Circuits : Notes-10

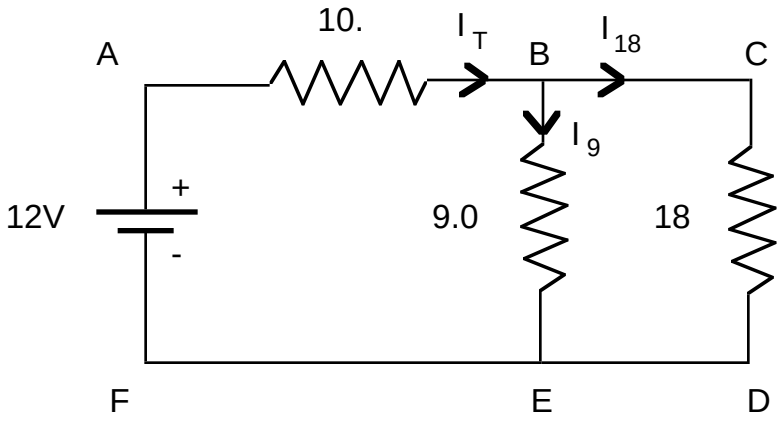
When analyzing circuits, we can use two rules known as Kirchoff's rules.

1) The sum of the currents entering a junction equals the sum of the currents leaving the junction.

2) For any loop in a circuit, the sum of the cell/battery voltages equals the sum of the IxR voltage drops.

The first rule is a statement of the conservation of charge. The second rule is a statement of the law of conservation of energy. These rules can be used to solve complex circuits. This means that the currents through all resistors in a circuit can be found, if the value of all resistors and voltages is known.

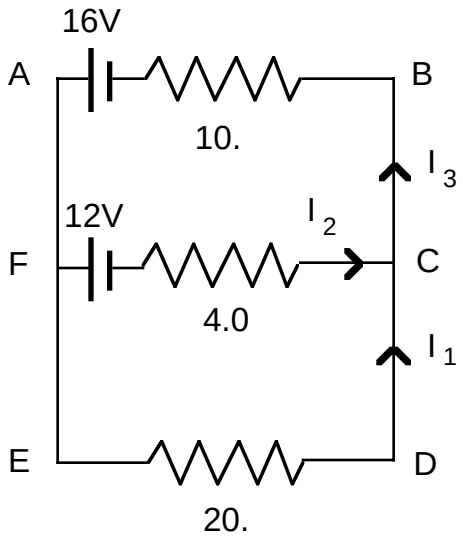
Example: Find the current through each of the resistors. The resistances are given.



Using the first rule, we have $I_T = I_9 + I_{18}$. Using the second rule, we have, for the loop ABEF (going clockwise), $+12V = 10.(I_T).+ 9(I_9)$. The voltage source is positive (since we are going from the positive terminal), the IxR voltage drops are taken as positive, since the current direction is in the same direction as the clockwise motion. Using the second rule again, we have, for the loop ACDF (going clockwise), $+12V = 10.(I_T) + 18(I_{18})$.

The three equations can be solved for the three unknowns. I_T (total current) = 0.75 A, I_9 = 0.50 A, I_{18} = 0.25 A.

Another circuit with two cells is shown below. The currents in the resistors can be found using Kirchoff's rules.



We assign the directions to the three currents arbitrarily. We don't yet know the current directions. At the junction C, we have $I_3 = I_1 + I_2$, using rule 1. Using rule number 2, we have two other equations. We need three equations to solve for the three unknowns.

For loop FEDC we have (going counter-clockwise), $12 = 20(I_1) - 4.0(I_2)$. Go in a direction from the positive terminal. The IxR voltage drops are taken as positive if the direction we go around the loop is in the same direction as that assigned to the (conventional) current. It is negative otherwise. For loop AEDB, we have $16 = 20(I_1) + 10(I_3)$.

Solving the three equations for the three unknowns, we have, I_1 = 0.58A, I_2 = - 0.13A, and I_3 = 0.45A. The negative value for I_2 indicates that the direction originally chosen was wrong. The direction of the conventional current through the 4.0 ohm resistor is really from right to left.

Note: We could also use the equation for the loop AFCB, going counter-clockwise. $16 - 12 = 4.0(I_2) + 10(I_3)$.