Light Bulb Brightness In Two Types Of Circuit

Topic

Series and parallel circuits

Introduction

In Experiments 7.02 and 7.03, the circuits had components connected in such a way that current moved in series through each component in turn. In this experiment, you will look in more detail at a series circuit. You will also look at a circuit where components are joined at junctions where the current can take one of a number of paths. Such a circuit is called a parallel circuit.

Time required

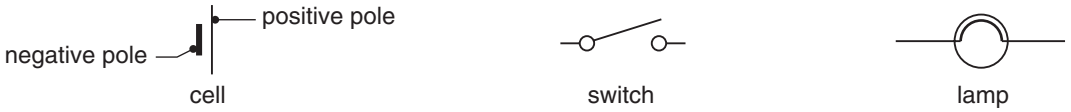
15 minutes for Part A
15 minutes for Part B

Materials

3 × 1.5 volt D cell batteries in holders
3 × 4.5 volt (0.3 amp) bulbs in holders
knife switch (single pole, single throw type)
9 clip leads

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 below shows the symbols used in these diagrams.

1



Symbols used in circuit diagrams

Safety note

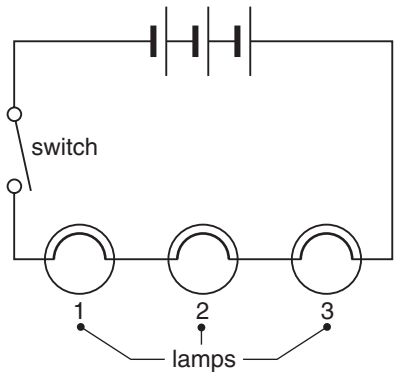
Do not use an electrical outlet.

Procedure

Part A: Series circuits

1. Connect the cells, bulbs, and switch (open) as shown in diagram 2 below.
2. Close the switch and observe the brightness of the bulbs. Record your observations in data table A below.
3. Open the switch and remove one of the bulbs from its holder. Close the switch. Record your observations in data table A.
4. Open the switch and disconnect two of the bulb holders. Reconnect the circuit leaving one bulb with its holder in the circuit with the cells and switch.
5. Close the switch and observe the brightness of the bulb. Record your observations in data table A.

2



Arrangement of series circuit

DATA TABLE A

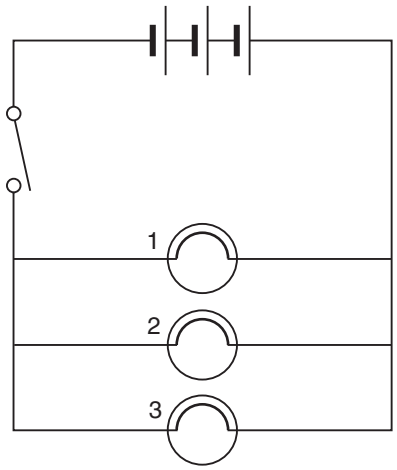
	Observations
Circuit with three bulbs connected	
Circuit with one bulb removed from its holder	
Circuit with one bulb connected	

Part B: Parallel circuits

1. Arrange the cells, bulbs, switch (open), and connectors as shown in diagram 3 on the next page.
2. Close the switch and observe the brightness of the bulbs. Record your observations in data table B on the next page.

3. Open the switch. Remove one of the bulbs from its holder.
5. Close the switch and observe the bulbs. Record your observations in data table B.

3



Arrangement of parallel circuit

DATA TABLE B

	Observations
Circuit with three bulbs connected	
Circuit with one bulb removed from its holder	

Analysis

Part A: Series circuits

1. Are the three lights connected in series bright or dim?
2. When one of the bulbs is removed from its holder, what happens to the other bulbs in the circuit when the switch is closed?
3. If only one bulb is connected in the circuit, is it bright or dim?

Part B: Parallel circuits

1. Do the three bulbs connected in parallel glow brightly or dimly?
2. When one bulb is removed from its holder and the switch is closed, what happens to the remaining bulbs?

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To understand the way in which the electric circuits work, it might be useful to imagine the circuit as a pavement on which a large number of runners are trying to race around as fast as possible (the track is the electric circuit and the runners are the electrons). A bulb resists the flow of electricity – it is like a narrow bridge over a river; it is difficult for the runners to get over the bridge and it slows them down. The table on the next page gives more examples of this type of imagery. A bulb glows brightly if there is a large electric current through it and glows dimly if the current is small.

Part A: Series circuits

1. When three lights are connected in series, they are all glow dimly. This is because the power produced by the cells has to "push" the electrons through

three bulbs one after the other. This slows the electrons down. (This is rather like expecting the runners to line up to pass over three narrow bridges one after another – it slow them down.) Slower electrons in the circuit mean that the electric current is smaller, which in turn means that the bulbs glow more dimly.

Item	Representation
Electrical circuit	Running track
Electrons	Runners
Large electric current	High speed of runners
Small electric current	Slow speed of runners
Break in circuit (no current)	Obstruction on track, runners stop
Resistor (such as light bulb)	Narrow bridge
3 resistors in series	Bridges over three consecutive rivers
3 resistors in parallel	Three bridges side by side over one river

2. If one bulb is removed from its holder, the other two bulbs in the circuit do not light. This happens because the circuit is not complete, and the electrons are unable to flow around the circuit. (Imagine that one of the narrow bridges is removed. The runners will come to a stop.)
3. If only one bulb is connected in the circuit, it glows brightly. This is because the power produced by the cells only has to "push" the electrons through one bulb. (Imagine there is now only one bridge in the running track. The runners only have to slow down once and can therefore keep up a higher speed than if there were three bridges.) Faster moving electrons in the circuit mean that the electric current is larger, which in turn means the bulb glows more brightly.

Part B: Parallel circuits

1. The bulbs connected in parallel all glow brightly because each is effectively connected to the cells. (Imagine that there are three narrow bridges in the running track as before, but now they are arranged side by side – as if giving alternative routes over a single river. The runners have a choice of bridges so they don't have to slow down and line up, but can keep up their speed.) The electrons have a choice of paths around the circuit and can keep up their speed. The current is therefore larger and the bulbs glow brightly.
2. The remaining bulbs in the parallel circuit glow even more brightly. (Imagine that one of the bridges is removed. There are still two bridges available so the runners don't have to slow down much, and each bridge carries more runners in the same time than it did before). More electrons are now passing through each bulb in the same time, i.e., the speed of electrons per second is greater. This means that the electric current is larger and thus the bulbs glow more brightly.