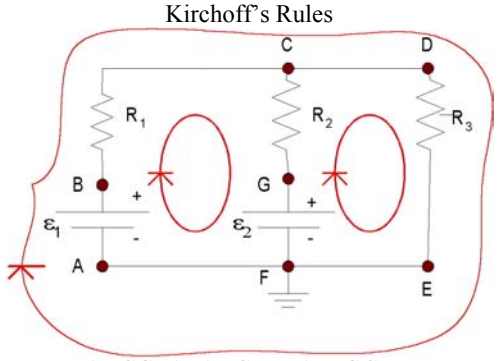
Kirchoff's Rules



Loops ABCGFA; ABCDEFA; FGCDEF
Junctions: C & F;

Kirchoff Definitions & Rules

- Arm or Branch of circuit: Portion of circuit having only one value of current
- Junction: Point where three or more arms join
- Loop: Single continuous path; ends on start pt.
- ***Junction Rule:*** Total current into a junction = total current out of junction $\sum I_{in} = \sum I_{out}$

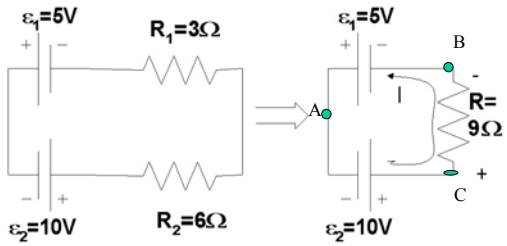
  (Charge cannot build up at junction)
- ***Loop Rule:*** Net change in potential around any closed loop = 0 $\sum_{closed\ loop} \Delta V = 0$

  Get junction equation at each junction and loop eqn. for each different loop. Need one equation per unknown.

Steps for Kirchoff Solutions

- Draw circuit diagram
- Reduce any series or parallel resistors
- Draw in a current for each arm. (***Assume*** a direction) Label resistor ends + & - so that I goes from + to -
- Write junction equations until all currents are included
- Write loop equations until each arm is included
- Solve system of equations. *Negative* current indicates wrong assumed direction (not a problem)

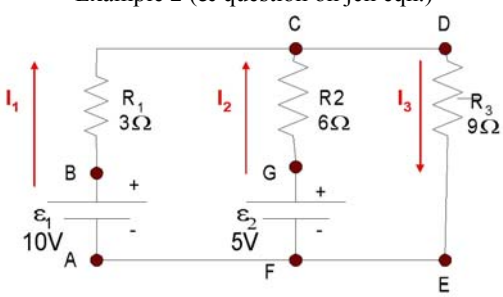
Examples



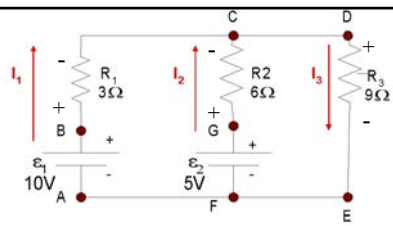
- No junctions. Loop eqn (ABCA): $-\varepsilon_1 + IR - \varepsilon_2 = 0$

  $IR = \varepsilon_1 + \varepsilon_2$; $I = (\varepsilon_1 + \varepsilon_2)/R = 15V/9\Omega = 1.7A$

Example 2 (& question on jcn eqn.)



Junction C: $I_1 + I_2 = I_3$ Junction F: $I_3 = I_1 + I_2$ (nothing new)



Loop ACFA: $\varepsilon_1 - I_1R_1 + I_2R_2 - \varepsilon_2 = 0$

Loop FCDEF: $\varepsilon_2 - I_2R_2 - I_3R_3 = 0$

Three equations in three unknowns; solve

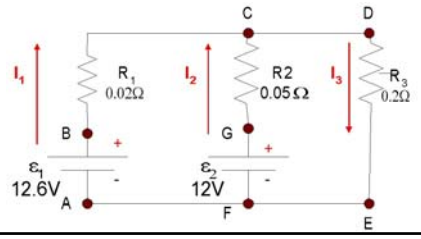
Add loop eqns.: $\varepsilon_1 - I_1R_1 - I_3R_3 = 0$ or $I_3 = (\varepsilon_1 - I_1R_1)/R_3$

Junc. eqn: $I_1 + I_2 = I_3 = (\varepsilon_1 - I_1R_1)/R_3$ or $I_2 = (\varepsilon_1 - I_1R_1)/R_3 - I_1$

Put into L1 eqn.:

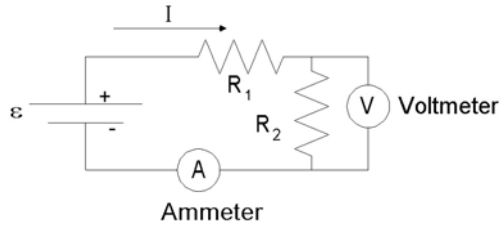
$$I_1 = \frac{\varepsilon_1 - \varepsilon_2 + \varepsilon_1(R_2/R_3)}{R_1 + R_2 + R_1R_2/R_3} = \frac{21}{0}\ A$$

- Then $I_2 = (\varepsilon_1 - I_1 R_1)/R_3 - I_1 = -2A$
  Quest. - What is meaning of negative current?
- ***Finally, $I_3 = I_1 + I_2 = (1/3)A$***
- ***Can write 3 equations as matrix equation & solve***
- ***Similar to "jump-start"circuit:***



Voltmeters and Ammeters

- Typical Electrical Measurement Situation



- (Q) We want to avoid disturbing the circuit. What should be the resistance of the ammeter and of the voltmeter? (Q) What would be the value of the voltmeter reading divided by the ammeter reading?