Current Electricity

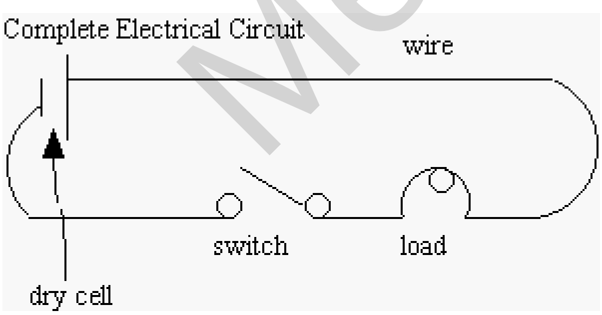
Current electricity is the flow of electrons (flow of charge)

- electrons are moving steadily in definite direction - continuously through some conductor
- electrons flow from point of excess electrons to point of deficiency of electrons
- separation of charge produces electromotive force (EMF)
- **EMF** pushes electrons through conductor

In an electrical circuit, current is the means by which energy is transferred from a source such as a battery or generator to a load (lamp, motor, or other device that absorbs electrical energy and converts it into some other form of energy or into work).

EMF - potential difference that exist across a battery, generator, etc. when it is not connected to any external circuit. The potential difference across the terminals of a source is always less than EMF due to internal resistance.

Complete electrical circuit:



4 parts:

- source of electrons - dry cell

- conducting path for electrons - wire
- device to open and close circuit - switch
- purpose of circuit - load

Other sources of electrons include electrochemical cells and electrical generators.

Electric plug - electrons leave negative terminal at source, go through switches into house, through one side of plug, through appliance or load, then out through other prong and back to positive terminal of source

Loads (resistances) - powered by moving electrons which must move through load before they can return to source

Switches - control circuit

Fuses - interrupt flow of current if flow becomes too great for wires to hold it safely (or appliance to use it safely). Fuses contain a small piece of wire that melts if too much current passes through it. Most household fuses will blow at 15 - 20 amps.

Circuit breakers - shut off current if too much flows (open switch)

Semi-conductors - silicon and germanium - conduct electricity poorly - resistance decreases with increasing temperature

Super-conductors - behave like normal materials at normal temperatures - at extremely low temperatures resistance decreases and vanishes = no energy loss when current flows

See electrical symbols here

Ohm's Law: $$\text{Current} = \frac{\text{Voltage}}{\text{Resistance}}$$

$$I\ (\text{amps}) = \frac{V\ (\text{volts})}{R\ (\text{ohms})}$$

Current:
Direction, by convention, is the direction in which positive charges would move. A current is always assumed to move from positive terminal of a battery or generator to negative terminal in circuit.

Actual electrical currents in metal consist of flow of electrons.

A current of negative particles moving in one direction is electrically the same as a current that consist of positive particles moving in the opposite direction.

Symbol = I unit = ampere (amp) measured by ammeter
Definition = rate of flow of electrons past a certain point
Example = gallons of water coming out of a pipe per second

1 amp = the flow of 1 coulomb of electrons passing one point in one second

$$1\ \text{amp} = \frac{\text{coulomb}}{\text{second}} = \frac{6.25\ \text{E}\ 18\ \text{electrons}}{\text{second}}$$

1 electron = charge of -1.6 E - 19 coulomb

a current of 1 amp in a metal wire has 1 coulomb's worth of electrons (6.25 E 18) passing a point every second.

The following chart list sample **amperage** ratings for common tools:

bug killer 1-2	fan = 1-3	hedge trimmer 2-3	weed trimmer 2-4
electric drill 3-6	saber saw 4-8	sander 4-8	band saw 5-12
lawn mower 6-12	grinder 7-10	chain saw 7-12	drill press 7-14
belt sander 7-15	router 8-13	shop vac 8-14	lawn edger 9-10
air compressor 9-15	table saw 12-15	snow blower 12-15	circular saw 12-15
1/4 HP motor = 6	1/2 HP motor = 10	3/4 HP motor = 14	1 HP motor = 16

amps	amps	amps	amps

Voltage

Symbol = V   unit = volt   measured by voltmeter

Definition = the driving force behind electrons; the work done per unit charge to move that charge from point A to B; the work required to get electrons passing some point per second

volt = $\frac{\text{joule}}{\text{coulomb}}$ = $\frac{\text{unit of work (F x d)}}{\text{\# of } e^{-}\text{/second}}$

If battery has a rating of 1 volt it is capable of doing 1 joule of work for each coulomb of charge that it delivers

Resistance

Symbol = R   unit = ohm (Ω)   measured by ohmmeter

Definition = opposition to flow of electrons; the ratio between potential difference (V) and the resulting current flow (I)

ohm = $\frac{\text{volt}}{\text{ampere}}$

A conductor in which there is a current of 1 amp when a potential difference of 1 volt exist across it has a resistance of 1 ohm.

Resistivity

Resistances of conductors that obey Ohm's Law depend on:

- material of which it is composed - the ability of a material to carry an electrical current varies more than almost any other physical property
- length - the longer the conductor the greater the resistance

- cross-sectional area - the thicker the conductor, the less its resistance

Resistivities of nearly all substances vary with temperature. In general: metals increase in resistivity with increase in temperature and nonmetals decrease in resistivity. $\Delta R = \alpha R \Delta t$

Electric Power

Electric power = current x potential difference
Unit of power = watt (amp x volt)

The power consumed in causing a current to flow is dissipated as heat.

$P = IV$ (power = current x voltage)

$P = I^2 R$ (power = current squared x resistance)

$P = \frac{V^2}{R}$ (power = voltage squared divided by resistance)

brightness = I V

Sample Problems:

1. A light bulb has a resistance ob 240 ohms. Find the current flowing in the circuit when placed in a 120 volt circuit.
   (I = V/R 120 volt/240 ohms = 0.50 amp)

2. The current in the coil of a 8 ohm loudspeaker is 0.5 amp. Find the voltage across its terminals.
   (V = IR 0.5 amp x 8 ohm = 4 volt)

3. Find the resistance in a circuit that has a voltage of 120 volts and a current of 4 amps.
   (R = V/I 120 volts/4 amps = 30 ohm)

4. In a simple house circuit there is an amperage of 0.6 amps and a resistance of 20 ohms. What is the voltage in this circuit?
(V = IR 0.6 amps x 20 ohms = 12 volts)

5. If a 100 watt light bulb burns for 10 hours, how many watt-hours of electricity are used?
(watt = volts x amps watt-hour = watt x hours
1000 watt-hours = 1 kilowatthour)

Series Circuits

In a series circuit electrons flow along a single path through 2 or more loads before returning to source.

Law #1 - any break in a series circuit stops the entire electron flow (a break or loose connection can prevent electrons from flowing)

Law #2 - when there are two or more loads in a series circuit, the voltage drop across each load is a fraction of the total voltage supplied by the source

- voltage across each load decreases as additional loads are wired into circuit
- the sum of the voltage drops across each load = voltage of source
- $V_1 = I R_1$ $V_2 = I R_2$ $V_3 = I R_3$
- $V_T = V_1 + V_2 + V_3 + ...$

Law #3 - the current is the same in all parts of a series circuit - all electrons flowing from source eventually return to source - only one path in series circuit - can measure current anywhere in circuit

Law #4 - the resistance (total) increases in a series circuit as the number of loads increases - the total resistance of a circuit is equal to the sum of the resistances of each wire and load
$R_T = R_1 + R_2 + R_3 + ...$

Parallel Circuits

A parallel circuit is one in which electrons flow through more than one path or branch. The electrons can flow through any one or more of the branches before returning to the source.

Law #1 - a break in one branch of a parallel circuit does not stop the flow of current in other branches

Law #2 - the voltage is the same in all branches of a parallel circuit and equals the voltage of the source

Law #3 - the current is not necessarily the same in all branches of a parallel circuit. The sum of the current drops in all resistances equals the total current flowing through circuit.

- $I_1 = V/R_1$ $I_2 = V/R_2$ $I_3 = V/R_3$
- $I_T = I_1 + I_2 + I_3 + ...$

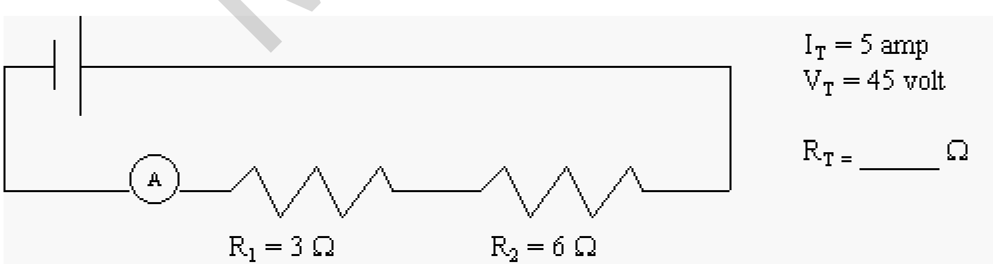
Law #4 - The total resistance in a parallel circuit decreases as the number of loads or individual resistances increases. The total resistance is less than that of the smallest single resistance. All branches act as one broad pathway which offers less resistance to the flow of electrons than any single pathway.

$1/R_T = 1/R_1 + 1/R_2 + 1/R_3 + ...$ or

$R_T = (R_1 \times R_2) / (R_1 + R_2)$

Problems with series and parallel circuits:

#1



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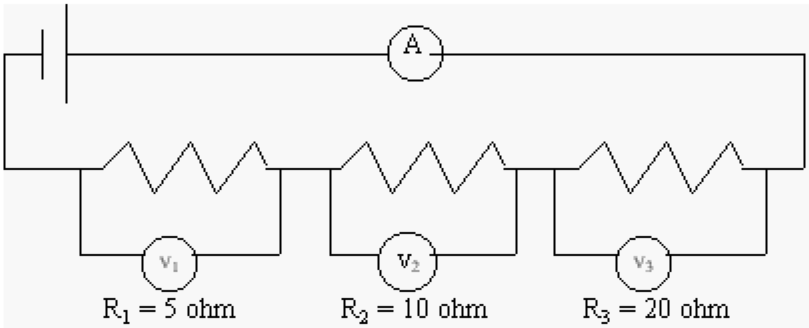


I_T = 5 amp

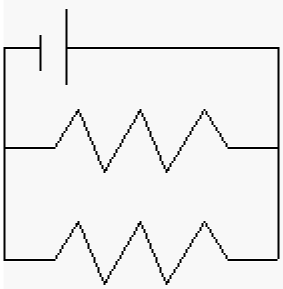
V_T = __________

R_T = __________

P = I V

P_T = __________

#3



6 volt dry cell

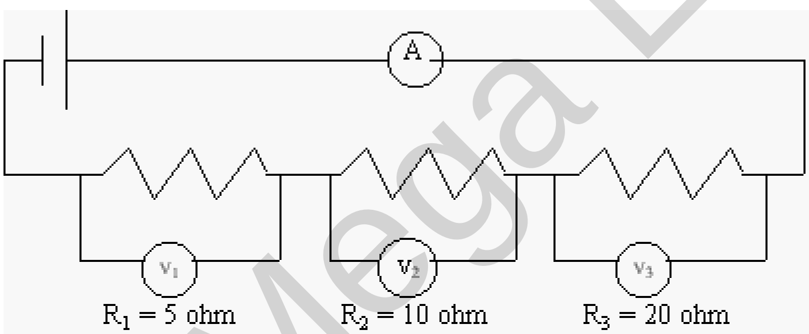
load #1 = 2 ohm
load #2 = 6 ohm

V_T = _____

R_T = _____

I_T = ______

#4



I_T = 5 amp

V_T = __________

R_T = __________

P = I V

P_T = __________