NATURAL SCIENCE GRADE 9

ELECTRICITY/FORCES TASK 1

Instructions:

1. FORCES

- All work on FORCES should have been completed . All pages in the Exam Fever Notes must be studied on FORCES .
- Exercises at the back of the Book pages 29,30 and 31 should

  have been completed in class or at home. (New book, pages 101,102 and 103)

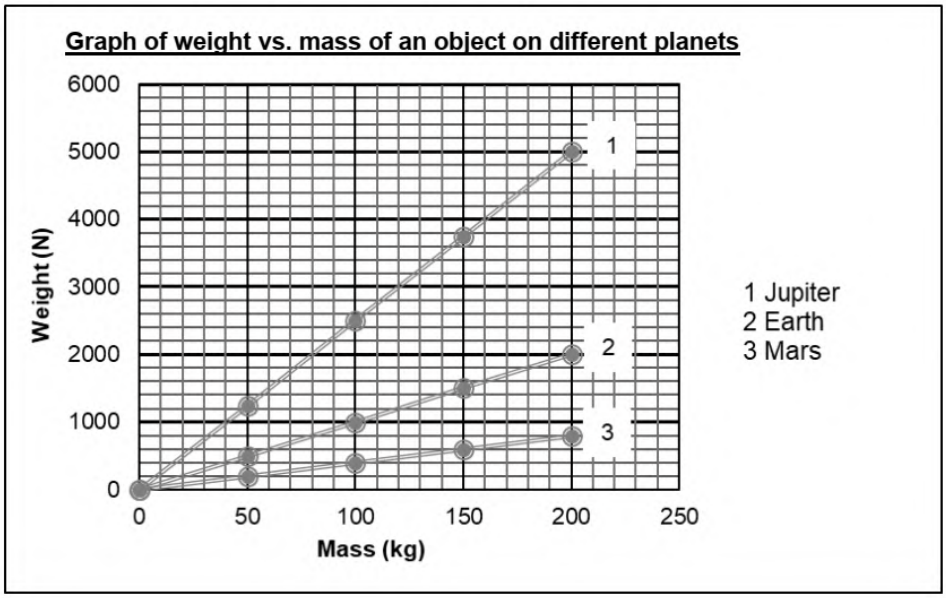
2. ELECTRICITY

- All pages in the Exam Fever Notes on ELECTRICITY must be studied.
- Additional Notes are attached below.
- Please complete the Exercises on Electricity at the back of the book. **(Excluding** Electrostatics and Magnetism)
- Complete the exercises below as well.

3. TESTING

- Open Book Assessment in school to be completed on Ohm's Law Practical.
- Controlled TEST on work done in TERM 3 only.

10. The graph below shows the relationship between the mass and the weight of an object on the planets, Mars, Earth, and Jupiter.



10.1 Define:

10.1.1 Mass
10.1.2 Weight

10.2 Use the graph and determine the weight of a 150 kg mass on:

10.2.1 Mars
10.2.2 Earth
10.2.3 Jupiter

10.3 Which planet has the strongest gravitational force?

10.4 Explain why Mars, Earth and Jupiter do not have the same gravitational force on a 150 kg object.

10.5 Identify the following variables when comparing the weight of a 150 kg object on each of the tree planets.

10.5.1 Independent variable.
10.5.2 Dependent variable.
10.5.3 Controlled variable.

10.6 Bongi made the following statement:
"I have realised that I should go on a diet an lose some weight, after measuring my weight on a bathroom scale." Indicate the scientific misconception(s) in Bongi's statement.

Circuits and current electricity - Background knowledge (GRADE 8)

- A circuit is a system for transferring electrical energy.
- An electric current is the flow of charge (kinetic energy).
- Cells or batteries store chemical substances (potential energy). When the chemicals react during chemical reactions, energy is produced and transferred to the charges which start to move and an electric current is produced.
- Electric cells supply the energy needed for electrons to move around an electric circuit.
- Electric current is the flow of charges (kinetic energy).
- A CLOSED circuit is needed to make a device work, such as making a bulb light up.
- A circuit has several components connected and current flows from one terminal at the source of energy (cell/battery), along conducting material (wires), through the device (bulb, resistor, buzzer), back to the other terminal of the source of energy (cell/battery).

GRADE 9 CONTENT - ELECTRIC CELLS AS ENERGY SYSTEMS

- A cell is a system in which certain chemical reactions can cause the flow of electricity through an external circuit.
- A cell is a source of electrical energy.
- A battery is a group of cells that are connected together.

INFORMAL ACTIVITY – ELECTRIC CELLS

1. Give the correct WORD or TERM for each of the following descriptions:

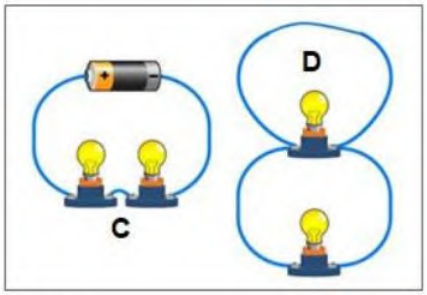
   1.1 The component in an electric circuit which converts chemical energy to electrical energy.
   1.2 The flow of charge.
   1.3 Two or more cells connected to each other.
   1.4 The circuit component that supplies the energy for charges to move.

2. Study photographs A and B.

   2.1 Which photograph represents a battery? Explain your answer.

   2.2 Describe the function of a battery in an electric circuit.

3. Consider the two circuit diagrams, C and D:



   In which circuit will the bulbs NOT glow. Explain why.

RESISTANCE

Uses of resistors

- Conductors (even good conductors) heat up when current passes through them: some energy is 'lost'/'wasted' as heat. All conductors have some resistance.
- A resistor is a conducting material selected to control the current or to provide useful energy transfer, such as in bulbs, rheostats, motors, light sensitive diodes, light emitting diodes.

Factors that affect resistance in a circuit

- **TYPE OF MATERIAL:**
  Different conducting materials have different resistance to an electric current.

- **THICKNESS OF THE CONDUCTOR:**
  Thinner wires have more resistance than thicker wires.

- **LENGTH OF THE CONDUCTOR:**
  Longer wires have more resistance than shorter wires.

- **TEMPERATURE OF THE CONDUCTOR:**
  Generally hotter conductors (metals) have higher resistance than colder conductors.

INFORMAL (PRACTICAL) ACTIVITY - RESISTANCE

Aim: To determine the relationship between the length of a conductor and the resistance of the conductor.

***NOTE:** A decrease in the total current strength in a conductor as measured with an ammeter correlates with an increase in the resistance of the conductor.

Procedure:

Set up an electric circuit which consists of 2 cells, a switch, an ammeter connected in series and a voltmeter connected across a 30 mm conducting wire (e.g., nichrome wire). Complete the circuit for a **short time** by closing the switch. Record the ammeter and voltmeter readings. Repeat the experiment with two more lengths (60 mm and 120 mm) of the same type of wire, with the same cross-sectional area (thickness).

Circuit diagrams:

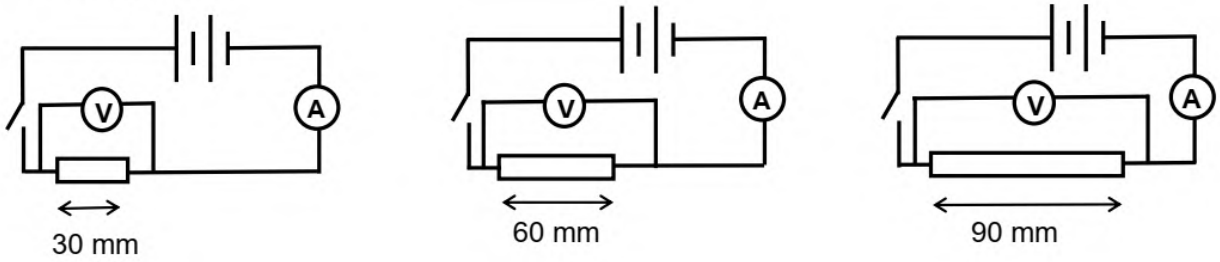


Table of results:

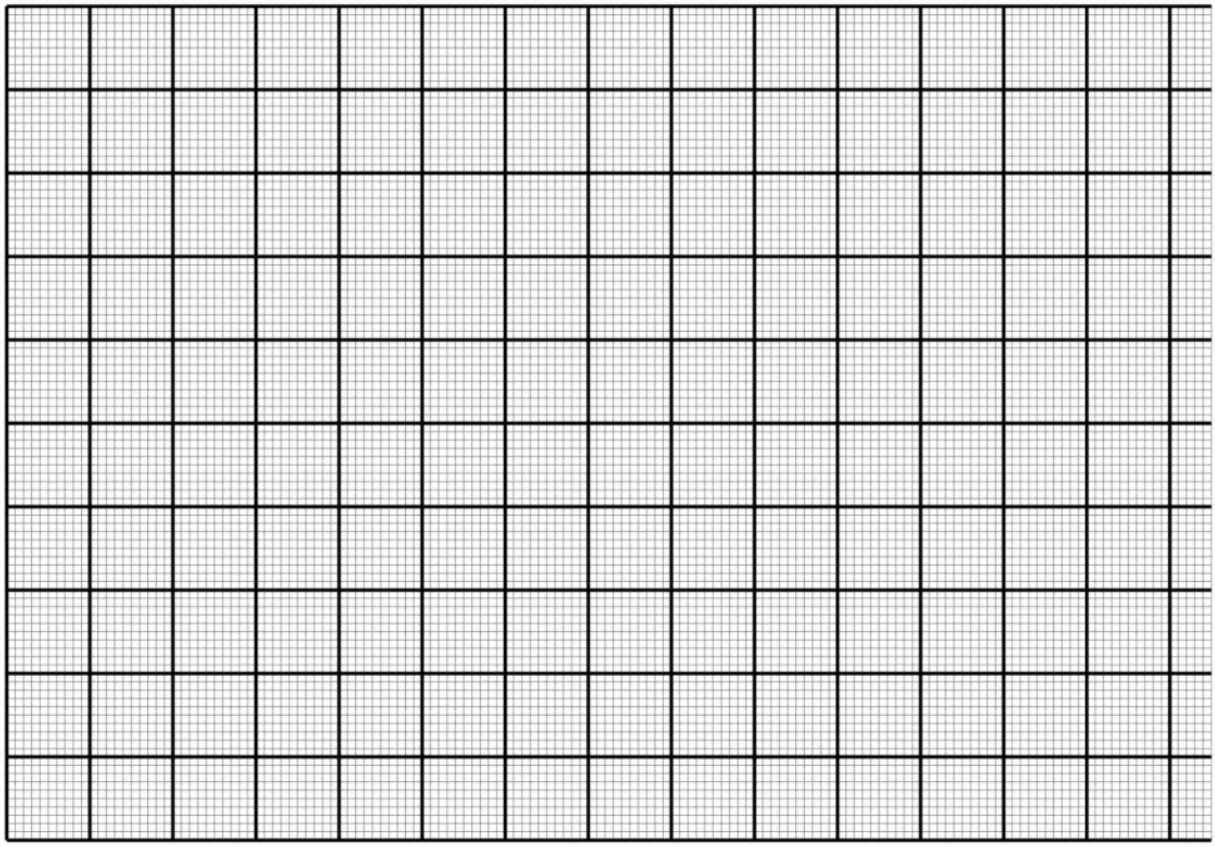
Length of conductor in (mm)	Potential difference "Voltmeter reading" measured in in Volts (V)	Current strength "Ammeter reading" measured in Ampere (A)	Resistance is calculated by dividing the voltmeter reading by the ammeter reading. $R = \frac{V}{I}$ (unit is ohm, Ω)
30	2	1,0	2
60	2	0,5	4
120	2	0,25	8

1.1 Use the results in the table and draw a graph that represents the relationship between the length of a conductor (nichrome wire) and the resistance of a conductor. Make use of the graph paper provided.

Supply the graph with:

- a suitable heading.
- labels on both axes.
- units on both axes.

Heading: _____



1.2 Formulate an investigative question.

1.3 Write down a hypothesis based on the information given in the aim of this experiment.

1.4 When drawing a graph based on the results of the investigation it is important to first identify the dependent and independent variables. Name the dependent and independent variables.

1.5. Name all the controlled variables in this investigation. These are the variables that were kept constant during this investigation.

1.6 Explain the difference between a dependent and an independent variable.

1.7 Do the results of this investigation confirm your hypothesis? Give a reason for your answer. (An analysis of the graph can lead you to an answer.)

1.8 Use the graph to answer the following questions:

1.8.1 What is the shape of the graph?

1.8.2 Determine the resistance of the same nichrome wire used in this activity, but with a length of 45 mm.

1.8.3 Determine the length of a piece of nichrome wire with a resistance of 7 Ω.

1.9 Consider the shape of the graph and derive the relationship that exists between the length of a conductor and the resistance of the conductor.

1.10 Based on the relationship between the length of a conductor and the resistance of a conductor which you have established in question 1.9, predict what will happen to the overall resistance of the conductor when the nichrome wire is extended to twenty times its original length?

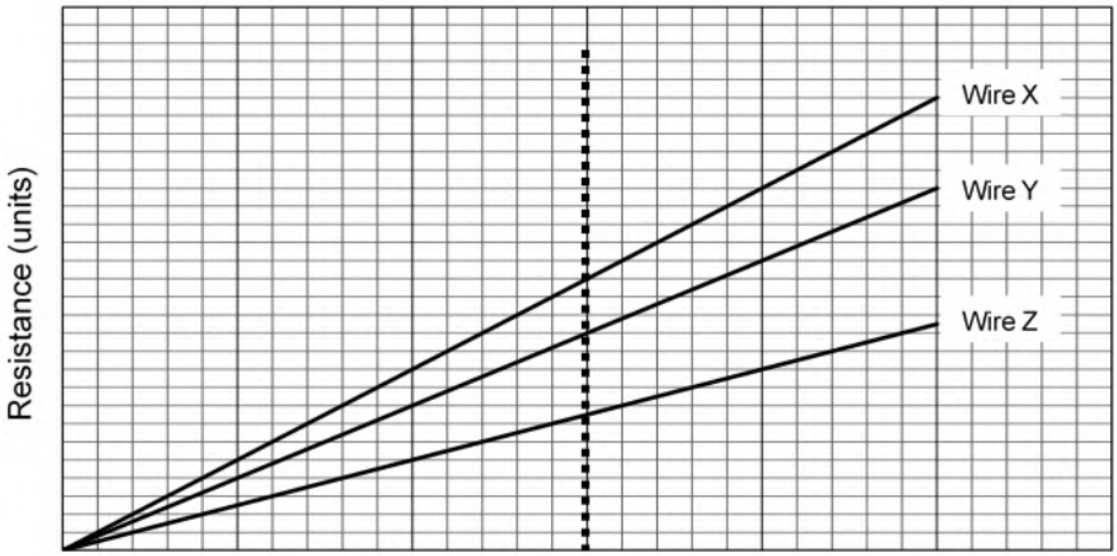
1.11 Choose the correct answer from the following possibilities and write only the LETTER representing the correct answer.

What will happen to the ammeter reading in a series circuit with one bulb when an identical bulb is added in series to the circuit?

A Remains the same
B Increases
C Decreases
D Doubles

1.12 Explain your answer in question 1.11 by referring to the factor which influenced the overall resistance of the circuit when connecting an additional bulb in series.

1.13 The graph below shows the effect of different types of wires of the same length on the resistance in a circuit.



1.13.1 What is the independent variable?

1.13.2 Select the wire which is the best conductor. Write only X, Y or Z.

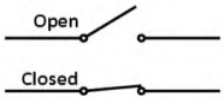
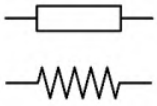
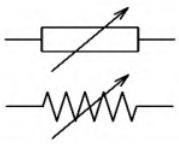
1.13.3 Motivate your choice in question 1.13.2.

1.13.4 Write down THREE other factors that affects resistance.

SERIES AND PARALLEL CIRCUITS

Background knowledge - GRADE 8

Components of a circuit

COMPONENT	SYMBOL	FUNCTION
Cell		Source of energy. Converts chemical potential energy to electrical energy.
Battery (Two or more cells in series.)		Source of energy. Converts chemical potential energy to electrical energy.
Bulb		Source of light. Converts electrical energy to light (and heat) energy.
Open switch Closed switch		Switches control electrical circuits. **Open switch** breaks the circuit and prevents the flow of current. **Closed switch** completes the circuit and allows the current to flow in the circuit.
Resistor		Resists or opposes the flow of electrical current. Resistors control the amount of electric current flowing in a circuit. Resistors (bulb filaments, heating wires, elements in kettles/heaters/geysers/stoves) converts electrical energy to heat energy.
Variable resistor		A resistor whose resistance can be adjusted higher or lower to allow less or more current to flow.
Conduction wire		Carries electric current over a distance.
Ammeter		Measures current strength in ampere (A).
Voltmeter		Measures potential difference in volt (V).

Series circuits
A series circuit provides only ONE PATHWAY for the current passing through it.
The current is the same everywhere in the circuit but every time a resistor is added in series, the overall current in the circuit decreases.

Parallel circuits
A parallel circuit provides TWO OR MORE PATHWAYS for the current passing through it, but the overall current increases when more resistors are added in parallel.

Series and Parallel Circuits

First do the theory and activities on series circuits, then do the theory and activities on parallel circuits.

What you should know:

Series circuits:

S1. A series circuit provides only one pathway for the current passing through it. The current is the same when measured at any point in the circuit.

S2. For **cells** connected in series, the total voltage (potential difference) across the battery is the sum of the voltages of each individual cell.
$V_{total} = V_1 + V_2 + V_3 + \ldots$

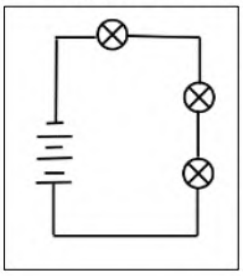
S3. For **resistors** connected in series, the total voltage across the battery is the same as the sum of the voltages across each of the resistors.
$V_{total} = V_1 + V_2 + V_3 + \ldots$
Resistors in series are potential dividers.

S4. A resistor with a higher resistance will have a higher voltage across it.

S5. A resistor with a lower resistance will have a lower voltage across it.

S6. The total current DECREASES with each resistor added in series because the total resistance INCREASES.

S7. If one light bulb fuses (filament breaks) or if the circuit is broken, the rest/all the bulbs go off.



When one bulb is removed from its socket, the other bulbs in series "goes out".

NOTE: "TOTAL" MEANS THE TOTAL CURRENT IN THE CIRCUIT OR THE TOTAL RESISTANCE IN THE CIRCUIT.

Parallel circuits:

P1. A parallel circuit provides two or more pathways for the current passing through it.

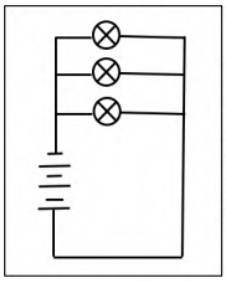
P2. For **cells** (of same voltage) connected in parallel, the voltage across them is the same as for one cell.
$V_{battery} = V_1 = V_2 = V_3 = \ldots$

P3. For **resistors** connected in parallel, the voltage is the same across each resistor connected in parallel.
$V_{R1} = V_{R2} = V_{R3} = \ldots$

P4. The total current through the battery is the same as the sum of the currents through the resistors.
Resistors in parallel are current dividers.

P5. The total current in the circuit INCREASES with each resistor added in parallel because the total resistance DECREASES.

P6. The lighting system in our homes is usually connected in parallel. If one light bulb fuses (filament breaks), the rest of the lights remain on because they are each connected in their own parallel pathway to the mains circuit.

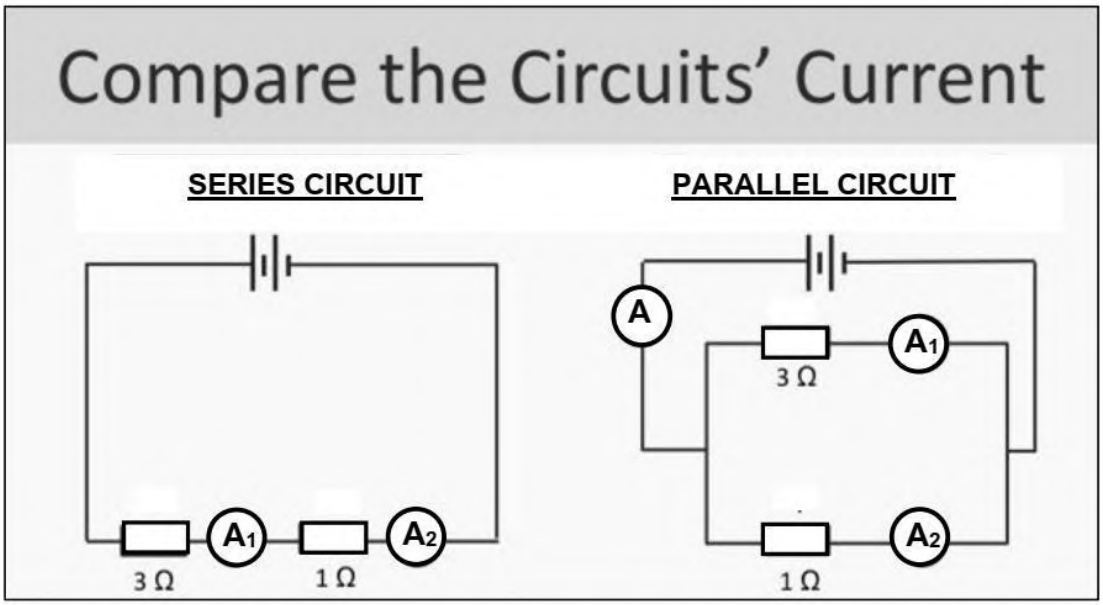


When one bulb is removed from its socket, the other bulbs in the parallel branches remain lit.

P7. For two circuits/resistors with the same total voltage the current will be bigger in a circuit/resistor with low resistance.

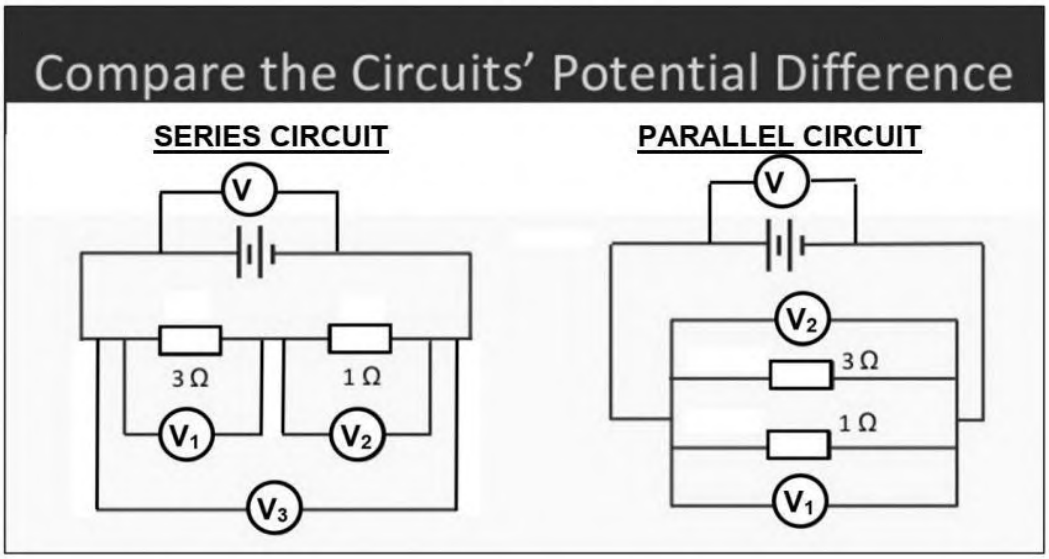
P8. For two circuits/resistors with the same total voltage the current will be smaller in a circuit/resistor with high resistance.

Compare the Circuits' Current



Current has only one path to flow.	Current splits into different paths.
Reading on A_1 = Reading on A_2	Reading on A = Reading on A_1 + A_2.
Same current flows through all resistors.	Main current is shared between the two resistors.
	Resistors in parallel are current dividers.

Compare the Circuits' Potential Difference

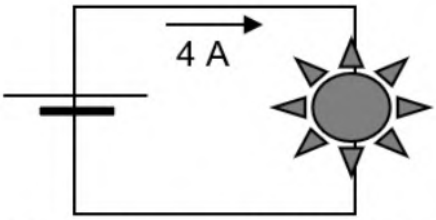


Reading on V = Reading on V_3 = Reading on V_1 + V_2	Reading on V = Reading on V_1 = Reading on V_2
Potential difference is shared by the two resistors.	Potential difference is the same across each resistor.
Resistors in series are potential dividers.	

Note:
*To measure voltage, a **voltmeter** must be connected in **parallel** across a resistor or battery.*
*To measure current, an **ammeter** needs to be connected in **series** (in line) with the resistor or battery.*

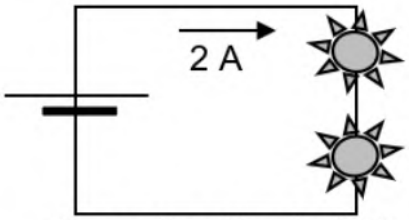
Compare the brightness of bulbs:

1.



One cell and one bulb in series.

- Bulb glows bright.



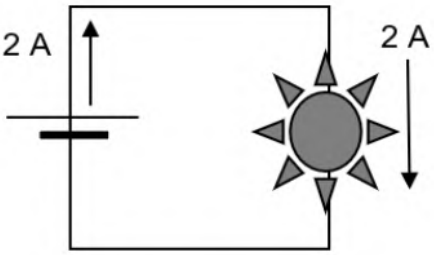
One cell and two bulbs in series.

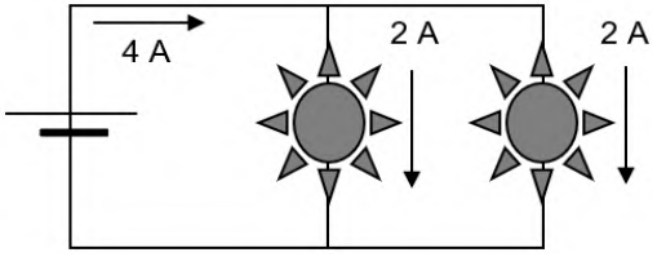
- Bulbs glow dimmer.

Explanation:

When a second bulb is connected in series, the overall resistance of the circuit will increase, therefore the total current which flows through all the components (bulbs) will decrease.

2.





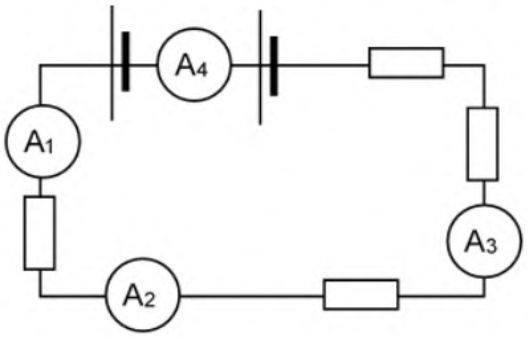
Explanation:

When a second bulb is connected in parallel, the **overall resistance** of the circuit **decreases**, therefore the **total current** in the circuit i**ncreases**. This larger total current (4 A) divides into two branches in the parallel circuit. The branches receive a current of 2 A each.

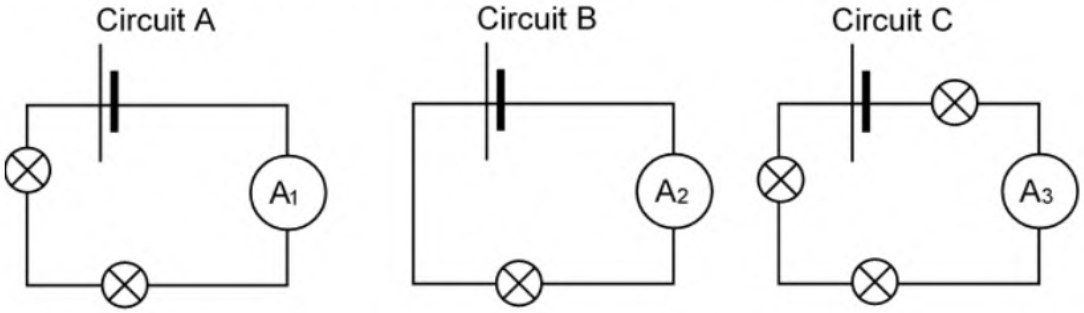
INFORMAL ACTIVITY – SERIES AND PARALLEL CIRCUITS

SERIES CIRCUITS

1. In the circuit diagram below, the reading on ammeter A_1 is 2 A.
Give the readings on ammeters A_2, A_3 and A_4. Explain your answer(s)



2. In the circuit diagrams below, all the cells and bulbs are identical.

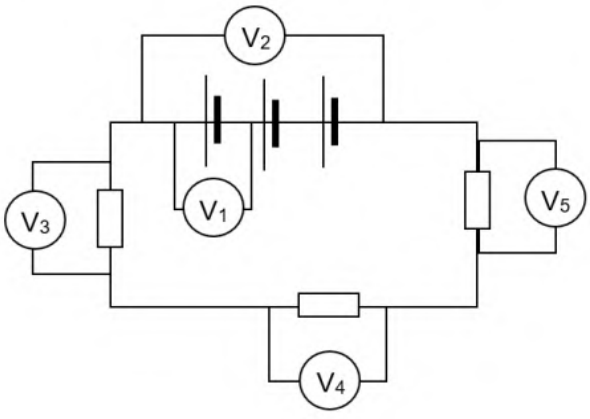


2.1 Arrange the ammeter readings from highest to lowest. Explain your answer.

2.2 Arrange circuits A, B and C in order from dimmest bulbs to brightest. Explain your answer.

2.3 What will happen in Circuit C if one of the bulbs fuses? Give a reason for your answer.

3. In the circuit diagram below, the cells and resistors are identical. The reading on V_1 is 1,5 V. Determine the readings on all the other voltmeters.



SAFETY WITH ELECTRICITY

Safety practices

- Parallel connections can cause overload on mains circuits.
- Circuit breakers, fuses and earth leakage systems are used as SAFETY DEVICES.
- Many appliances have a 3-pin plug as a safety device to connect to the main circuit.
- THE 3-PIN PLUG has a live wire, neutral wire, and an earth wire.
- The earth wire is connected to the metal case of the appliance, such as in a kettle. The earth wire is connected via the wall plug to an earth cable in the ground.
- The earth cable has almost zero resistance, so if the metal casing of an appliance becomes charged due to a fault, the charge is safely discharged to the ground.
- Illegal connections to the ESKOM mains supply can be dangerous and are regarded as energy theft.

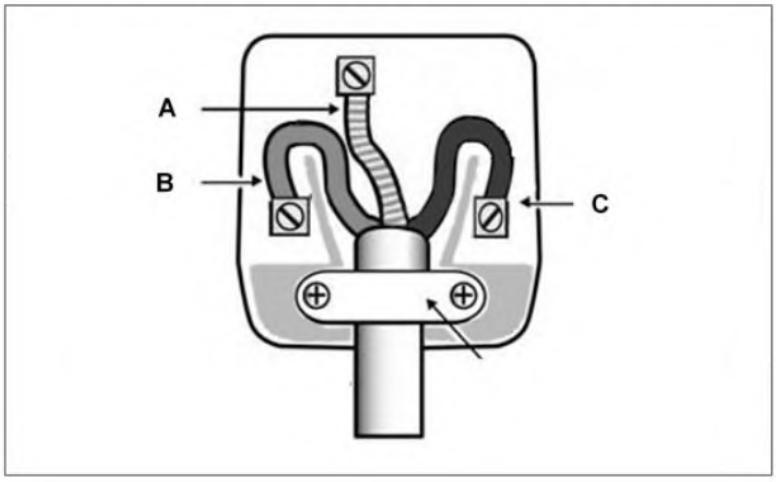
INFORMAL ACTIVITY – SAFETY PRACTICES

1. Study the following items. Only give the LETTER of the correct answer.

Identify the items from left to right as shown above.

A Fuses, resistors, LED, circuit breaker.
B Conductors, insulators, light bulb, switch.
C Connectors, resistors, fuse, circuit breaker.
D Connectors, resistors, circuit breaker, switch.

2. Label A, B and C in the drawing of a 3-pin plug to show the correct wiring.



ENERGY AND THE NATIONAL ELECTRICITY GRID

Electricity generation

- A power station is a system for generating electricity.
- Most power stations in South Africa use coal as a fuel to boil water.
- The steam from the water turns a turbine which turns a generator, which produces electricity.
- There are other alternative sources of energy besides coal, that can be used to drive turbines and generators including wind, falling water (hydroelectric), sun-heated steam, nuclear fission, waves in the sea.

Nuclear power in South Africa

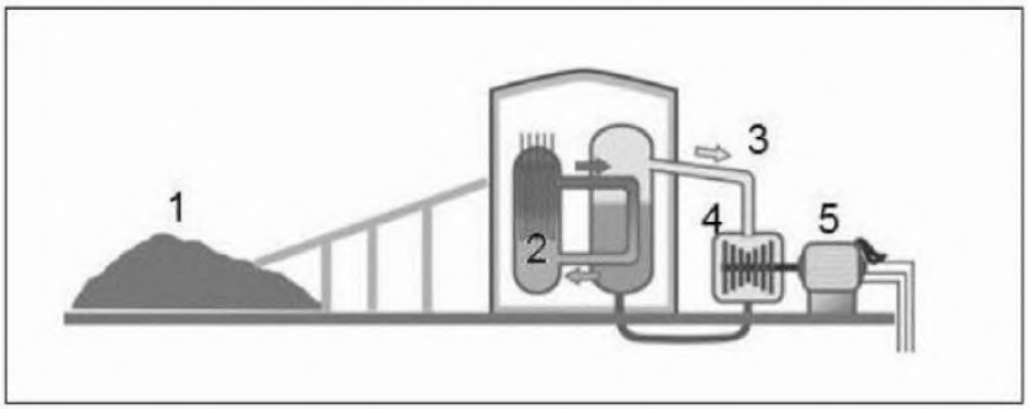
- A nuclear power station such as Koeberg in the Cape, uses radioactive fuel. The radioactivity produces heat through nuclear fission. The heat is then used to boil water to produce steam.
- The steam from the water turns a turbine which turns a generator, that produces electricity.
- The electricity is then channelled into the national electricity grid.
- Spent nuclear fuel (nuclear waste) is still radioactive and remains so for many hundreds of years, therefore it needs to be properly disposed of, so it is not a danger to life for years to come.

National electricity grid

- The national grid is a network of interacting parts (a system).
- Change in one part of the grid affects other parts of the grid.
- Power stations feed electrical energy into the national grid at high voltages.
- Power lines carry electricity at high voltages.
- Transformers step down the voltage for local distributors and consumers: 15% of energy is wasted due to heating of ttransmission lines and transformers.
  [No details are required of alternating current or step-down transformers].
- Power surges and grid overload can disrupt the power supply.

INFORMAL ACTIVITY – ENERGY AND THE NATIONAL ELECTRICITY GRID

1. Study the diagram below and read the passage before answering the questions.



This diagram shows a typical coal-fired power station producing electricity.
Coal (1) is burnt to generate heat which boils water under high pressure in a boiler (2). This produces high pressure steam which is taken through pipes (3) to the turbine (4) where it is used to turn the turbine at high speeds. From the turbine, the steam enters the condenser where it is cooled back into liquid water. The water is then returned to the boiler.

The turbine shaft is used to rotate the large magnets within coils of wire which form the main parts of the generator (5). The energy needed to spin the magnet in the coils of wire comes from the heat produced by burning the coal. A giant power station can burn about 350 tons of coal per hour.

1.1 What causes the turbine to rotate?

1.2 List two DISADVANTAGES of coal-fired power stations.

1.3 Suggest FIVE alternative sources of energy that can be used for the generation of electricity, other than coal.

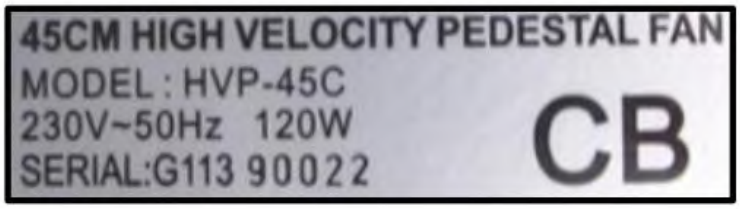
1.4 State the similarities and differences between a coal fired power station and a nuclear power station.

INFORMAL ACTIVITY - THE COST OF ELECTRICAL POWER CONSUMPTION

1. Calculate the cost of using a 2500 W electric dryer for 30 minutes when the cost of electricity is R 2.40/kWh.

2. The power rating of an electric frying pan and a fan is indicated on the labels found on these two appliances.

Fan



Frying Pan

2.1 Convert the power rating for BOTH the fan and the frying pan to kW.

2.2 Determine the number of electricity units used by the frying pan when it is operating for 4 hours.

2.3 Calculate the cost of electricity when the frying pan is used for four hours. You can assume that the unit cost of electricity is R1.94 /kWh.

2.4 Calculate the number of hours that the fan can operate using the same amount of electricity that the frying pan uses in 4 hours.

3. For a family of four, an ordinary electric geyser with a power rating of 2 600 W uses electricity for 4,4 hours a day. A solar geyser with electric back-up uses 4,42 kWh per day. The cost of a unit of electrical power is R 1,22 / kWh.

Calculate the amount of money that can be saved per day if the solar geyser with electric back-up is used instead of the ordinary electric geyser.