Current And Voltage Measurements: Resistors In Parallel

Topic

Characteristics of parallel circuits

Introduction

In Experiment 7.05, you investigated circuits connected in series. This experiment is concerned with parallel circuits. In parallel circuits, a number of components are joined at junctions so that the current divides, with part of the current passing through each component before recombining to pass through the rest of the circuit. In this experiment, you will investigate the rule governing how the current in a circuit splits between different resistors wired in parallel. You will also measure the voltages at different points in a parallel circuit.

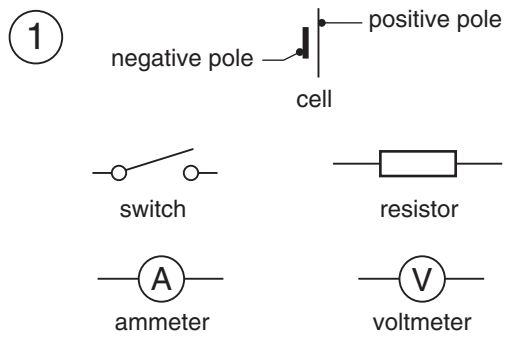
Time required

30 minutes for Part A
30 minutes for Part B

Materials

3 × 1.5 volt D batteries in holders
3 resistors (0.25 watts) with a fixed resistance of between 20 and 50 ohms
11 clip leads
knife switch (single pole, single throw type)
ammeter
voltmeter
small piece of aluminum foil (about 5 cm square)
marker pen

The appearance of the components may vary among suppliers (see Appendix A for website addresses of possible suppliers). Circuit diagrams are given in this experiment to show the arrangement of the components. Diagram 1 adjacent shows the symbols used in these diagrams.



Symbols used in circuit diagrams

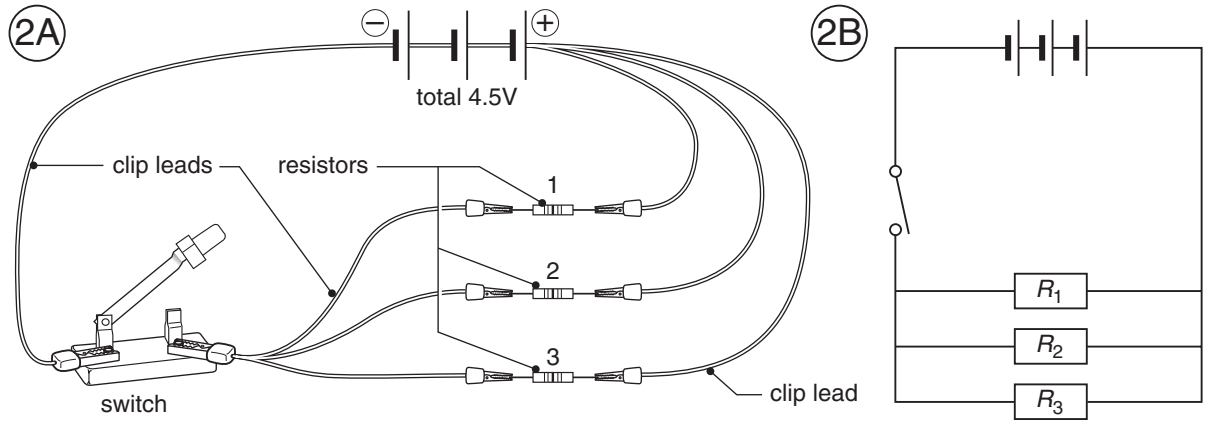
Safety note

Do not use an electrical outlet.

Procedure

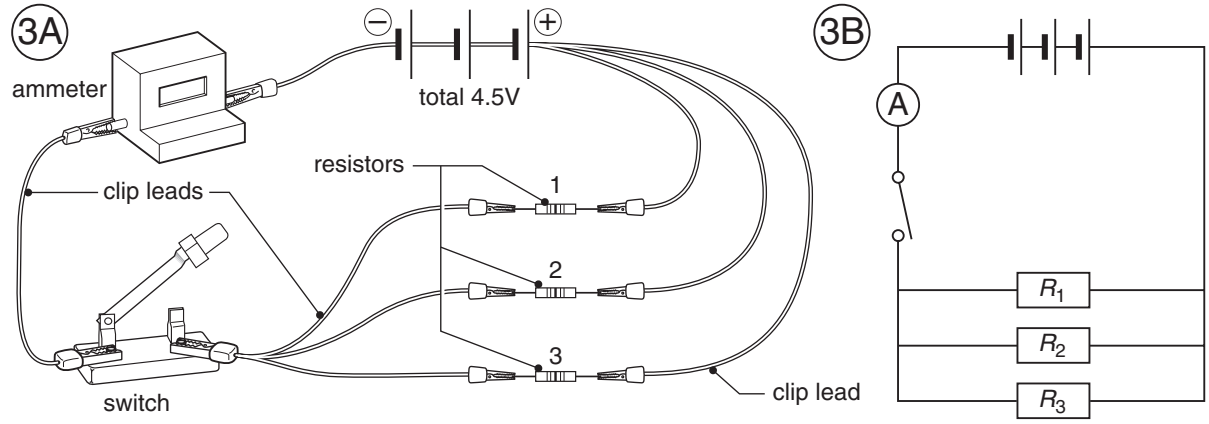
Part A: Investigating electric current flowing through a parallel circuit

1. Connect the cells, switch, and resistors as shown in diagram 2 below. Number the resistors 1 – 3. If necessary, tear off a piece of aluminum foil and wrap it around the wire end of a resistor to make a more secure connection in the clip.



Circuit with three resistors connected in parallel: wiring diagram (A) and circuit diagram (B)

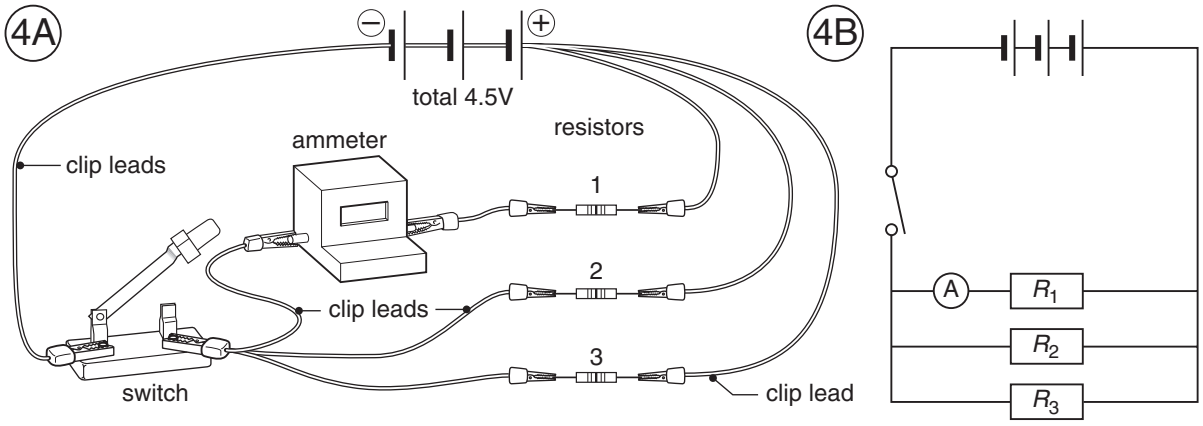
2. Connect the ammeter between the switch and a cell to measure the current in the undivided part of the circuit (see diagram 3 below). Close the switch and record the ammeter reading in data table A on the next page.



Circuit with ammeter connected between the switch and a cell: wiring diagram (A) and circuit diagram (B)

3. Open the switch. Disconnect the ammeter and reconnect the switch to the cell. Connect the ammeter between the switch and resistor 1 (see diagram 4 on the next page) to measure the current flowing through this resistor. Close the switch and record the ammeter reading for resistor 1 in data table A.
4. Open the switch. Disconnect the ammeter and reconnect the switch and resistor 1. Connect the ammeter between the switch and resistor 2 to measure the current flowing through this resistor. Close the switch and record the ammeter reading for resistor 2 in data table A.

5. Open the switch. Disconnect the ammeter and reconnect the switch and resistor 2. Connect the ammeter between the switch and resistor 3 to measure the current flowing through this resistor. Close the switch and record the ammeter reading for resistor 3 in data table A.
6. Open the switch.
7. Add up the readings taken for the current through each resistor. Record this value in the cell at the bottom of the right-hand column of data table A.

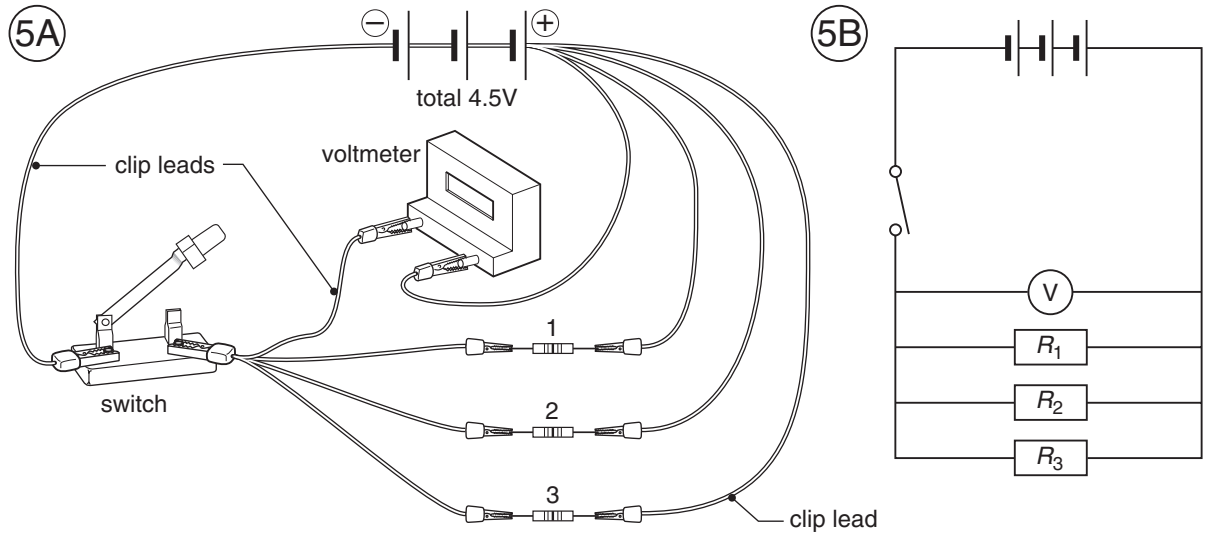


Circuit with ammeter connected between the switch and resistor 1: wiring diagram (A) and circuit diagram (B)

DATA TABLE A		
		Amperes
Ammeter reading between switch and cell (main part of the circuit)	I	
Ammeter reading through resistor 1	I_1	
Ammeter reading through resistor 2	I_2	
Ammeter reading through resistor 3	I_3	
Sum of the ammeter reading through resistors 1, 2, and 3		

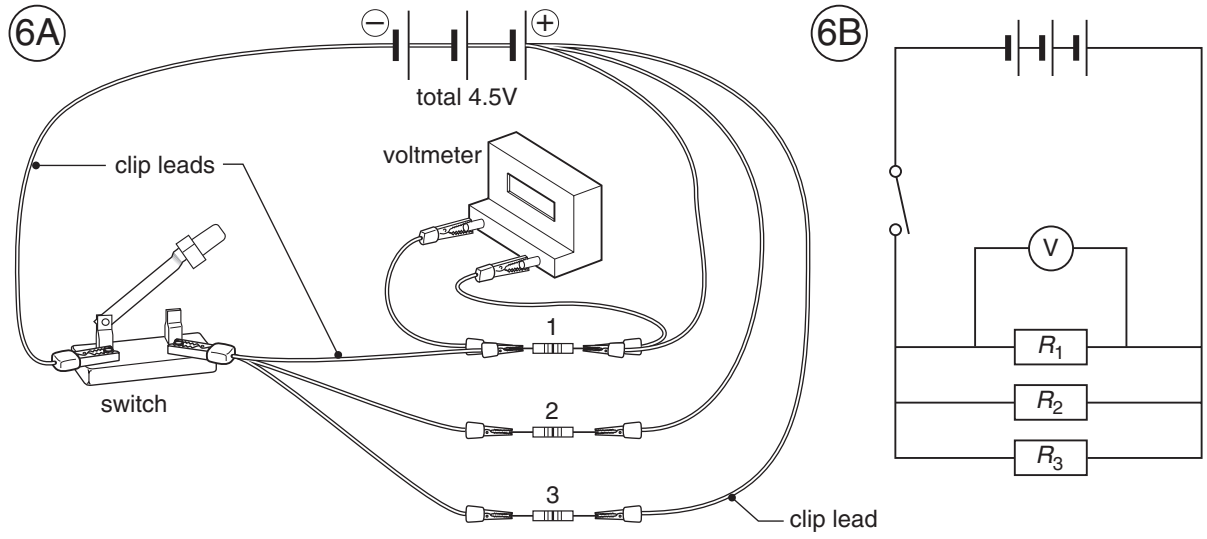
Part B: Investigating potential difference across resistors in a parallel circuit

1. Connect the components as shown in diagram 5 on the next page. The voltmeter is connected to measure the voltage across all three resistors.
2. Close the switch. Record the voltmeter reading in the first row of data table B on page 7.06–5.
3. Open the switch. Disconnect the voltmeter and connect it across the terminals for resistor 1 (see diagram 6 on the next page). Close the switch and record the voltmeter reading for resistor 1 in data table B.



Voltmeter connected to measure voltage across all three resistors: wiring diagram (A) and circuit diagram (B)

4. Open the switch. Disconnect the voltmeter and reconnect it across the terminals for resistor 2. Close the switch and record the voltmeter reading for resistor 2 in data table B.
5. Open the switch. Disconnect the voltmeter and reconnect it across the terminals for resistor 3. Close the switch and record the voltmeter reading for resistor 3 in data table B.
6. Open the switch.



Voltmeter connected to measure voltage across resistor 1: wiring diagram (A) and circuit diagram (B)

DATA TABLE B		
		Volts
Voltmeter reading across all three resistors	V	
Voltmeter reading across resistor 1	V_1	
Voltmeter reading across resistor 2	V_2	
Voltmeter reading across resistor 3	V_3	

Analysis

Part A: Investigating electric current flowing through a parallel circuit

1. How do the readings for the current through each resistor compare with the reading for the main (undivided) part of the circuit?

Part B: Investigating potential difference across resistors in a parallel circuit

1. What can you say about the voltages across the resistors in the parallel circuit compared with the voltage measured across all three resistors?

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Part A: Investigating electric current flowing through a parallel circuit

1. The current in the main part of the circuit is equal to the sum of the current through the individual resistors in the parallel part of the circuit:

   $I = I_1 + I_2 + I_3$

   where I is the current in the main (undivided) part of the circuit, I_1 is the current through resistor 1, I_2 is the current through resistor 2, and I_3 is the current through resistor 3.

Part B: Investigating potential difference across resistors in a parallel circuit

1. The voltage is the same across all individual resistors (irrespective of their resistance) and across all three resistors.

   $V = V_1 = V_2 = V_3$

   where V is the potential difference across all three resistors, V_1 is the potential difference across resistor 1, V_2 is the potential difference across resistor 2, and V_3 is the potential difference across resistor 3.

   At a constant temperature, the resistance of a conductor (R) is equal to the potential difference across the conductor (V) divided by the current through it (I), i.e.,

   $$R = \frac{V}{I}$$

   This is statement is known as Ohm's Law. It is investigated in Experiment 7.07 Relationship Between Current, Voltage, and Resistance In A Circuit.

The total resistance of conductors connected in parallel (R) is given by:

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

Resistors are used in this experiment rather than light bulbs because the wire in a light bulb heats up when it is lit. This increases its resistance.