum of voltages across each resistor in the circuit*.



- 6) A resistor that has a *high resistance* will have a *higher voltage across it* & resistor that has a *lower resistance* will have a *lower voltage across it*.
- 7) The **current** in the circuit *decreases with each resistor* that is *added*.
- 8) You can *calculate the total resistance of a series* circuit by *adding up the resistance of each component*.



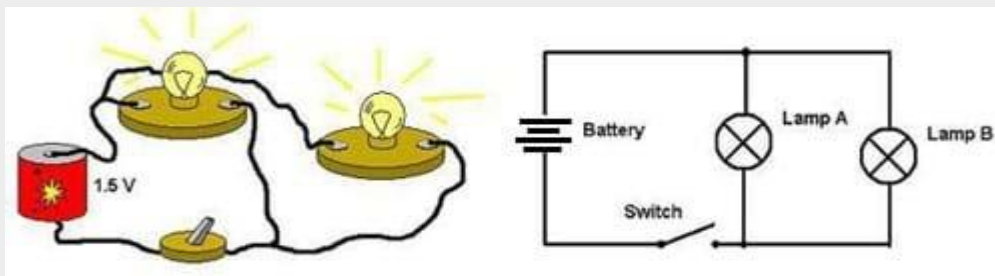
$R_{\text{total}} = R_1 + R_2 + R_3$ in the given circuit,

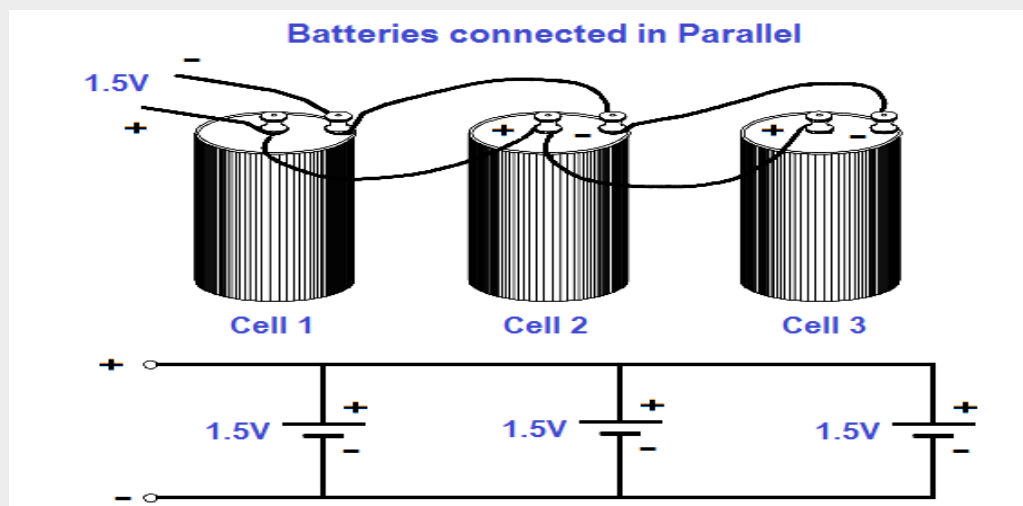
$$R_{\text{total}} = 2\ \Omega + 3\ \Omega + 4\ \Omega$$

$$= 9\ \Omega$$

PARALLEL CIRCUITS

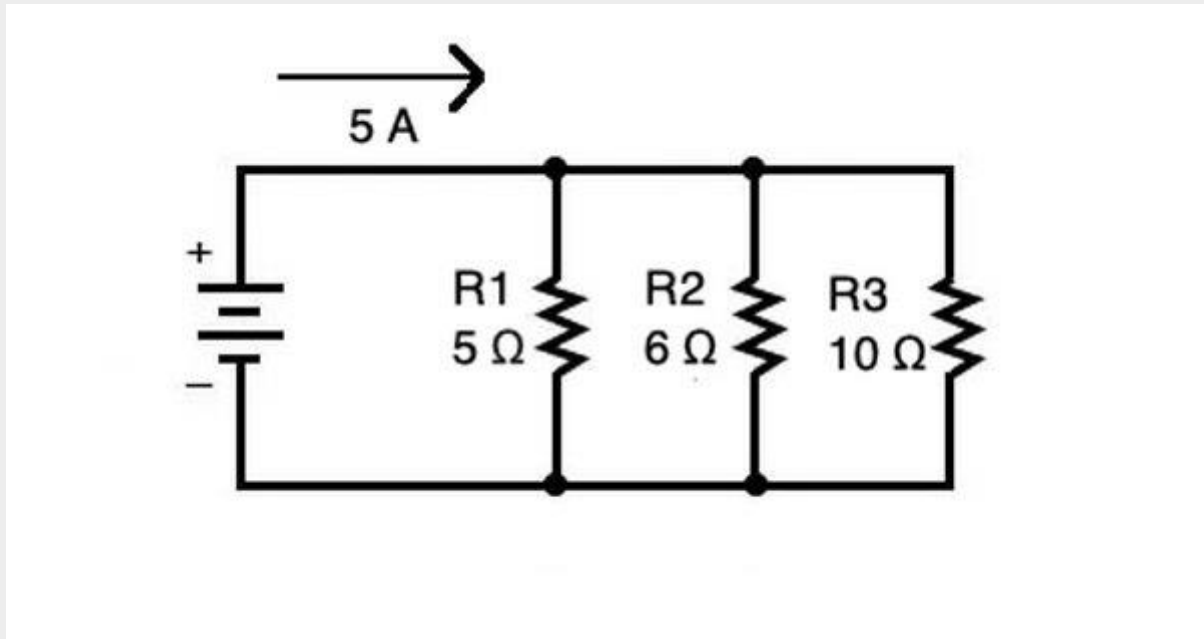
- 1) The current in a parallel circuit **divides** when *it enters the separate branches*.
- 2) The **total current is the sum of the current in the branches**.
- 3) The **potential difference across the branches of the circuit is the same as the potential difference across the battery**.
- 4) **Cells or resistors can be connected in parallel in a circuit**.



CELLS IN PARALLEL

- 5) A *positive pole* is connected to another *positive pole* & *negative pole to another negative pole*. Each cell should have the same emf.
- 6) The *total emf of battery is equal (=) to the emf of one cell*.
 - **Example:** a battery with 2 cells in parallel *generates the same total current as a battery with 1 cell*; *every cell generates half of the total current*.
 - The *more cells are in parallel*, the *smaller the fraction of the total current each cell generates* & *longer they last*.
- 7) As we *add more cells in the parallel circuit*, the *brightness of the light bulbs does not change* and the **total voltage in the circuit stays the same**. We can represent this using the equation: $V_1 = V_2$
- ❖ **Example:** What is the total voltage across each cell in a circuit that has 3 x 1.5 volt cells connected in parallel?: **Answer:- 1.5 volts**

NUMBER OF CELLS	VOLTMETER READING (V)	BRIGHTNESS OF LIGHT BULBS
1	1.5	<i>Same brightness</i>
2	1.5	<i>Same brightness</i>
3	1.5	<i>Same brightness</i>

RESISTORS IN PARALLEL

- 1) The *voltage across all the resistors* connected in parallel *equals (=) the voltage across each individual resistor*: $V(\text{total}) = V1 = V2 = V3$
- 2) As *more or fewer light bulbs connected* in parallel, their *brightness remains the same*.
- 3) The *A reading of the main current* = the *sum of the A readings (current strength) in each of the parallel branches*: $A = A1 + A2 + A3$
- 4) *Resistors in parallel share the total current strength* & act as *Current dividers*.
- 5) As *the number of resistors in parallel increases*, the *total resistance lowers* & the *current strength increases*.
- 6) The *sum of the ammeter readings at the resistors* is *equal to the ammeter reading at the battery*.
- 7) Readings on the voltmeters across the resistors and across the battery are the same.

SERIES AND PARALLEL CIRCUITS IN THE HOME

- 1) Resistors can *control the voltage* and *current in parallel and series circuits*.
- 2) Resistors are designed to have accurate resistances in order to control the current through the **electrical system**. For example, for 2 circuits that have the same total voltage, the *circuit with the lower resistance* will have a **higher current** and the circuit with the higher resistance will have the lower current.
- 3) Electric circuits are used for the wiring in our homes, cars and even in toys.
- 4) The lighting system in our homes is usually connected in parallel. If one light bulb **fuses** (the filament breaks), the *rest of the lights will stay on*, because they are **each connected to the mains circuit by their own parallel path**.
- 5) Many Christmas lights are connected in series. This can cause a problem, because if one light bulb fuses or breaks, all the lights will stop working.

TOPIC 5: SAFETY PRACTICES WITH ELECTRICITY [1 WEEK]**Core concepts:**

- **Safety practices**

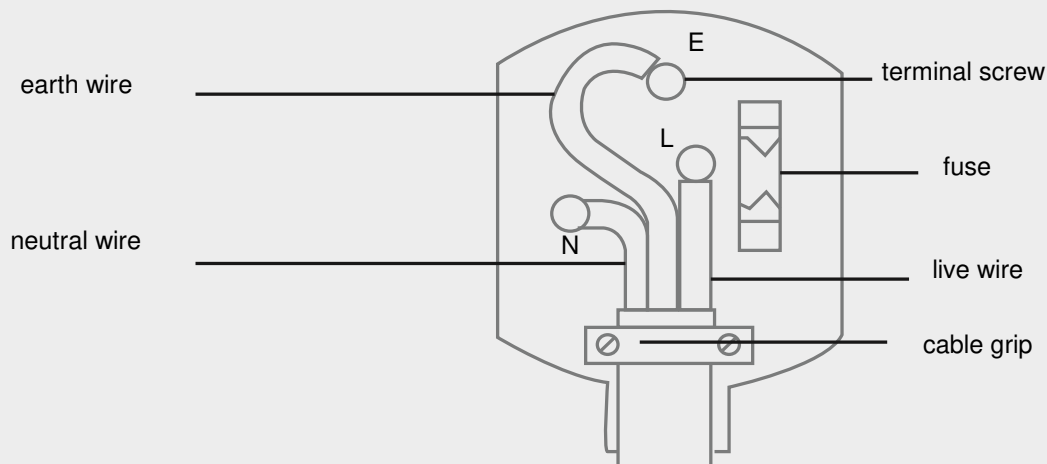
- 1) Circuits that have **parallel connections** can *cause overloads on main circuits*.
- 2) A circuit is overloaded when *more current flows through the circuit than the circuit can handle*, for example, when *too many devices are plugged into one power point*.
- 3) This is **dangerous** because the *wires can become very hot and start fires*. The wires can also *melt and break the circuit*.
- 6) **Circuit breakers, fuses and earth leakages** can be used as safety devices.
- a) **Circuit breaker:** is a safety device that has an **electromagnet** that *breaks/ stops the circuit or electricity from flowing* when the **current is too high**.

- There are *different circuit breakers* for the *different circuits in the house* eg there are **circuit breaker for the lights**, and **circuit breakers for the plugs in different rooms**, the **geysers and other connections**.
- 1. There is also a **main circuit breaker** that is *connected in series to all other circuit breakers*. If the current is too high from the main supply, the **main circuit breaker will trip and no current will flow through any part of the house**.
- The main circuit breaker should always be disconnected before any electrical work is done on the house.
- b) Fuses: device that is *connected in series to the main supply*.
 - If the *current becomes too high*, the (**filament**) **wire** in the fuse **melts and breaks the circuit**, disconnecting the main supply to the house. Each fuse shows the maximum current it can carry before it breaks. Once a fuse has melted, it has to be replaced.
- c) **Earth leakage system**: allows extra current produced to travel safely to the earth. People who are working on a system, or animals that may have accidentally come into contact with a high voltage line, are protected from being shocked.

THREE PIN PLUGS

- Many devices use a **3-pin plug as a safety device to connect to the main electricity supply**.
- 1) 3-pin plugs have a **live wire** (brown), **neutral wire** (blue) and an **earth wire** (green and yellow). Some 3-pin plugs also have fuses.
- 2) The **live and neutral wires carry the current around the circuit**.
- 3) The **earth wire is connected to the outer metal casing** of the appliance. For example, the casing of a kettle.
- 4) The **other end of the earth wire is connected to the earth cable in the ground by the wall plug**.
- 5) If the **live wire becomes loose and touches the outer casing of the appliance**, the **appliance becomes live** and we can get **shocked** when we touch the appliance.

- 6) The *earth wire has almost zero resistance*. It prevents current from flowing through us when we touch the live appliance by safely discharging the current to the ground.
- 7) **Illegal connections** to the ESKOM mains supply are dangerous and are considered as energy theft.
- 8) All the wires are **insulated** with a plastic covering, preventing the current from flowing to other objects that touch the wires.



- **Wiring of three prong plugs:**
 - 3 separate conductors:
 - Brown – live
 - Blue – neutral
 - Yellow/green – earth

TOPIC 6: ENERGY AND THE NATIONAL ELECTRICITY GRID 1 WEEK**Core concepts**

- Electricity generation
- Nuclear power in South Africa
- National electricity grid

ELECTRICITY GENERATION

- **Power station:** is a system that **generates** electricity.
 - 1) Most power stations in South Africa *use coal as a fuel in the generation of electricity.*
 - 2) *Coal is burned in order to boil water.*
 - 3) The *steam* from the boiling water *rises and turns turbines.*
 - 4) The turbines *turn a generator* which *produces electricity.*

ALTERNATIVE RESOURCES OF ENERGY

- Alternative resources include: wind, falling water (hydroelectric), sun-heated steam, **nuclear fission**, and waves in the sea.
 - a) **Wind:** *turns turbines* that *turn generators* which *produce electricity.*
 - b) **Falling water/ hydroelectric power:** which is usually found in dams, also *turns turbines* that turn generators which produce electricity.
 - c) **Solar/Sun-heated steam:** uses the Sun's energy to generate electricity.
 - d) **Nuclear fission:** involves the *splitting of the nucleus of an atom* which *releases large amounts of energy* that is used to turn generators and produce electricity in nuclear power stations.
 - e) **Waves:** in coastal areas, the waves of the ocean can be used to generate electricity.
 - These alternative resources are **renewable** and can be *re-used or replaced.*
 - ❖ *The disadvantage with coal* is that it is a **non-renewable energy source** and *cannot be replaced once it is used up.*

- This means that coal is not a **sustainable** energy source.
- Coal also has a negative **environmental impact**. Burning coal produces **carbon dioxide** that contributes to **global warming**.
- *Energy cannot be created or destroyed*, but it can be **transferred from one form to another** eg
 - *Power stations* use **energy from coal, oil, natural gas, nuclear resources**, and other renewable resources, and **transfer the energy into electrical energy**.
 - A **power station** is *made up of many parts that work together* in a system to **transfer the energy from one form to another**.
 - **Eskom is the leading supplier of electricity in South Africa.**

NATIONAL ELECTRICITY GRID

- **National grid:** is a **network of interacting parts**, a *system* where a *change in one part of the grid affects the other parts* of the grid.
- The **3 main parts** of the national grid include a **power station, power lines** and **transformers**.
 - 1) **Power stations:** *feed electrical energy into the national grid at high voltages.*
 - 2) **Power lines:** *carry electricity at high voltages (500 000 volts) from the power station to our homes.*
 - They *carry electricity over long distances* and need to have **high voltages** to make sure *electricity with a high enough voltage reaches houses*.
 - These voltages are too high and will damage our appliances and need to be lowered.
 - 3) **Transformers:** is a device that *changes the voltage*.
 - They *step down the voltage* for local distributors and consumers to **230 volts**.
 - **15% Of the energy is wasted** due to **heating** in the transmission lines and transformers.
 - A **power surge** occurs when the **voltage is 110% above the normal voltage in the power line**.

- The voltage is too high and can damage many appliances in your home. Many appliances have fuses which melt and cause a break in the system during power surges. This protects your appliance.
- Power surges occur when one part of the grid breaks down and the other parts of the grid must carry more electricity.
- Power surges and grid overload can disrupt the power supply.

TOPIC 7: COST OF ELECTRICAL POWER **1 WEEK**

Core concept

- The cost of power consumption

- 1) **Power:** the rate at which energy is transferred or at which work is done per unit time
 - It is the *amount of electrical current* that is *flowing through a system* as a *result of voltage*.
 - Electric Current (I) flowing through a circuit *transfers electrical energy (E) to the electric appliances* for them to have power.
 - The *energy transferred* is *equal to the amount of work (W) done by the charges* & is *measured in Joules (J)*.
- 2) The formula of Power: $P = E/t$, where *P* means *power*, *E* means *energy*, and *t* means *time in seconds*.
 - Electric power is measured in watt (W) or *kilowatts (kW)*.
 - *1 watt = 1 joule of energy transferred or work done per second.* **1 Watt = 1 Joule per second (1W = 1 J/s).**
 - **1 kW = 1000 J/s.**
- 3) The power rating of appliances can be *determined by looking at the back panel of the appliance*.

APPLIANCE	POWER RATING (W)
Television	140
Radio	80
Electric iron	2200

MEASURE ELECTRICAL POWER

1) *Eskom reads the electricity meter on a specific day each month to determine **how many units of electricity were used** by the consumer during that month.*

2) *Quantity of power used is **measured in kilowatt hours (kWh)***

○ ***1 Watt = 1 joule per second.***

○ ***1 Kw = 1 000 Watts***

○ *We calculate the **electrical power** used by **multiplying power rating of the appliance** by the number of hours it was used for:*

Electrical power used = power rating x number of hours used.

• *Joule is the **unit of measure of energy.***

- *If we use appliances with a higher power rating, it will **cost more to run.***
- *If we use appliances for longer periods of time, it will **cost more to run.***
- *An **electric meter records the amount of power used in kWh.***

THE COST OF ELECTRICAL POWER

- *Example: An **electric hairdryer** is labelled as: 240 V, 2000 W.*
- *Assume the **electricity tariff** at the start of the year was **R1.53 per kWh**. **How much would it cost you** at the **end of January** if you used the hairdryer every morning for 15 minutes?*

SOLUTION

❖ *Cost of E/Power = power rating (kWh) x time (hours used) x unit cost of electricity/ Tarif*

- ✓ *Power rating* = **2000 W** (same as 2 Kw)
 - ✓ *Time* (hours): **15 minutes** = half an hour which = **0.25 hours** and January has 31 days
 - ❖ *Cost* = **power rating (kWh) x time (hours) x tariff**
- $$= 2 \text{ kWh} \times 7.75 \text{ h} \times 1.53$$

Cost = **R23, 72**

- The **unit price of electricity** changes every year.
- *Once a month*, households receive *an electricity tariff account* that states **how much their electricity usage has cost for that month.**
 - i. The reading period, which is 31 days.
 - ii. As the quantity of power used increases, so does the unit cost.
 - iii. A management levy, service charge, network charge and VAT charges are also added onto the cost of electricity.
- We can also *load money on prepaid electricity cards*. This means that our **electricity will switch off once all the money on the card has been used.**

FORMULAR TO ESTIMATE ENERGY CONSUMPTION

Appliances	Watts	Time used
TV 19 — colour	70W	
100W light bulb	100W	
Electric kettle	2000W	4 hours (per day)
Iron	1000W	
Toaster	1500W	

- Use this formula to estimate an appliance's energy use:
 - **Wattage × Hours Used per Day ÷ 1000 = Daily Kilowatt-hour (kWh) consumption**
 - **1 kilowatt (kW) = 1,000 Watts**