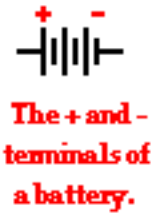
Circuit Diagrams

A **circuit diagram**, or **schematic**, is a simplified drawing used to represent an electric circuit. These diagrams use a set of standard symbols to represent the various components of an electric circuit. Some of these symbols are shown below.

A single cell (a single 1.5 V battery) or other power source is represented by a long and a short parallel line. A collection of cells, or a larger battery (like a 9 V), is represented by a collection of long and short parallel lines. In both cases, the long line represents the positive terminal of the battery, and the short line represents the negative terminal.

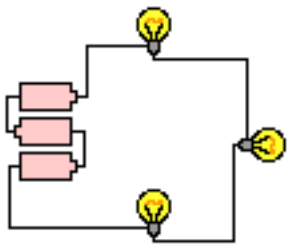


A straight line represents the wire connecting any two components of the circuit. An electrical device that resists the flow of charge (resistors, light bulbs, heaters, etc.) is represented by a zigzag line.

An open switch (turned off) is represented by a break in a line, with a portion of the line "lifted" upward. A closed switch (turned on) is represented by "lowering" the line on an open switch so that it bridges the break in the line.

Example 1
Three D-cells are placed in a battery pack to power a circuit containing three light bulbs.

Drawing of Circuit

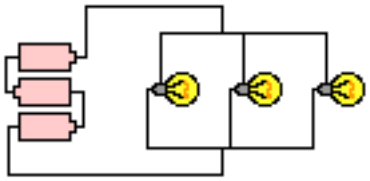


Schematic Diagram of Circuit

The circuit in example 1 assumed that the three light bulbs were connected so that the charge flowing through the circuit would pass through each of the three bulbs in turn. Example 2 shows an alternative way of connecting the bulbs.

Example 2
Three D-cells are placed in a battery pack to power a circuit containing three light bulbs.

Drawing of Circuit **Schematic Diagram of Circuit**

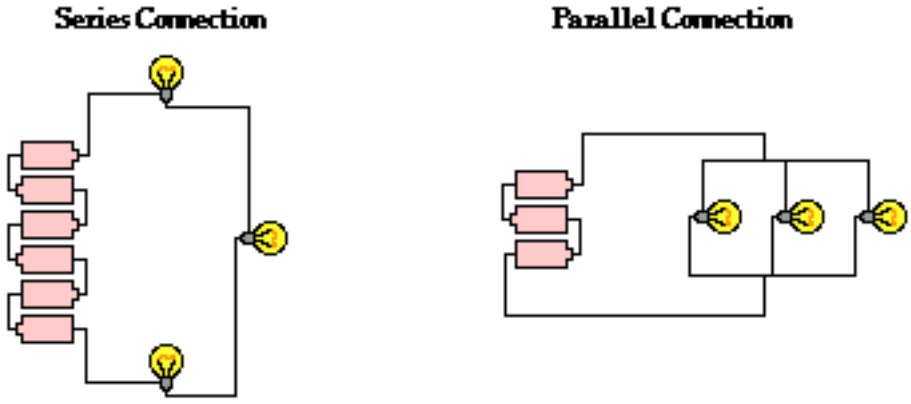


These two examples illustrate the two common types of connections made in electric circuits: series and parallel.

Series and Parallel

Suppose that three light bulbs are connected together in the same circuit. If they are connected in **series**, then they are connected in such a way that a single charge will pass through each one of the bulbs, one after the other.

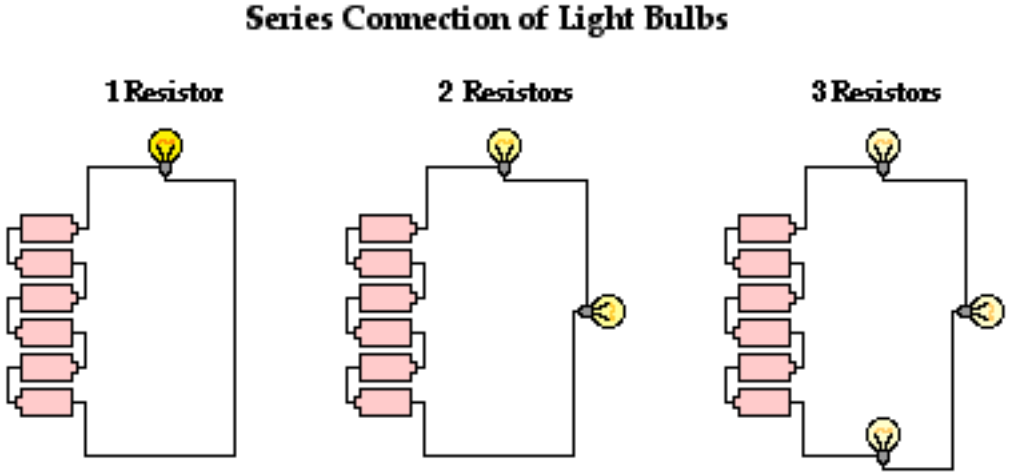
If they are connected in **parallel**, each bulb is placed on a separate branch of the circuit. A single charge passing through the circuit will only pass through one of the branches, and so will only pass through one of the bulbs.



Series Circuits

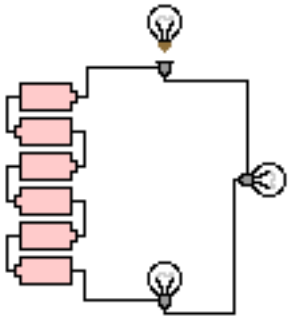
A series circuit can be constructed by connecting light bulbs in such a way that there is only one pathway for charge to flow. In other words, the bulbs are added to the same line with no branching point.

As more bulbs are added in series, the brightness of each bulb will decrease. This observation indicates that the amount of current in the circuit decreases as more bulbs are added.



So for series circuits, as more bulbs are added the total resistance increases, resulting in a decreased amount of current in the circuit.

A final observation that is unique to series circuits is the effect of removing a bulb from a socket. If one of three bulbs in a series circuit is removed from its socket, all the other bulbs will immediately go out.



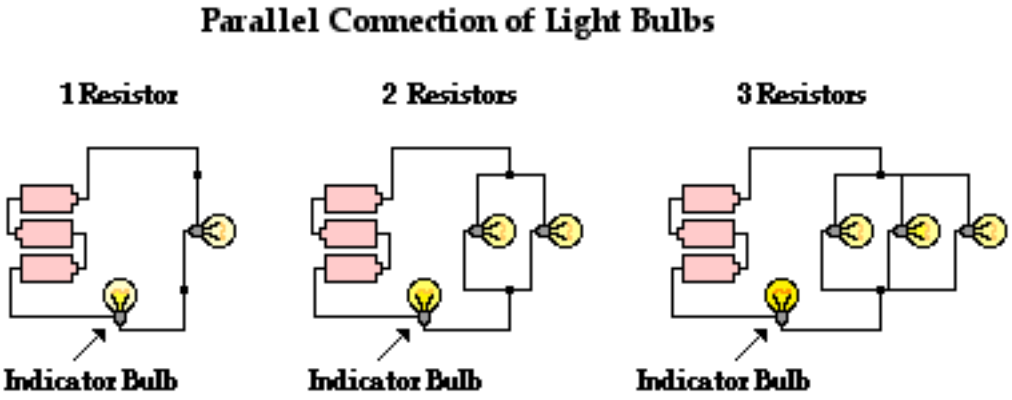
When one bulb is removed from its socket, the other bulbs in series "go out."

In order for devices in a series circuit to work, all the devices must work. Suppose your kitchen appliances were connected in series. Then, in order for the fridge to be on, the toaster, dishwasher, stove, and lights would all have to be on as well.

Parallel Circuits

A parallel circuit can be constructed by creating separate branches and placing each light bulb on a different branch. In this case, each charge must "choose" which branch it will follow as it moves around the circuit.

With parallel circuits, it has been observed that adding more bulbs in parallel does not affect the brightness of each bulb.

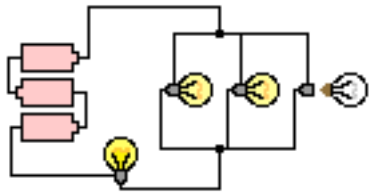


This observation suggests that, as the number of resistors increases, the amount of current through each branch remains the same. However, since each new bulb adds another branch, the total current in the circuit must be increasing.

Since the voltage of the battery is constant, the increasing current must be due to the overall resistance of the circuit decreasing. So, for parallel circuits, as more bulbs are added the total resistance decreases, resulting in an increased amount of current in the circuit.

This can be compared to the flow of cars on a highway. The main source of resistance to the flow of traffic is the number of lanes. If 200 cars must drive in a single lane, traffic will move slowly. Adding a second lane will allow traffic to flow faster (more lanes = less resistance). Every additional lane will further decrease the resistance, and allow the traffic to flow faster.

Devices connected in parallel have one significant advantage over devices in series. If three bulbs are connected in parallel, and one of the bulbs is unscrewed from its socket, the other bulbs will remain lit. This is because each bulb is on a completely separate branch.



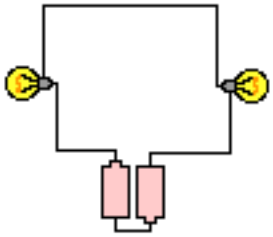
When one bulb is removed from its socket, the other bulbs in the parallel branches remain lit.

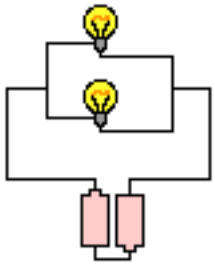
Circuit Diagrams Worksheet

1. Use circuit symbols to construct schematics for the following circuits:

   a) A single cell, light bulb and switch are placed together in a circuit so that the switch can be opened and closed to turn the light bulb on.

   b) A three-pack of D-cells is placed in a circuit to power a flashlight bulb.

   c) 

   d) 

2. Examine the schematics below. Indicate whether the connections are series or parallel. Explain each choice.

Diagram A

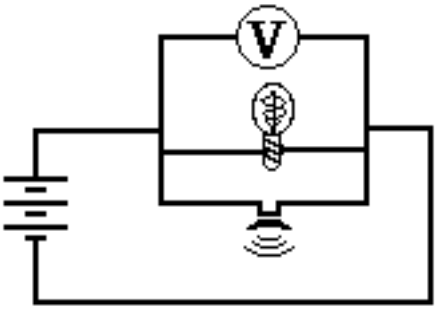
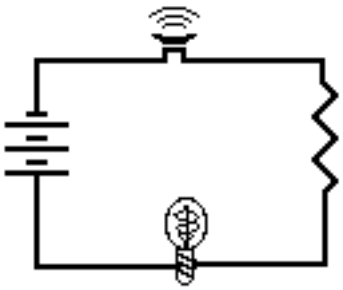


Diagram B



3. Two electric circuits are shown below. For each circuit, indicate which two devices are connected in series and which two devices are connected in parallel.

Diagram A

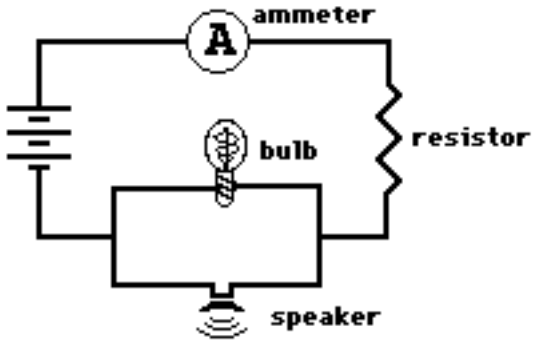
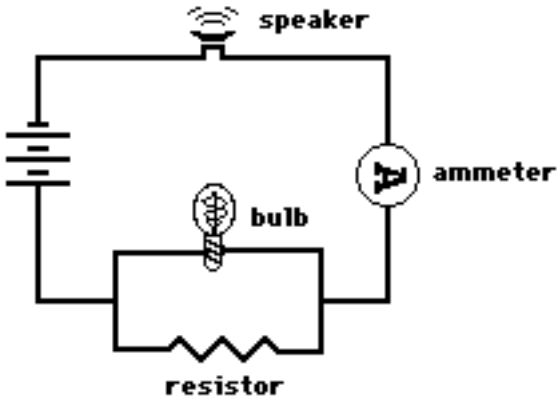


Diagram B



4. Draw a circuit diagram with 2 cells connected in series, 2 bulbs in series and an open switch.

5. Draw a circuit diagram containing a 3.0 V battery, a switch, and a bulb.

6. Draw a circuit diagram containing a 4.5 V battery and two lamps. Each lamp needs its own switch, and each switch must control only one lamp.

7. Draw a circuit diagram containing a 6.0 V battery, a switch controlling a lamp (and only the lamp), and a resistor.