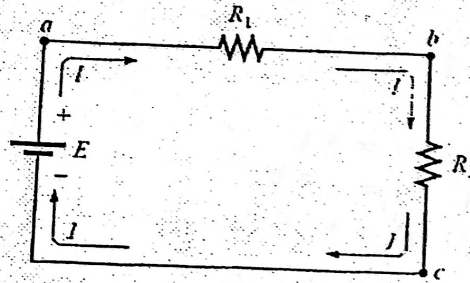

Series Circuits:

Two elements are in series if

1. They have only one terminal in common (i.e., one lead of one is connected to only one lead of the other).

2. The common point between the two elements is not connected to another current-carrying element.



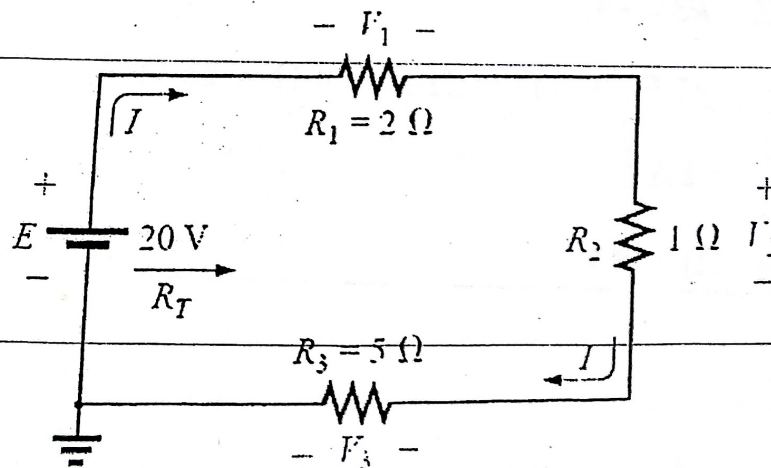
- The current is the same through series elements, but the voltage is different.
- The total resistance of a series circuit is the sum of the resistance levels.

$$R_T = R_1 + R_2 + R_3 + \dots + R_N$$

$$V_1 = IR_1, V_2 = IR_2, V_3 = IR_3, \dots, V_N = IR_N$$

EXAMPLE: for the figure below

- Find the total resistance for the series circuit.
- Calculate the source current I_s .
- Determine the voltages V_1 , V_2 , and V_3 .
- Calculate the power dissipated by R_1 , R_2 , and R_3 .
- Determine the power delivered by the source, and compare it to the sum of the power levels of part (d).



Solution:

$$a. R_T = R_1 + R_2 + R_3 = 2 \Omega + 1 \Omega + 5 \Omega = 8 \Omega$$

$$b. I_s = \frac{E}{R_T} = \frac{20 \text{ V}}{8 \Omega} = 2.5 \text{ A}$$

$$c. V_1 = IR_1 = (2.5 \text{ A})(2 \Omega) = 5 \text{ V}$$

$$V_2 = IR_2 = (2.5 \text{ A})(1 \Omega) = 2.5 \text{ V}$$

$$V_3 = IR_3 = (2.5 \text{ A})(5 \Omega) = 12.5 \text{ V}$$

$$d. P_1 = V_1 I_1 = (5 \text{ V})(2.5 \text{ A}) = 12.5 \text{ W}$$

$$P_2 = I_2^2 R_2 = (2.5 \text{ A})^2 (1 \Omega) = 6.25 \text{ W}$$

$$P_3 = V_3^2 / R_3 = (12.5 \text{ V})^2 / 5 \Omega = 31.25 \text{ W}$$

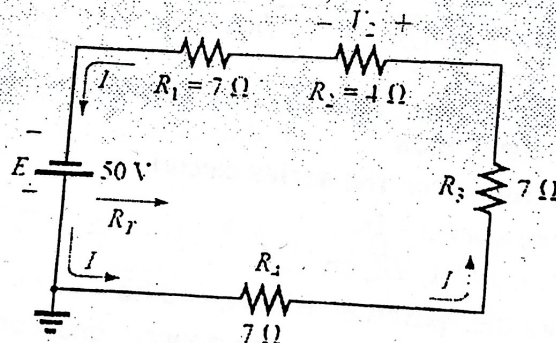
$$e. P_{\text{del}} = EI = (20 \text{ V})(2.5 \text{ A}) = 50 \text{ W}$$

$$P_{\text{del}} = P_1 + P_2 + P_3$$

$$50 \text{ W} = 12.5 \text{ W} + 6.25 \text{ W} + 31.25 \text{ W}$$

$$50 \text{ W} = 50 \text{ W} \quad (\text{checks})$$

EXAMPLE: Determine R_T , I , and V_2 for the circuit of Figure below.



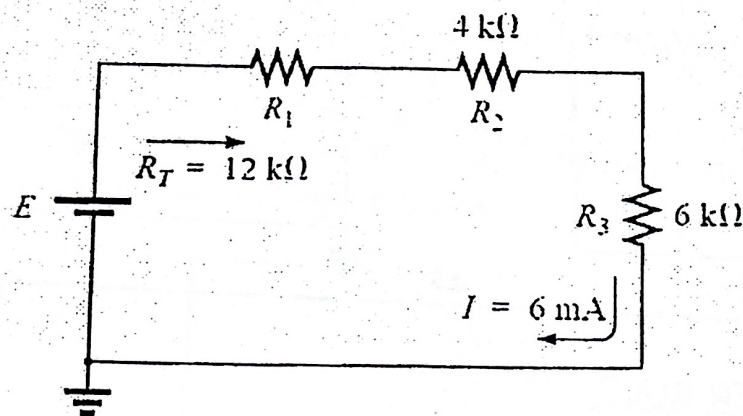
Solution: Note the current direction as established by the battery and the polarity of the voltage drops across R_2 as determined by the current direction. Since $R_1 = R_3 = R_4$,

$$R_T = NR_1 + R_2 = (3)(7 \Omega) + 4 \Omega = 21 \Omega + 4 \Omega = 25 \Omega$$

$$I = \frac{E}{R_T} = \frac{50 \text{ V}}{25 \Omega} = 2 \text{ A}$$

$$V_2 = IR_2 = (2 \text{ A})(4 \Omega) = 8 \text{ V}$$

EXAMPLE: Given R_T and I , calculate R_1 and E for the circuit of Figure below.



Solution:

$$R_T = R_1 + R_2 + R_3$$

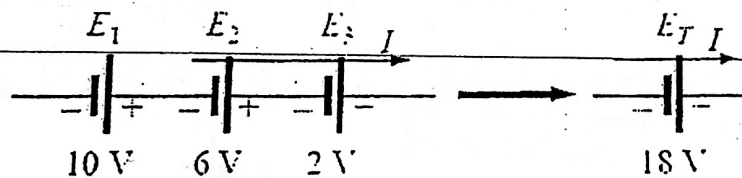
$$12 \text{ k}\Omega = R_1 + 4 \text{ k}\Omega + 6 \text{ k}\Omega$$

$$R_1 = 12 \text{ k}\Omega - 10 \text{ k}\Omega = 2 \text{ k}\Omega$$

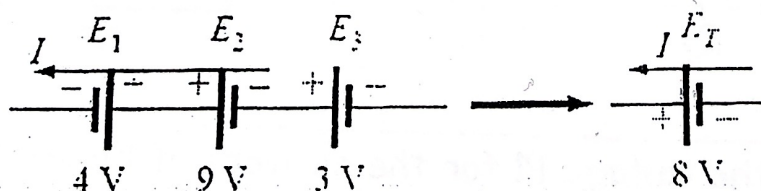
$$E = IR_T = (6 \times 10^{-3} \text{ A})(12 \times 10^3 \Omega) = 72 \text{ V}$$

Voltage Sources in Series:

Voltage sources can be connected in series as shown in figure below. The net voltage is determined simply by summing the sources with the same polarity and subtracting the total of the sources with the opposite.



(a)



(b)