Electromotive Force

Electromotive force is the work done to bring a charge in the circuit. An electric current flows from the positive potential to negative potentials.

Electromotive force or (emf, ε) is a work done to drive a charge throughout a complete circuit.

$E = \frac{W}{Q}$ W = Work Done , Q = Charge

Examples:
The emf of a battery cell is 3V. If the work done to bring the charge from the positive terminal to negative terminal is 200 joules, find the total charge throughout the circuit

$E = \frac{V}{Q}$ $\quad 200 = \frac{3V}{Q}$

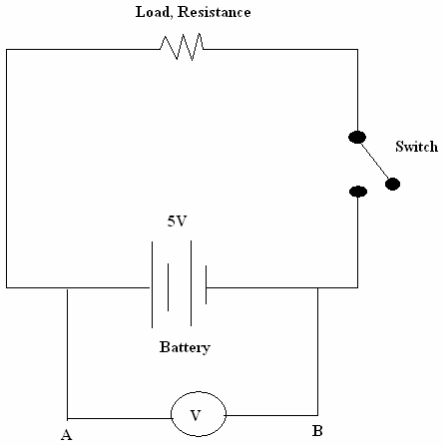
$Q = 66.66C$

Examples:
The emf of a battery cell is 3V. If the work done to bring the charge from the positive terminal to negative terminal is 200 joules, find the total electrons flow in the circuit

$E = \frac{V}{Q}$ $\quad 200 = \frac{3V}{Q}$

$Q = 66.66C$

One electrons is $-1.6 \times 10^{-19} C$ $\qquad No.Electrons = \frac{66.66}{1.6 \times 10^{-19} C} = 41.25 \times 10^{19}$



When the Switch is Open the Voltmeter shows the reading approaching emf.

When the Switch is Close the Voltmeter shows that the reading V

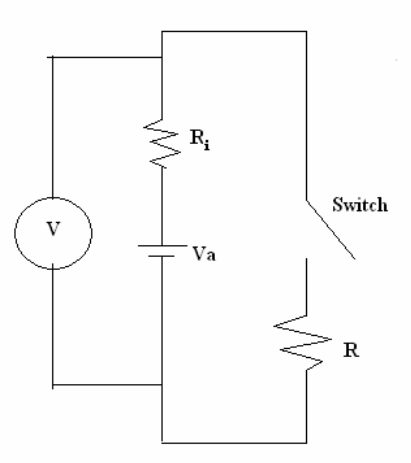
Conclusion
Emf > V

Reason: Due to internal resistance in the circuit

Internal Resistance

Internal resistance of a battery is mainly due to the chemical reaction between the electrolyte and the electrodes

Current have to flow through the internal resistance causing voltage to drop.



Open Circuit
When the Switch is open the voltmeter shows the emf. value

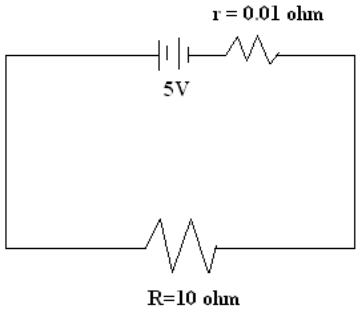
Close Circuit
When the switch is switch closed the voltmeter shows that the $V < V_a$

Conclusions:
Emf > V which shows that the voltage drop is due to the internal resistance. The internal resistance reduce the current and the voltage on the load.

Formula for the Internal Resistance

$$V_{emf} = V_i + V_{RLoad}$$
$$V_{emf} = I(R_i + R_{Load})$$

Questions:
A battery produces the power supply of 5V with an internal resistance of 0.01 ohm. If the load is connected in series with the battery, find the voltage drops on the load



Solution:

$$V_{emf} = V_i + V_{RLoad}$$
$$V_{emf} = I(R_i + R_{Load})$$
$$5 = I(0.01 + 10)$$
$$I = \frac{5}{10.01} = 0.499A$$
$$V_{load} = 0.499 \times 10 = 4.99V$$