PHYS 2212

Look over
Chapter 27 sections 1-7 we will cover section 8 in lab
Examples 1, 2, 3

PHYS 1112

Look over
Chapter 19 sections 1-4, 7
We will cover section 8 in Lab
examples 1, 3, 4, 5, 7, 8

Good Things to Know

1) What an Emf $\mathscr{E}$ device is.
2) How to use Kirchhoff's rules
3) How to add up resistors in series and Parallel.
4) How to analyze circuits.

Pumping Charges

To produce a steady flow of charge, you need a "charge pump," a device that --by doing work on charge carriers-- maintains a potential difference between a set of terminals.

We call such a device an **emf device**, and the device is said to provide an **emf** $\mathscr{E}$ which means that it does work on charge carries.

Emf and Energy Transfer

In any time interval Δt a charge Δq passes through any cross section of the circuit, such as aa'. This same amount of charge must enter the emf device at its low-potential end and leave at its high-potential end.

The device must do an amount of work ΔW on the charge Δq to force it to move in this way.

emf is just Another Name for Volts

We define the emf of the device in terms of this work as:

$$\mathscr{E} = \lim_{\Delta q \Rightarrow 0} \frac{\Delta W}{\Delta q} = \frac{dw}{dq}$$

The emf of an emf device is the work done per unit charge that the device does in moving charge from its low-potential terminal to its high-potential terminal.

$$\mathscr{E} \Rightarrow \frac{Joule}{Coulomb} = Volt$$

Current in a Single Loop Circuit

Let say you are out mountain bike riding.

We can proceed around the circuit in either direction, adding algebraically the potential difference that we encounter. When we arrive at our starting point, we must have returned to our starting potential

Kirchhoff's Loop Rules

To analyze a circuit we will make use of some rules put forth by a German physicist Gustav Robert Kirchhoff.

Loop Rule: The algebraic sum of the changes in potential encountered in a complete traversal of any loop of a circuit must be zero.

Kirchhoff's Rules

Resistance Rule: For a move through a resistance in the direction of the current, the change in potential is $-iR$; in the opposite direction it is $+iR$.

Emf Rule: For a move through an ideal emf device in the direction of the emf arrow, the change in potential is $+\mathscr{E}$; in the opposite direction it is $-\mathscr{E}$.

Current Rule: The sum of the currents entering any junction must be equal to the sum of the currents leaving.

Real Batteries

A real emf device, such as a battery will have some internal resistance.

$$\boxed{\mathscr{E} - ir - iR = 0}$$

$$\boxed{i = \frac{\mathscr{E}}{r + R}}$$

Resistors in Series

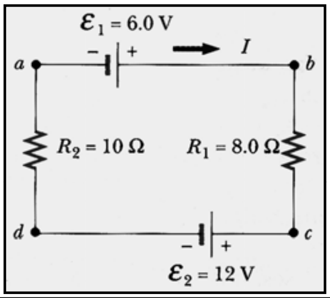
Connected resistors are said to be in series when a potential difference that is applied across their combination is the sum of the resulting potential difference across all the resistors.

Resistors in Series

$$\boxed{R_{\text{eq}} = R_1 + R_2 + R_3}$$

$$\boxed{R_{\text{eq}} = \sum_{j=1}^{n} R_j}$$

Example 1



1) In the above circuit find:
   a) the current.
   b) the potential difference between points *a* and *c*.

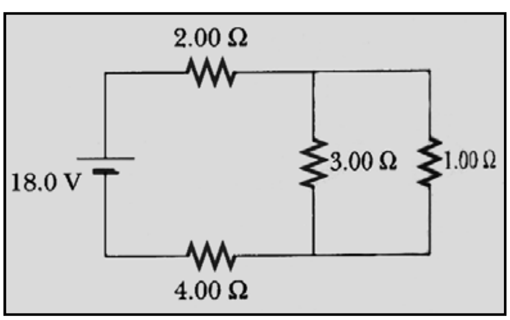
Resistors in Parallel

Connected resistors are said to be in parallel when a potential difference that is applied across their combination results in that same potential difference across each resistor.

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_{eq}} = \sum_{j=1}^{n} \frac{1}{R_j}$$

Example 2



2) Find the currents in the circuit shown.

Problem-Solving Techniques

In problems associated with multi-loop circuits, we must find unknown circuit parameters (such as resistance or currents) when other parameters are given. To solve these problems, the following procedure may be helpful.

❶Draw a diagram with sources of emf, resistors, capacitors and so forth clearly labeled. List which parameters are known and which are unknown.
❷Assign a separate current for each leg of the circuit, and indicate that current on the diagram
❸Apply the junction rule for the currents at each junction.
❹Identify the number of loops by counting the number of ways that a pencil can poke through the circuit. Indicate the loops on the diagram.

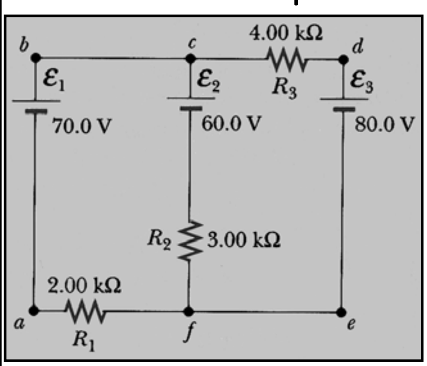
Problem-Solving Techniques

❺Apply the loop rule to each of these loops.

❻Check to see that the number of linear equations from steps 3 and 5 matches the number of unknowns.

❼Solve these equations for the unknowns, whether they are currents or other parameters of the circuit. It is usually best to solve these equations algebraically and only later substitute numerical values.

Example 3



3) Find the three currents in the circuit shown.