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ENERGY AND CHANGE**Types of forces**

-
- (a) A force can be defined as a push, pull or twist acting on an object.
- (b) The unit used to measure force is newton (N) named after Sir Isaac Newton.
- (c) Forces always act in pairs, e.g. when a force pushes an object forward another is acting in the opposite direction.
- (d) A force can change the direction of an object, speed, shape or stop an object in motion.

Examples of effects of a force

- Pushing a trolley: the applied force is cause it to accelerate.
- Opening a door: the applied force at the edge of the door causes it to rotate around its hinges.
- Squeezing a loaf of bread: The force applied changes the shape and size of the bread.
- A goal keeper stopping a ball: A force is applied to stop the movement of the ball.

Name the following forces:

-
1. A force that tries to slow things down when two things rub together _____
 2. A force from water that brings water to your house. _____
 3. A force that act in the opposite direction of things that are moving through the air. _____
 4. The force that enables the Earth to pull things towards itself. _____
 5. The object that attract and repel each other and also attract things made of iron. _____

-
6. Give the effects of an applied force by referring to the examples given.

CONTACT FORCES

- (a) Contact force (including friction, tension, and compression) is a result of contact / touching between bodies.
- (b) The contact can also be through a medium such as a rope, cable, bar etc.

NON-CONTACT FORCES (FIELD FORCES)

- Field forces are forces that can act at a distance to each other or can create a field around them such as gravity, magnets and electrostatic forces.

APPLIED FORCE

Use the diagram to answer some of the questions:

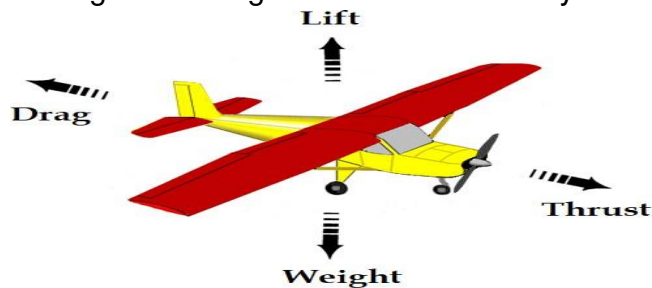
1. How much force is applied by each person in the diagram? _____

2. What is the net force acting on the wagon? _____

Use Net force = _____



3. Looking at the diagram below: What do you think is:



1. A drag? _____

2. A lift? _____

3. A thrust? _____

4. Weight? _____

4. What think would happen if the drag and the thrust are equal?

5. How do you think the weight and the lift should not be of the same magnitude?

MAGNETIC FORCE

- (a) **M**agnets attract magnetic materials such as iron, steel, cobalt and nickel.
- (b) A magnet has a north and a south pole with like poles repelling and unlike poles attracting.
- (c) Just like a magnet, the Earth has a magnetic field with its South Pole under Earth's magnetic North pole.

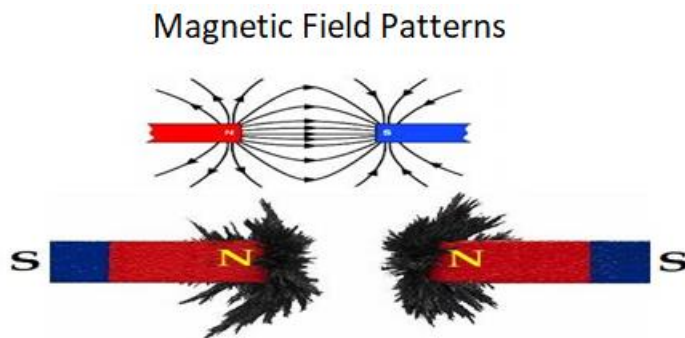
1. Looking at the diagram.



1.1 How can the soccer player stop the movement of the ball?

1.2 Explain how the player can cause the ball to change direction.

2 Looking at the diagram below:



2.1 What are the two poles in a magnet?

2.2 What is observed when the same poles of a magnet are brought against each other?

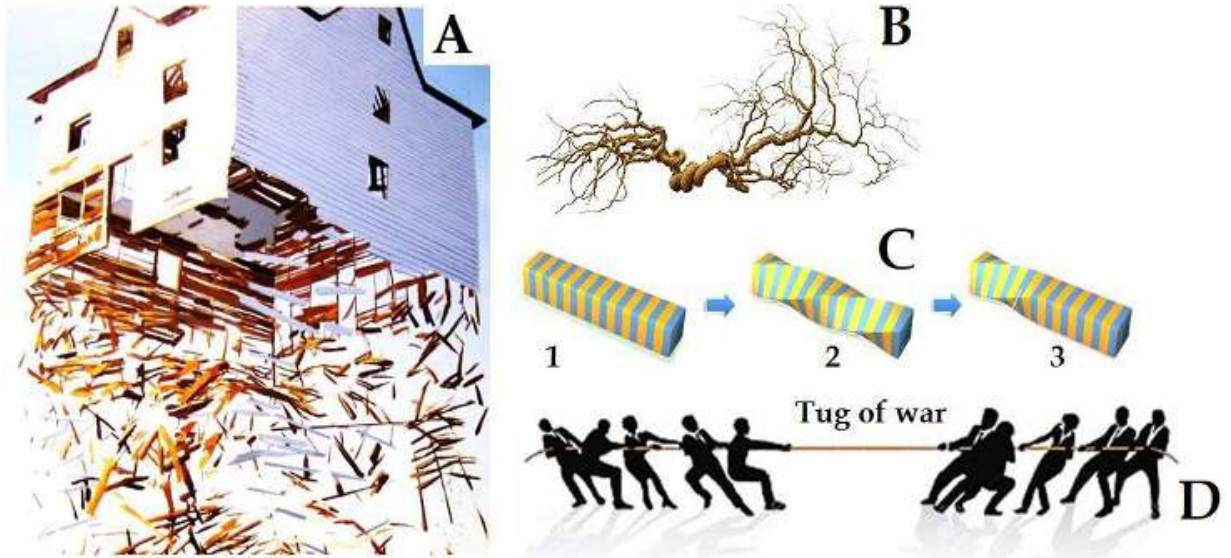
2.3 Looking at the magnets, what do you observe about the iron filings?

2.4 What do you think the iron filings are made of? _____

2.5 Magnets are examples of non-contact forces because they (create /don't create) _____ magnetic field around them.

2.6 Explain by referring to the 2.3 why non-contact forces are also called field forces.

3 A force is applied when pulling, pushing and twisting objects. Study the diagram and answer the questions that follow:



3.1 Mention the type of applied force in each of the diagrams:

- A. _____
 B. _____
 C. _____
 D. _____

3.2 Describe the effect of the force applied in the following diagrams:

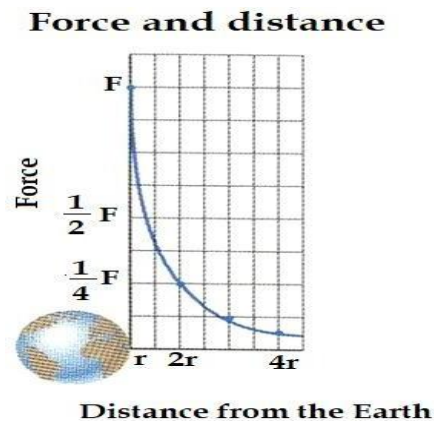
- A. _____
 B. _____
 C. _____
 D. _____

4 A force can stop movement, change shape, increase speed or slow down an object. Refer to the diagram and identify the mentioned effects of a force.

GRAVITY

- (a) There is pulling force between objects which varies according to their masses. Such a pulling force is observed between objects on earth and the Earth, the Moon and the Earth, the Earth and the Sun, the Sun and the planets moving around it.
- (b) According to a scientist known as Sir Isaac Newton, the pulling force between objects is directly proportional to the masses of the objects.
- (c) The force is also affected by the distance between the forces, the force is inversely related to the distance between them.

Use the graph to answer some of the questions that follow:



1. If the distance from the Earth is r , what is the force? _____

2. If the distance from the Earth is $2r$, what is the force? _____

3. Thinking of Sir Isaac Newton, explain the relationship between force and distance, also indicate if the relationship is inverse or direct.

4. If the force (F) in the diagram was 4000N, what will the force be when the distance is $2r$? _____

5. The graph shown above represents what is known as the inverse square. Do some research on the inverse square rule.

RELATIONSHIP BETWEEN MASS AND FORCE

Use the table below to answer the questions that follow:

PLANET	DISTANCE FROM THE SUN (km)	DISTANCE FROM THE EARTH (km)
Mercury	58 000 000	92 000 000
Venus	108 000 000	42 000 000
Earth	150 000 000	
Mars	228 000 000	78 000 000
Jupiter	778 000 000	628 000 000
Saturn	1 427 000 000	1 277 000 000
Uranus	2 870 000 000	2 720 000 000
Neptune	4 497 000 000	4 347 000 000

1. Which planet is the furthest from the Sun? _____
2. What is the distance from the Earth to the Sun? _____
3. Lerato thinks the gravitational pull between the Earth and the Sun will be greater than the pull between the Sun and Neptune. Megan disagree with her but she cannot support her argument. Use the table to provide a sound explanation to both of them.

MASS AND FORCE

Use the diagram in answering some of the questions that follow:

1. What is represented by A, B and C in the diagram?

2. Which one is the closest to C? _____



3. Dean was able to calculate the force of gravity between the Earth and the Sun and between the Earth and the Moon and found the following:

- Sun and Earth = $3.6 \times 10^{22} \text{N}$
- Earth and Moon = 1.89×10^{20}

- 3.1 What unit is used to measure force? _____

- 3.2 Fully explain the force of gravity between the Earth and the Sun and between the Earth and the Moon.

- 4 The force exerted by the Earth on an object is known as its weight also measured in newtons (N). Mass of an object does not change whereas weight changes according to position or gravitational force at that point; that includes the Moon and other planets. Study and complete the table shown.

Mass of the object: 62 kg

Weight = mass x gravitational acceleration

Planet	Strength of Gravity (gravitational acceleration)	Weight on the planet (N)
Mercury	0.38	
Venus	0.91	
Earth	9.8	
Mars	0.38	
Jupiter	2.54	
Saturn	1.08	
Uranus	0.91	
Neptune	1.19	

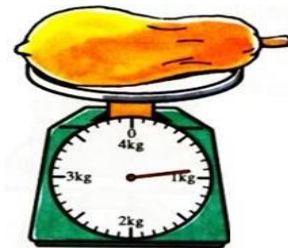
- 5 What are the readings of the following scales?



A



B



C

- A. _____
 B. _____
 C. _____

6 Use the diagram to complete the table that follows:

Banana	Pawpaw	Brick	Printer	Water melon	Speaker
					
250g	500g	1kg	2kg	4kg	6kg

Object	Mass	Reading in newtons (N)
Banana	250g	
Pawpaw	500g	
Brick	1kg	
Printer	2kg	
Watermelon	4kg	
Speaker	6kg	

INVESTIGATION

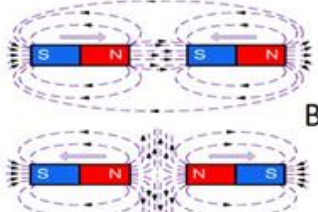
- Observe the patterns created by a magnet on iron filings spread on paper.
- Magnets brought closer to each other.

Magnetic field lines



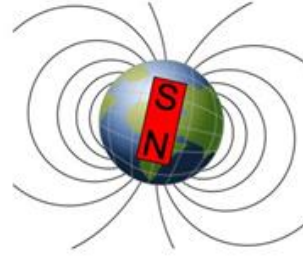
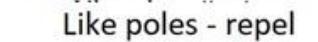
A

Unlike poles - attract



B

Like poles - repel



C

Answer the following questions:

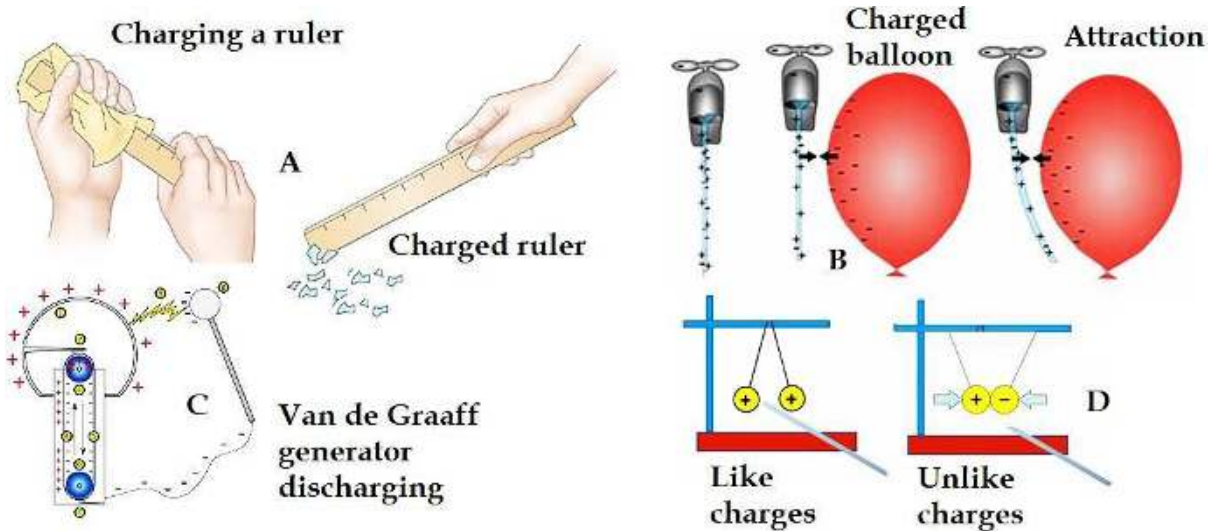
1. What are the two poles in a magnet? _____
2. Describe the iron filings in A (use closer, denser, spaces, no spaces in your explanation).

3. Explain what you observe as two like poles (North and North or South and South) of a magnet come closer to each other.

4. Explain what you observe as two unlike poles of a magnet come closer to each other.

ELECTROSTATIC FORCE

- Rubbing materials together results in a gain or loss of electrons.
- The loss of electrons leaves the material positive and a gain of electrons results in the material being negatively charged.
- Like charges repel while unlike charges attract each other.



Answer the following questions:

- How does a material become positively charged?

- How does a material become negatively charged?

- Discuss what happens in C.

- Try the experiment in B and then explain how the balloon was able to attract the water.

- The Van de Graaff generator becomes charged as the belt is scratched and loses electrons and it then transfers the charge to the dome. Explain why the dome is positively charged.

6. How does the metal sphere discharge the dome?

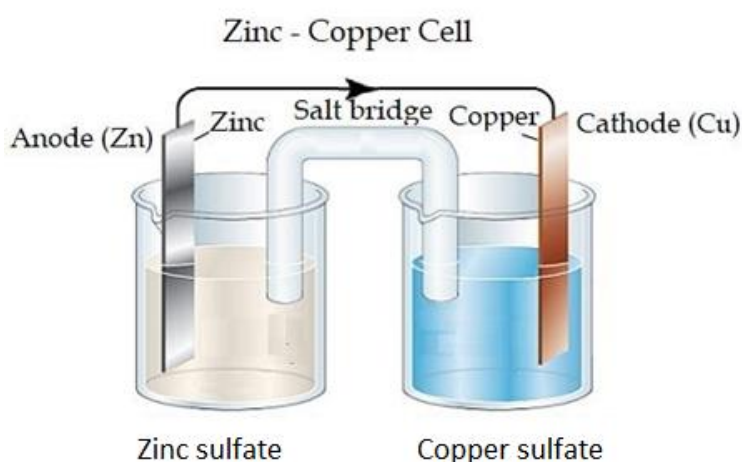
7. Explain what is happening in D.

8. Lightning is a natural form of static electricity. When lightning strikes, it is a result of discharge or release of a charge between the clouds carrying a charge and the ground. Do a research on safety precautions that must be considered during thunder and lightning storms.

ELECTRIC CELLS AS ENERGY SYSTEMS

Electric cells

- An electric cell refers to a system where chemical reactions results in the flow of electricity.
- The flow of electricity occurs through the external circuit.
- An electric circuit is a closed loop though which electric current flows.
- A battery is made of two or more cells connected together.
- The following zinc – copper cell uses one of the solutions in the salt bridge.



Answer the following questions:

- What do we call the cell shown in the diagram? _____
- Mention the two electrodes used in the cell.

- What are the two salts used in the solutions?

- Looking at the direction of the arrow, which one between zinc and copper donates electrons? _____
- The function of the salt bridge is to complete the circuit and allow the flow of ions from one beaker to another.

RESISTANCE - USES OF RESISTORS

- (a) A conductor allows electric current to pass through it.
- (b) Some of the energy in a conductor is lost as heat when the conductor heats up.
- (c) All conductors have some resistance but the resistance differs from one conductor to another.
- (d) A resistor controls the movement of current as it passes through.
- (e) Resistors change electric energy into useful energy e.g. for cooking, light, ironing etc.

Answer the following questions

1. What is a conductor?

2. Explain how energy is lost through a conductor.

3. Discuss why it is important for materials to have resistance. Use examples of some appliances in your explanation.

4. Explain the importance of resistors, make use of 5 appliances as your examples and explain how resistance makes those appliances useful.

5. Suggest how you can build a bulb that can light up the whole school. Mention resistance in your explanation.

6. Do a research on one appliance you use at home to find out how it works. Try and sketch your own design of the appliance and give it a name.

FACTORS THAT AFFECT RESISTANCE IN A CIRCUIT

(a) Different materials have different resistance because materials have different properties.

(b) Resistance is affected by the following:

- Thickness of the conductor – thicker conductors have less resistance and vice versa.
- Length of the resistor - longer conductors have more resistance and vice versa.
- Temperature of the resistance – higher temperature has higher resistance and vice versa.
- The type of material used as a conductor -different materials have different resistances.

Answer the following questions

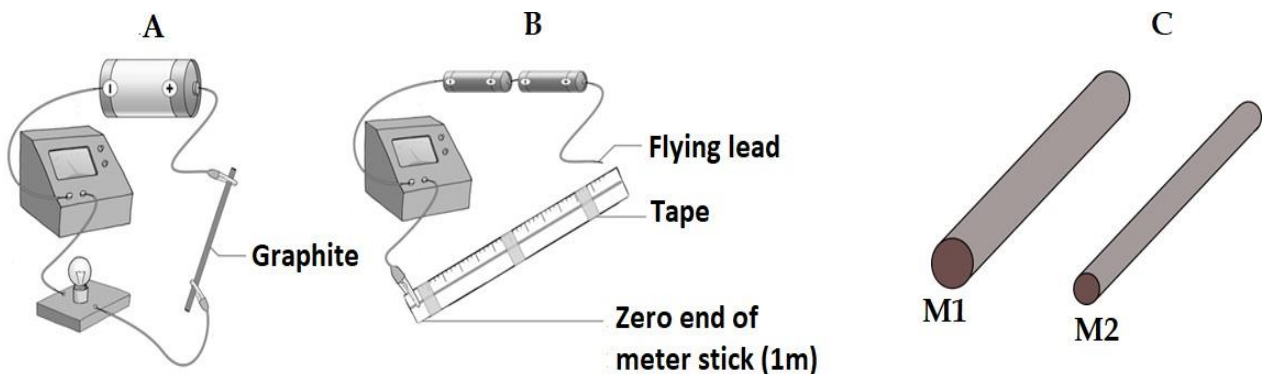
1. Give details of the four factors affecting resistance.

2. Which factors are being investigated in the two diagrams?

A

B

C



INVESTIGATION

Investigative question

- Do different factors affect the resistance of a material?

AIM

- To investigate the effect of length, thickness and type of material on resistance.

Specific Aims: 1, 2 & 3

Skills to be assessed:

- Observing, communicating, comparing, predicting, hypothesizing, recording information, measuring and doing investigations.

APPARATUS

- Circuit board, copper wire, zinc wire, nichrome wire, ruler and vernier scale or micrometre.

HYPOTHESIS

What is your hypothesis for investigation A?

_____ (2)

METHOD

1. Set up a circuit containing two cells, ammeter and a copper wire of 10 cm long.
2. Take the reading from the ammeter and record it in the table.
3. Repeat the procedure using a 15cm and lastly a 20cm long copper wire.
4. Using the same circuit, use three wires of the same length with the thicknesses of ~ 3mm, 5mm and 8mm.
5. Connect the ~3mm wire to the circuit and take a reading from the ammeter and record it in the table.
6. Repeat the procedure using the 5mm and 8mm wires.
7. Using the same circuit now use different wires with the same length (copper, zinc and nichrome).
8. Connect a copper wire, take a reading from the ammeter and record in the table.
9. Repeat the procedure using zinc and nichrome wires.

RESULTS

Investigation A						
Factor Investigated		Ammeter Reading		Ammeter Reading		Ammeter Reading
Length	10 cm		15 cm		20 cm	
Investigation B						
Thickness	~3mm		~5mm		~ 8mm	
Investigation C						
Type of material	Copper		zinc		Nickel	
						[9]

OBSERVATION

- What is your variable in investigation A?
_____ (1)
- What is your variable in investigation A?
_____ (1)
- What is your variable in investigation A?
_____ (1)
- Discuss how temperature also affects resistance.
_____ (2)

CONCLUSION

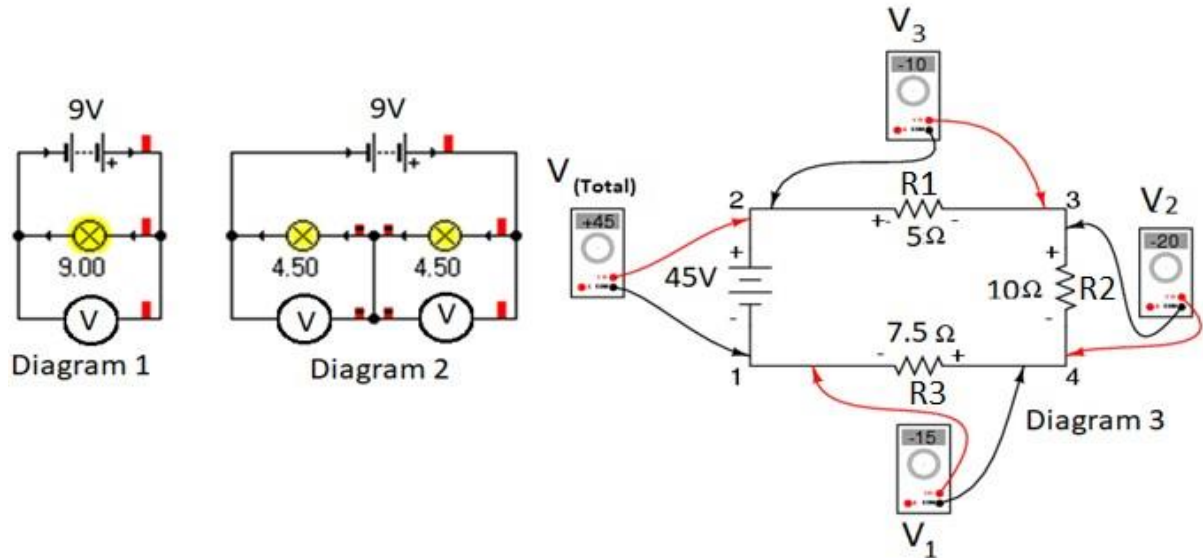
- What is your conclusion?

_____ (4)

SERIES CIRCUITS

Series circuits:

- (a) For cells connected in series their voltages (potential differences) add up.
- (b) Resistors can also be connected in series.
- (c) In a series circuit, the electric current has only one path to follow.
- (d) The resistor with higher resistance has a higher voltage of the total voltage in the circuit. Use the diagram to answer some of the questions that follow:



- What is the reading in the voltmeter of diagram 1? _____
- What is the voltage in the resistors in diagram 1? _____
- What is the voltage of the battery in diagram 2? _____
- Discuss why the readings in the two bulbs are the same.

- What is the relationship between the reading in each bulb of diagram 2 and that of the battery?

- What is the total voltage in diagram 3? _____
- Which resistor has the highest voltage? _____

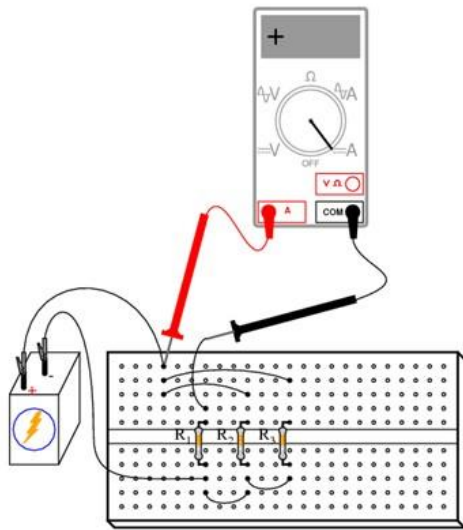
8. Discuss why the resistor you identified has the highest voltage?

9. What is the relationship between voltage and resistance?

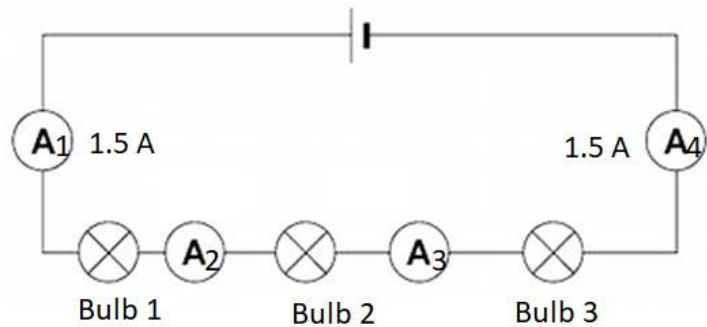
10. If all resistors in diagram 3 had the same resistance, how would that affect the voltage in each resistor?

SERIES CIRCUITS

Use the diagram to answer some of the questions that follow:



Current in a series circuit



1. What is the reading in ammeter 1? _____
2. What do you think will be the readings in ammeters 2 and 3? _____
3. Explain your reason for your predictions in the readings of ammeters 2 and 3.

What conclusion can be drawn about current at any point in a series circuit?

5. Complete the table below for four identical (4) bulbs connected in series

Number of bulbs	Voltmeter reading V (volts)	Ammeter reading (Amperes)	Resistance R (Ohms)
1	12 V	4 A	3 Ω
2	6		
3	4		
4	3		

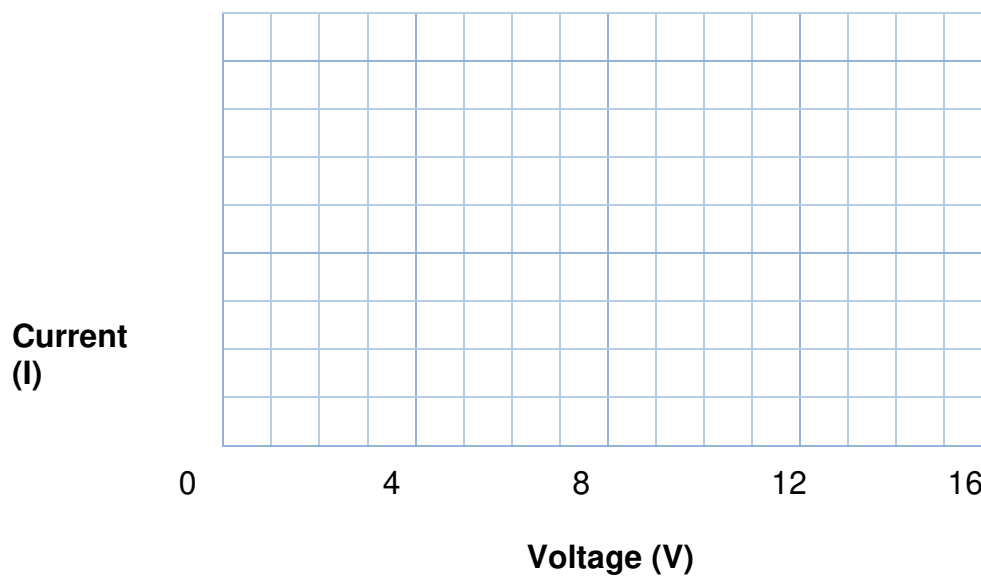
6. By looking at the table, what happens to the ammeter reading as you increase the number of bulbs?

7. What conclusion can be drawn regarding the relationship between current and resistance?

8. Use the graph grid to draw a graph of current v/s voltage using the following data:

Voltage V (V)	Current I (A)
3	0.4
6	0.8
9	1.2
12	1.6

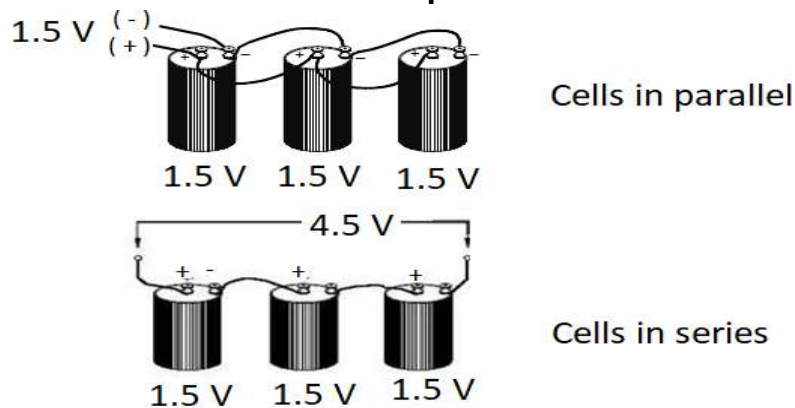
Heading: _____



PARALLEL CIRCUITS

- (a) Cells of the same voltage connected in parallel produce a voltage equivalent to that of one cell.
- (b) Cells in parallel are connected positive to positive and negative to negative whereas series cells are connected end to end (negative end to positive end).
- (c) Connecting resistors in parallel reduces the resistance, such that the more the resistors the less the resistance.
- (d) Parallel connections are used in our households.
- (e) The higher the resistance, the smaller the current and vice versa.
- (f) For parallel resistors voltage is the same across each resistor.
- (g) Parallel resistors split or divide the current at each junction. (**Kirchhoff's law**)

Use the diagram to answer some of the questions that follow:



1. How are cells in series connected compared to cells in parallel?

2. What is the advantage and disadvantage of connecting cells in parallel?

3. Looking at the diagram, explain how one connection differs from the other.

4. If 3 bulbs were connected, which connection would make the bulbs brighter and why?

5. What is the advantage of connecting resistors in parallel?

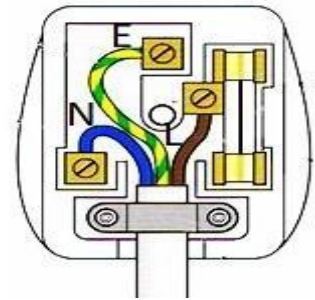
6. How does connecting resistors in parallel affect the potential difference?

7. Discuss the relationship between resistance and current in a parallel circuit.

SAFETY WITH ELECTRICITY

- (a) Sometimes parallel connections are overloaded.
- (b) Safety devices such as circuit breakers, fuses and earth leakage systems are used to prevent fire.
- (c) A three pin plug comprising live (brown), neutral (blue) and earth (yellow and green) wires are commonly used.
- (d) The earth cable releases a charge to the ground if there is a fault.
- (e) Illegal connections disregard safety measures and are a form of energy theft.

Three (3) Pin plug



Answer the following questions:

1. What is the purpose of safety when using electricity?

2. Mention three safety devices when working with electricity.

3. Explain how the earth cable works in a three pin plug.

4. Explain the colours in a 3 pin plug.

5. Why are illegal connections a wrong practice?

ELECTRICITY GENERATION

- (a) Power stations generate electricity.
- (b) Most power stations in South Africa are coal-fired (use coal).
- (c) In a coal fired power station coal is used to heat water, the water produces steam and the steam is used to turn turbines.
- (d) The turbines turn generators which produce electricity.
- (e) Solar, wind, energy and nuclear are some of the alternative means to produce electricity.

Answer the following questions

1. What is a power station?

2. List some of the alternative means of generating electricity.

3. What is the meaning of coal-fired power stations?

4. Discuss how electricity is generated using coal.

5. Do a research on one alternative means of generating electricity. Make a 3 minutes presentation to your class. You can also present with a partner.

NUCLEAR POWER IN SOUTH AFRICA

- (a) Nuclear power stations use radioactive fuel instead of coal.
- (b) Heat is produced by nuclear fission.
- (c) Nuclear fission is the splitting a nucleus of an atom into two smaller ones producing a lot of energy in the process.
- (d) Nuclear power station such a Koeberg in the Cape helps channel electricity into the national energy grid.
- (e) Nuclear waste is dangerous and remains radioactive for hundreds of years and must be correctly stored and disposed.

Answer the following questions:

1. What is a nuclear power?

2. Explain how a nuclear power works, you can also do some research.

3. Discuss the possible dangers of a nuclear waste.

NATIONAL ELECTRICITY GRID

- (a) National grid produces electricity in a huge scale using different systems.
- (b) The different systems feed high voltages to the national grid.
- (c) The electricity is transported by power lines.
- (d) Step down transformers are used to reduce the voltage for local users.
- (e) About 15 % of the energy is wasted as heat in transformers and power lines.

Answer the following questions:

1. What is an energy grid? _____

2. Explain in details how the National Electricity grid works.

3. Explain the role of step down transformers.

4. Discuss how much of the energy produced is delivered to the consumers.

5. Elaborate on how much of the energy is wasted and how is it wasted?

THE COST OF ELECTRICAL POWER

CALCULATING THE COST OF ELECTRICITY

- (a) The SI unit for power is Watt.
- (b) One Kilowatt is equivalent to 1000 W.
- (c) Kilowatt-hour (kWh) is the unit used to measure energy over a certain period.
- (d) If a unit is given in Watts, it must first be converted to kW.
- (e) When the unit is in kW, it can then be multiplied by the time of usage.

- **Example:**

What is the energy used when a 6kW heater is in use for 5 hours? To calculate energy consumption we can use:

$$\begin{aligned}\text{Energy} &= \text{power rating} \times \text{time (in hours)} \\ &= 6 \text{ kW} \times 5 \text{ h} \\ &= 20\text{kWh}\end{aligned}$$

Study the table and complete it: Cost of electricity for a day (1kWh = 212 cents)

Appliance	Power rating (kW)	Duration	Energy used (kWh)	Cost in cents	Cost per month (31 days)
Television	0.14	3h	0.42	89 cents	
Refrigerator	3	24h	72	15 264 cents	
Microwave	0.8	30 min	0.4	85 cents	
Heater	1	3	3	636 cents	
Hot plate	1.5	4			
Air conditioner	1.5	6			
Clothes Iron	1.5	6			
TOTALS					