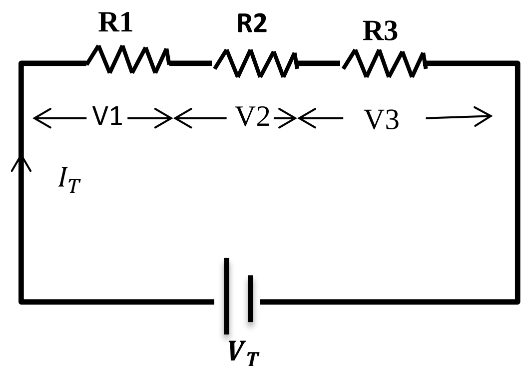
Series connection:

$$I_1 = I_2 = I_3 = I_T$$

$$V_T = V_1 + V_2 + V_3$$

$$R_T = R_1 + R_2 + R_3$$

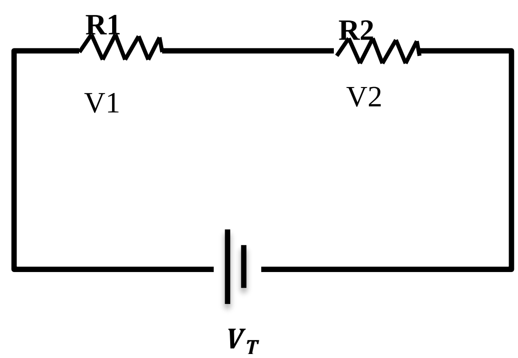
$$also\ R_T = \frac{V_T}{I_T}$$



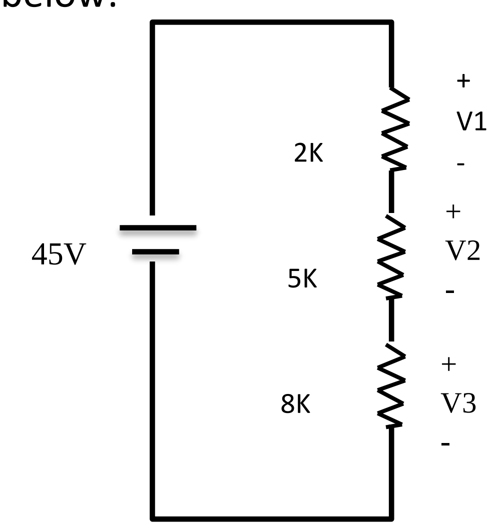
Voltage divider circuit

$$V_1 = V_T \frac{R_1}{R_T}$$

$$V_2 = V_T \frac{R_2}{R_T}$$



EX: using voltage divider rule,
calculate V_1 and V_3 for the circuit shown below:



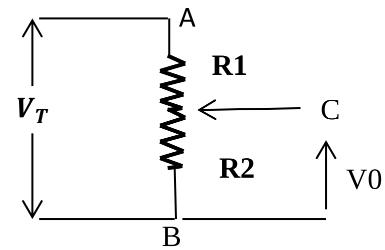
$$V_1 = V_T \frac{R_1}{R_T} = \frac{45 \times 2 \times 10^3}{(2+5+8) \times 10^3}$$

$$= \frac{90}{15} = 6V$$

$$V_3 = V_T \frac{R_3}{R_T} = \frac{45 \times 8 \times 10^3}{(2+5+8) \times 10^3}$$

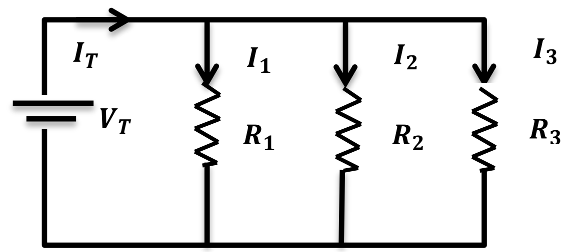
$$= \frac{360}{15} = 24V$$

Potentiometer



$$V_0 = V_T \frac{R_2}{R_1 + R_2}$$

Resistance in parallel



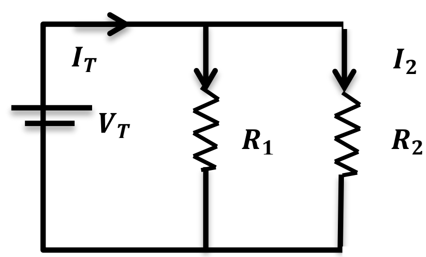
$$V_T = V_1 = V_2 = V_3$$

$$I_T = I_1 + I_2 + I_3$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$also\ R_T = \frac{V_T}{I_T}$$

Current divider rule



For two resistances in parallel

$$R_T = \frac{R_1 R_2}{R_1 + R_2}$$

$$I_1 = I_T \frac{R_2}{R_1 + R_2}$$

$$I_2 = I_T \frac{R_1}{R_1 + R_2}$$

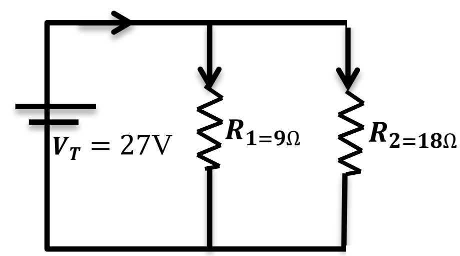
Note: for equal resistance in parallel;

$$\boldsymbol{R_T = \frac{R}{N} \quad (N = no. of\ resistances)}$$

Note: for three resistances in parallel

$$\boldsymbol{R_T = \frac{R_1 R_2 R_3}{R_1 R_2 + R_1 R_3 + R_2 R_3}}$$

EX: for the circuit shown find; R_T, I_T, I_1, I_2, P_T.



Sol: $R_T = \frac{R_1 R_1}{R_1 + R_2}$

$= \frac{9 \times 18}{9 + 18} = 6\Omega$

$I_T = \frac{V_T}{R_T} = \frac{27}{6} = 4.5A$

$I_1 = \frac{V_1}{R_1} = \frac{V_T}{R_1} = \frac{27}{9} = 3A$

$I_2 = \frac{V_2}{R_2} = \frac{V_T}{R_2} = \frac{27}{18} = 1.5A$

$\therefore I_1 + I_2 = 3 + 1.5 = 4.5A$

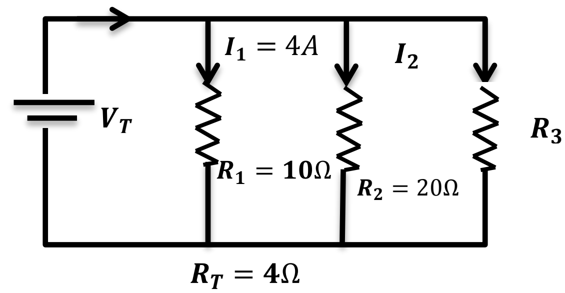
$P_T = V_T . I_T = 27 \times 4.5 = 121.5W$

$or\ P_T = I^2 . R_T = (4.5)^2 \times 6 = 121.5\text{W}$

EX: for the circuit shown below, find:-

$1 - R_3, V_T, I_T$

$2 - \ I_2 \ and \ power \ lost \ in \ R_2.$



Sol:

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{4} = \frac{1}{10} + \frac{1}{20} + \frac{1}{R_3}$$

$0.25 = 0.1 + 0.05 + \frac{1}{R_3}$

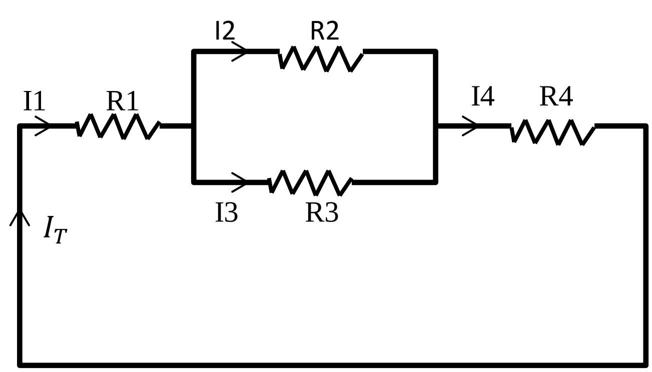
$$\therefore \frac{1}{R_3} = 0.1 \ \rightarrow \therefore \ R_3 = 10\Omega$$

$$I_2 = \frac{V_2}{R_2} = \frac{V_T}{R_2} = \frac{40}{20} = 2A$$

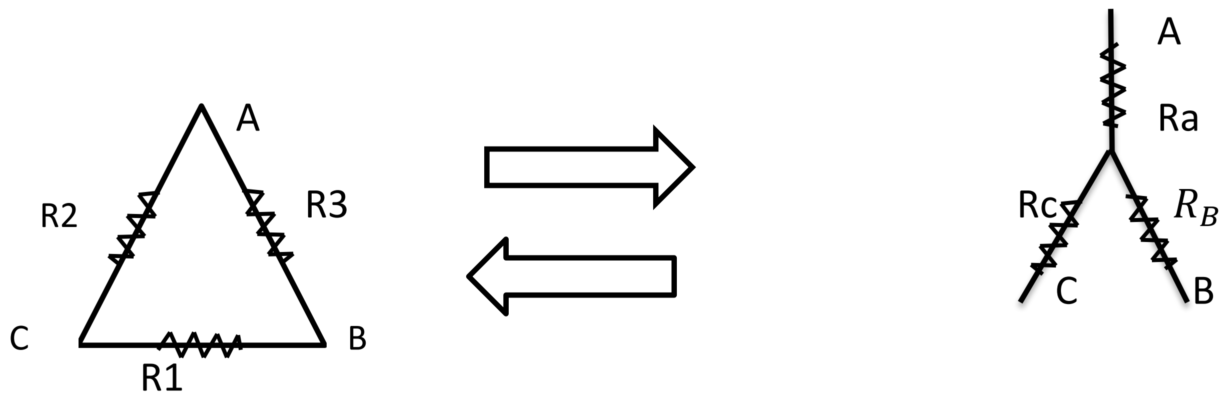
$$P_2 = I^2{}_2 . R_2 = (2)^2 \times 20 = 80W$$

Compound connection

It has the features of both series and parallel connection.



Delta/star and star/Delta transformation



$\Delta \rightarrow ⅄$

$$R_a = \frac{R_2 . R_3}{R_1 + R_2 + R_3}$$

$$R_b = \frac{R_1 R_3}{R_1 + R_2 + R_3}$$

$$R_c = \frac{R_1 R_2}{R_1 + R_2 + R_3}$$

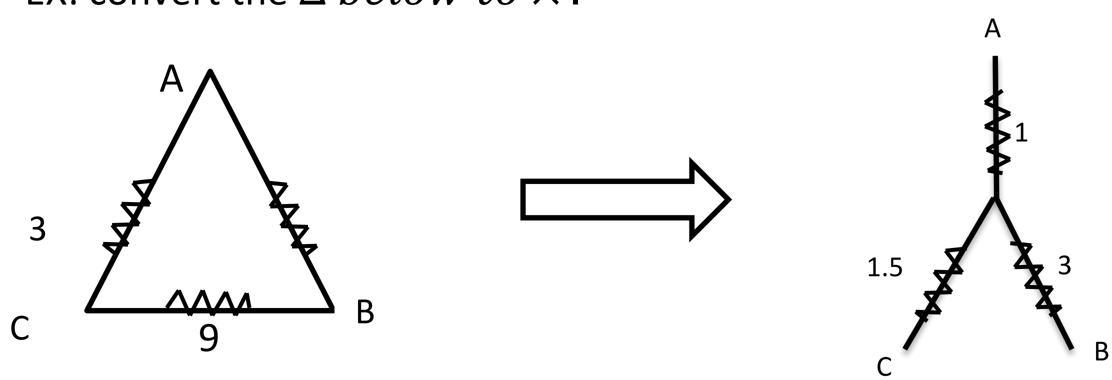
$⅄ \rightarrow \Delta$

$$R_1 = R_b + R_c + \frac{R_b R_c}{R_a}$$

$$R_2 = R_a + R_c + \frac{R_a R_c}{R_b}$$

$$R_3 = R_a + R_b + \frac{R_a R_b}{R_c}$$

EX: convert the Δ *below to* ⅄ .

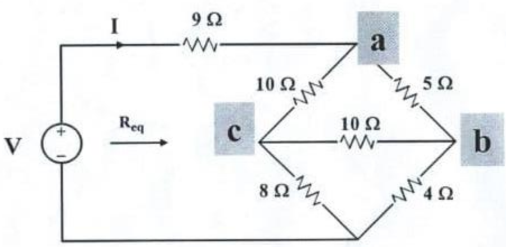


*convert back to delta

Basic Electric Circuits

Wye to Delta Transformation:

Example 5.3: Return to the circuit of Figure 5.13 and find R_{eq}.



Convert the delta around a – b – c to a wye.

Basic Electric Circuits

Wye to Delta Transformation:

Example 5.3: continued

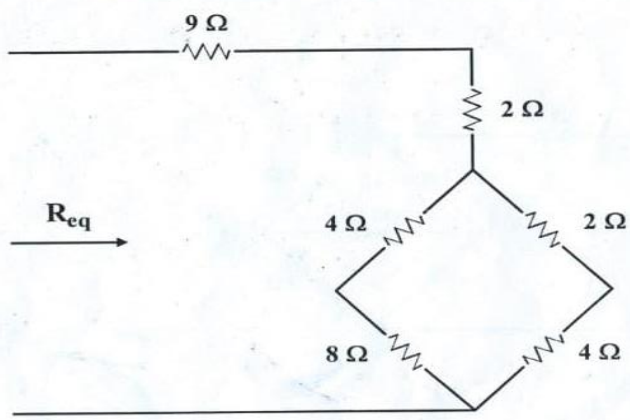


Figure 5.15: Example 5.3 diagram.

It is easy to see that $R_{eq} = 15\ \Omega$

Basic Electric Circuits

Wye to Delta Transformation:

Example 5.4: Using wye to delta. The circuit of 5.13 may be redrawn as shown in 5.16.

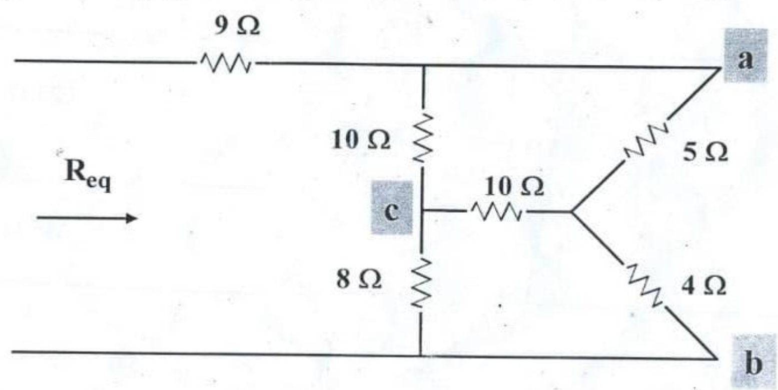


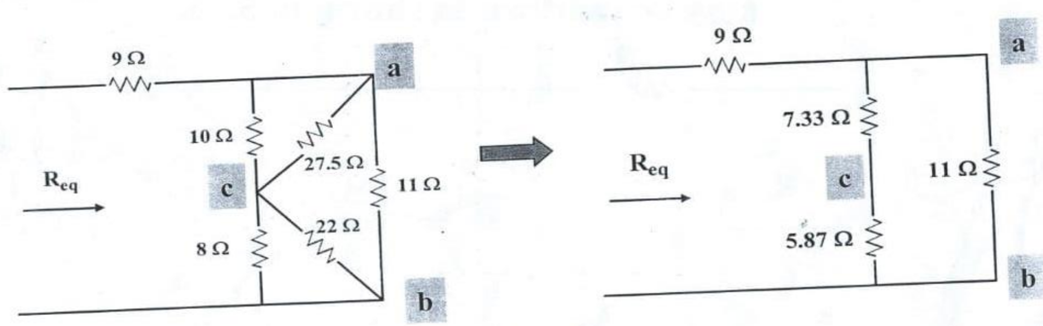
Figure 5.16: *"Stretching"* (rearranging) the circuit.

Convert the wye of a – b – c to a delta.

Basic Electric Circuits

Wye to Delta Transformation:

Example 5.4: continued



(a) **(b)**

Figure 5.17: Circuit reduction of Example 5.4.

23

Basic Electric Circuits

Wye to Delta Transformation:

Example 5.4: continued

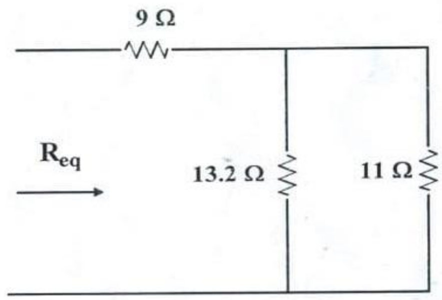


Figure 5.18: Reduction of Figure 5.17.

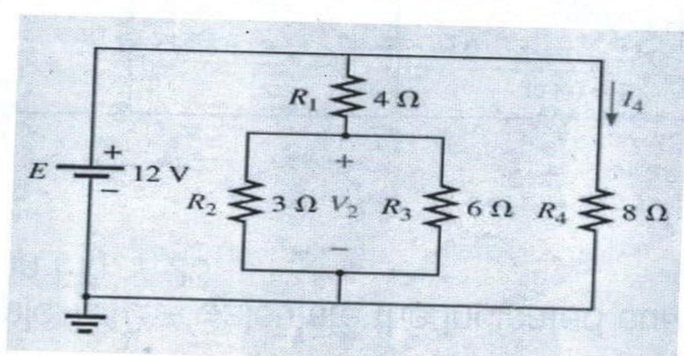
$$R_{eq} = 15\ \Omega$$

This answer checks with the delta to wye solution earlier.

24

7.5 – Descriptive Examples

♉ Example 7.5 – Find the current I_4 and the voltage V_2 for the network in Fig 7.14.



Ans:
$I_4 = 1.5\,[A]$
$V_2 = 4\,[V]$

Descriptive Examples

♉ Example 7.10 – Calculate the indicated currents and voltage in Fig. 7.26.

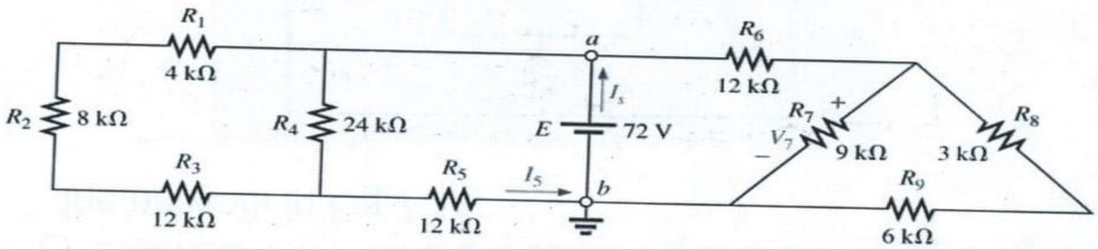
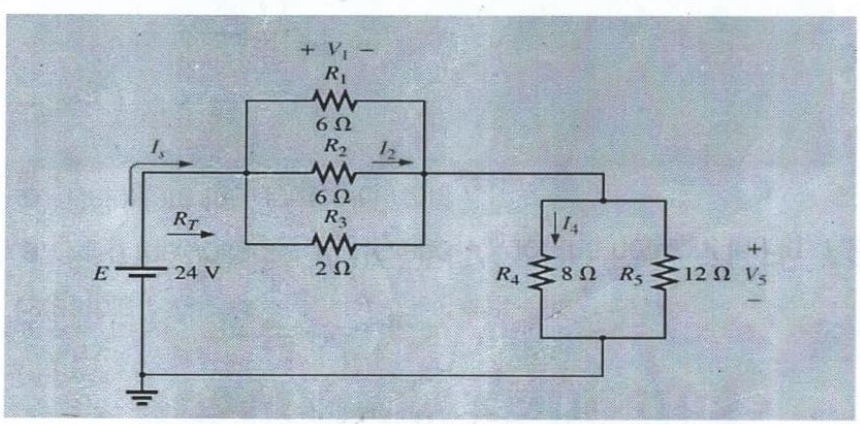


FIG. 7.22
Example 7.9.

$I_S = 7.363$ [mA]
$I_5 = 3$ [mA]
$V_7 = 19.63$ [V]

Descriptive Examples

♉ Example 7.6 – Find the indicated currents and voltages for the network in Fig. 7.17.



$R_T = 6\ \Omega$ $V_1 = 4.8$ V $V_5 = 19.2$ V

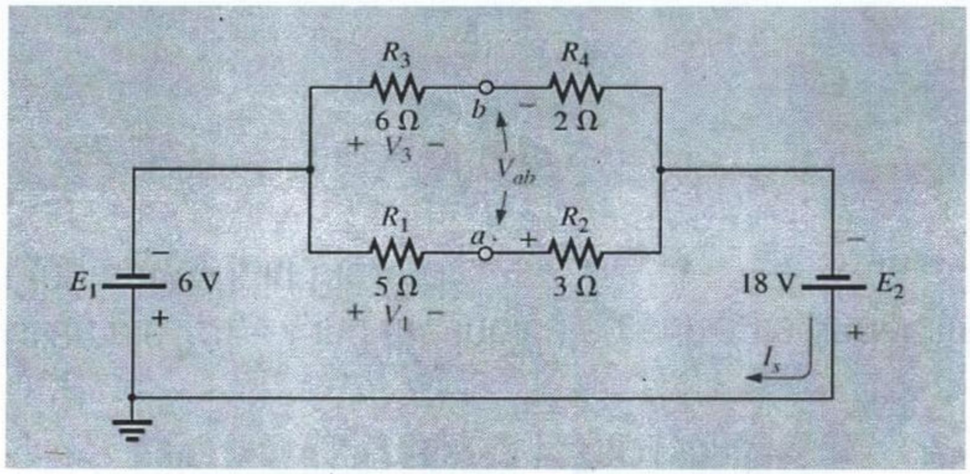
$I_S = 4$ A $I_2 = 0.8$ A $I_4 = 2.4$ A

Descriptive Examples

♉ Example 7.7

a. Find the voltages V_1, V_2 and V_{ab} for the network in Fig. 7.20.

b. Calculate the source current I_s.



$V_1 = 7.5\ V$

$V_2 = 4.5\ V$

$V_{ab} = 1.5\ V$

$I_S = 3\ A$