8.3 EXPERIMENT BOOKLET

8.3.3 Series and parallel circuits serve different purposes in households

3.P1 Plan, choose equipment or resources for and perform first-hand investigations to gather data and use available evidence to **compare measurements of current and voltage in series and parallel circuits** in **computer simulations** or **hands-on equipment**

Aim

To compare current and voltage in series and parallel circuits

Hypothesis

That, in series, **current will remain the same**, and **voltage differences will add** to supply voltage
That, in parallel, **current will add** to current through power supply, and **voltage will be the same**

Variables

Independent: Series and parallel, location of voltmeter and ammeter
Dependent: Measured current and voltage
Controlled: Supply voltage, resistance of components

Equipment

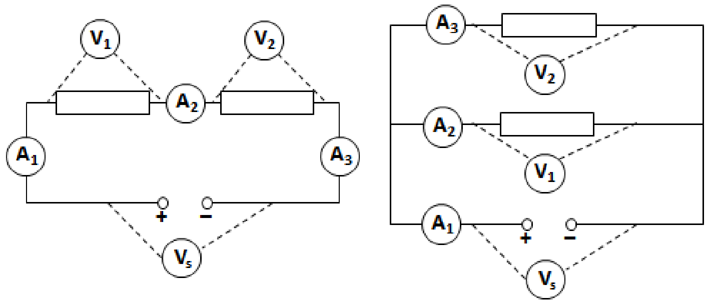
- Ammeter
- Voltmeter
- Power Pack
- 2 Light Bulbs
- Leads

Method

1. Set up equipment as shown in the Series Circuit Diagram.
2. Set power pack to 6V.
3. Record voltmeter and ammeter readings from positions shown in the diagram.
4. Repeat steps 2 and 3 using the Parallel Circuit Diagram setup.
5. Tabulate results.

Diagrams

Series Circuit Parallel Circuit



Safety

Identification of risk	Description of harm	Strategies to minimise risk
Components can get hot	Burning fingers	Switch off circuit when not in use
Circuit may be incorrectly wired	Short circuit, components may break	Test at 2V, flick switch on and off

Results

Series Circuit				Parallel Circuit			
V Position	Voltage (V)	A Position	Current (A)	V Position	Voltage (V)	A Position	Current (A)
V (supply)	5.5	A 1	0.15	V (supply)	5.5	A 1	0.4
V 1	2.75	A 2	0.15	V 1	5.25	A 2	0.2
V 2	2.75	A 3	0.15	V 2	5.25	A 3	0.2

Discussion

Trends: In series, $V_s = V_1 + V_2$, but current remains the same. In parallel, voltage remains the same, but $A_3 = A_1 + A_2$

Conclusion

In series, **current will remain the same**, and **voltage differences will add** to supply voltage, while in parallel, **current will add** to current through power supply, and **voltage will be the same.**

3.P2 Plan, choose equipment or resources and perform a first-hand investigation to **construct simple model household circuits** using **electrical components**

Aim

To construct a model of a household circuit

Equipment

- Power Pack
- 3 switches
- Leads
- 3 Light Bulbs

Method

1. Design the wiring system for a household, including a living room, bedroom, bathroom and kitchen.
    - The stove and hot water system are on a separate circuit
    - Lights and other appliances should be on separate circuits
    - Fuses should be placed for each circuit
    - Switches should be in series with the power outlet, and placed on active wire
2. Construct a circuit in parallel with three lights and switches, simulating a lighting system

Diagrams

Diagram unavailable
Diagram is different based on practical

Safety

Identification of risk	Description of harm	Strategies to minimise risk
Components can get hot	Burning fingers	Switch off circuit when not in use
Circuit may be incorrectly wired	Short circuit, components may break	Test at 2V, flick switch on and off

Discussion

Modelling:

Advantages:

- Allows predictions and design improvements when diagram is drawn
- Understanding of different current requirements for appliances
- Process can be visualised easily

Limitations

- Did not include many details, e.g. circuit breakers, specific current required for appliances
- Design could not be fully made using electrical components
- Circuit was a simplified – did not include earth wiring

Conclusion

By modelling and designing a household wiring system by setting up a simple circuit, a greater understanding of different wiring requirements can be achieved.

8.3.4 The amount of power is related to the rate at which energy is transformed

4.P1 Perform a first-hand investigation, gather information and use available evidence to demonstrate the **relationship between current, voltage and power** for a model **6 V to 12 V electric heating coil**

Aim

To test 6 V and 12 V heating coils and measure current, voltage and power

Hypothesis

That $R = \frac{V^2}{P}$ and $R = \frac{P}{I^2}$

Variables

Independent: Applied voltage onto heating coil
Dependent: Temperature
Controlled: Time, initial heating coil temperature

Equipment

- Power Pack
- Ammeter
- Voltmeter
- Thermometer
- Leads

Method

1. Set up a circuit with a voltmeter across a heating coil, ammeter and power pack.
2. Measure initial temperature, and switch on voltage to 6 V.
3. Measure final temperature after three minutes.
4. Repeat steps 2 and 3 for 12 V.
5. Calculate power.

Safety

Identification of risk	Description of harm	Strategies to minimise risk
Components can get hot	Burning fingers	Switch off circuit when not in use
Circuit may be incorrectly wired	Short circuit, components may break	Test at 2V, flick switch on and off

Results

Voltage (V)	Current (I)	Power (W)	Δt (s)	Energy In (J)	ΔT (°C)
6	2	12	180	2160	8
12	2.5	30	180	5400	34

Discussion

Trends:

- As **voltage increases**, **current** increases (as resistance increases due to heat) $R = \frac{V}{I}$
- As **voltage increases**, energy used (power) **increases more than double**
    - This is because $\boldsymbol{R = \frac{V^2}{P}}$ – a large increase in P required to keep R constant
    - However, resistance increased at a higher temperature

Validity – some energy was lost to the environment/container – fix by using foam cup

Conclusion

The relationship between power, voltage and current is $\boldsymbol{R = \frac{V^2}{P}}$ **and** $\boldsymbol{R = \frac{P}{I^2}}$, and was found by testing 6 V and 12 V heating coils for their temperature change.

8.3.5 Electric currents also produce magnetic fields and these fields are used in different devices in the home

5.P1 Plan, choose equipment or resources for, and perform a first-hand investigation to **build an electromagnet**

BACKGROUND

- Magnetic material becomes magnetised in a magnetic field
  - **Soft iron** – temporary: magnetised quickly, loses magnetism when field removed, e.g. nail
  - **Hard iron** – permanent: hard iron slowly magnetised
- **Electromagnet** – solenoid with a soft iron core – stronger magnet than just a solenoid

Aim

To build an electromagnet

Equipment

- Copper wire
- Power pack
- Long iron nail
- Paperclips
- Leads

Method

1. Wrap copper wire around the nail, and triple the layer of coil by winding back.
2. Connect the coil with the power supply.
3. Bring the coil near paperclips.
4. Record results.

Safety

Identification of risk	Description of harm	Strategies to minimise risk
Components can get hot	Burning fingers	Switch off circuit when not in use
Circuit may be incorrectly wired	Short circuit, components may break	Test at 2V, flick switch on and off

Results

Paper clips were attracted to the coil when power was turned on.
Paper clips did not attract to the coil without current.

Discussion

The paper clips were attracted to the iron nail when the iron core was magnetised, but did not attract to the coil when it was not magnetised.

Conclusion

When current flowed, the iron core became magnetised, as seen from the effect on the paper clips.

5.P2 Perform a first-hand investigation to observe magnetic fields by mapping **lines of force**: around a **bar magnet**, surrounding a **straight DC current-carrying conductor**, a **solenoid** and present information **using ⊗ and ⊙** to show the **direction of a current and direction of a magnetic field**

Aim

Observe magnetic fields around a bar magnet, surrounding a straight DC current-carrying conductor and a solenoid

Equipment

- Bar magnet
- Iron filings
- Leads
- Compass
- Solenoid
- Sheet of paper

Method

Part 1 – Bar Magnet

1. Place a bar magnet under a sheet of paper.
2. Sprinkle iron fillings over sheet of paper.
3. Draw the pattern formed by the iron fillings.

Part 2 – Straight DC Current-carrying Conductor

1. Straighten a wire and connect it to a power supply, allowing conventional current to flow from top to bottom.
2. Place a compass horizontal to the conducting wire.
3. Observe the position of the needle at different locations around the wire.

Part 3 – Solenoid

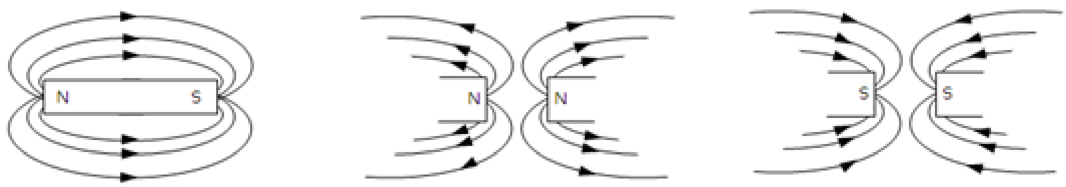
1. Connect a solenoid to the power supply, and allow conventional current to flow to the right.
2. Place a compass near the solenoid.
3. Observe the position of the needle when compass is placed around the solenoid.

Safety

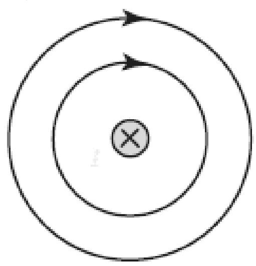
Identification of risk	Description of harm	Strategies to minimise risk
Components can get hot	Burning fingers	Switch off circuit when not in use
Circuit may be incorrectly wired	Short circuit, components may break	Test at 2V, flick switch on and off

Results

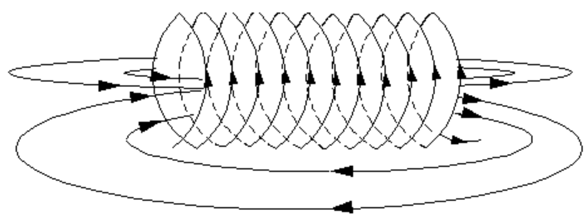
Part 1



Part 2



Part 3



Conclusion

By using the movement of a compass needle, the magnetic fields around a bar magnet, surrounding a straight DC current-carrying conductor, a solenoid were observed to travel from the North pole to the South pole, and clockwise towards the circuit.