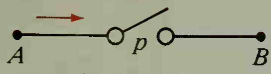
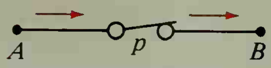
Application of Logic to Circuits

The diagram at the right represents part of an electrical circuit. When switch p is open, the electricity that is flowing from A will not reach B. When switch p is closed, as in the second diagram, the electricity flows through the switch to B.



Open switch

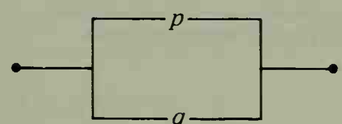


Closed switch

The diagram at the left below represents two switches p and q that are *connected in series*. Notice that current will flow if and only if both switches are closed. The diagram at the right below represents the switches p and q *connected in parallel*. Notice that current will flow if either switch is closed or if both switches are closed. If switches p and q are both open, the current cannot flow.

Series circuit

Parallel circuit



In order to understand how circuits are related to truth tables, let us do the following:

(1) If a switch is closed, label it T. If it is open, label it F.

(2) If current will flow in a circuit, label the circuit T. If the current will not flow, label the circuit F.

With these agreements, we can use truth tables to show what happens in the series circuit and the parallel circuit illustrated above.

Series circuit

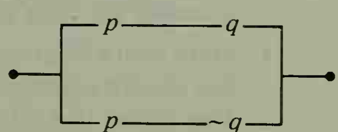
p	q	Circuit
T	T	T
T	F	F
F	T	F
F	F	F

Parallel circuit

p	q	Circuit
T	T	T
T	F	T
F	T	T
F	F	F

The truth table for the series circuit is just like the truth table for $p \wedge q$. Also, the truth table for the parallel circuit is just like the table for $p \vee q$.

Now study the circuit shown at the right. Notice that one of the switches is labeled $\sim q$. This means that this switch is open if switch q is closed, and vice versa. The circuit shown is basically a parallel circuit, but in each branch of the circuit there are two switches connected in series. This explains why the circuit is labeled $(p \wedge q) \vee (p \wedge \sim q)$. A truth table for this circuit is given on the next page.



$(p \wedge q) \vee (p \wedge \sim q)$