Abbreviation for multiples and submultiple

Multiplying factor	Prefix	Symbol	Multiplying factor	Prefix	Symbol
$1\,000\,000\,000\,000 = 10^{12}$	tera	T	$0.1 = 10^{-1}$	deci	d
$1\,000\,000\,000 = 10^{9}$	giga	G	$0.01 = 10^{-2}$	centi	c
$1\,000\,000 = 10^{6}$	mega	M	$0.001 = 10^{-3}$	milli	m
$1\,000 = 10^{3}$	kilo	k	$0.000\,001 = 10^{-6}$	micro	μ
$100 = 10^{2}$	hecto	h	$0.000\,000\,001 = 10^{-9}$	nano	n
$10 = 10^{1}$	deka	da	$0.000\,000\,000\,001 = 10^{-12}$	pico	p

Derived units

area	square meter	m^2	
volume	cubic meter	m^3	
frequency	hertz	Hz	1/s
mass density (density)	kilogram per cubic meter	kg/m^3	
speed, velocity	meter per second	m/s	
angular velocity	radian per second	rad/s	
acceleration	meter per second squared	m/s^2	
angular acceleration	radian per second squared	rad/s^2	
force	newton	N	$kg \cdot m/s^2$
pressure (mechanical stress)	newton per square meter	N/m^2	
kinematic viscosity	square meter per second	m^2/s	
dynamic viscosity	newton-second per square meter	$N \cdot s/m^2$	
work, energy, quantity of heat	joule	J	$N \cdot m$
power	watt	W	J/s
quantity of electricity	coulomb	C	$A \cdot s$
tension (voltage), potential difference, electromotive force	volt	V	W/A
electric field strength	volt per meter	V/m	
electric resistance	ohm	Ω	V/A
capacitance	farad	F	$A \cdot s/V$
magnetic flux	weber	Wb	$V \cdot s$
inductance	henry	H	$V \cdot s/A$
magnetic flux density	tesla	T	Wb/m^2
magnetic field strength	ampere per meter	A/m	
magnetomotive force	ampere	A	
luminous flux	lumen	lm	$cd \cdot sr$
luminance	candela per square meter	cd/m^2	
illuminance	lux	lx	lm/m^2

Factors affecting the resitance

1- Length of wire (L) meter
2- Cross- sectional area (A) $(\text{meter})^2$
3- Type of material (ρ) $(\Omega.m)$

$$R = \frac{\rho \times L}{A}\ \Omega$$

ρ = resistivity

4- Temperature (C°)

$$R_f = R_0\left[1+\alpha_0\left(T_f - T_0\right)\right]$$

R_f = Final Resistance

R_0 = Initial Resistance

α_0 = Temperature Coefficient

T_f = Final Temperature

T_0 = Initial Temperature

5- Type of current Ac or Dc

<u>*Ex*</u>: A wire of (2000m) length made of copper with resistivity of (2×10^{-8}Ω.m) and has across section area of ($10^{-4} m^2$), calculate its resistance?

<u>*Sol.*</u> $R = \frac{\rho \times L}{A}$

$$R = \frac{2\times10^{-8} \times 2 \times 10^{3}}{10^{-4}}$$

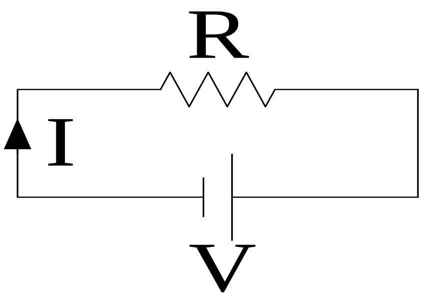
$$R = \frac{4 \times 10^{-5}}{10^{-4}}$$

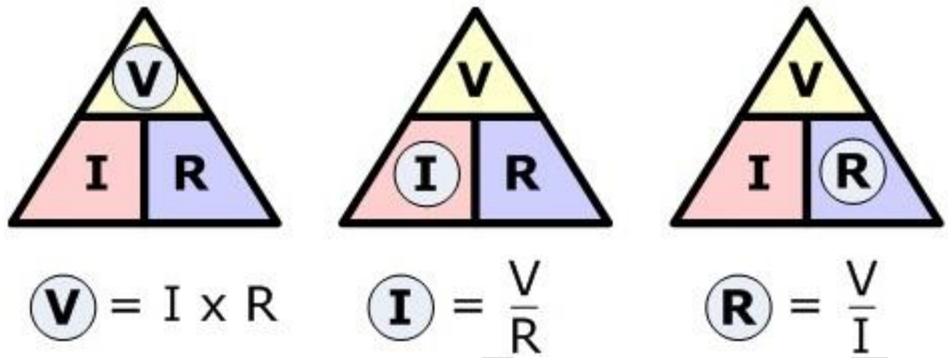
$$R = \frac{4 \times 10^{-5}}{10^{-4}}$$

$$R = \frac{4 \times 10^{-5} \times 10^{4}}{1} = 4 \times 10^{-1} = \frac{4}{10}$$

$$R = 0.4\ \Omega$$

Ohm's Law





Ex: The resistance of a coil (40Ω) at (20ºC) connected to (220V), and the temperature increased to (120ºC), if ($\alpha = 0.003$), calculate the final resistance and the variation in the electrical current?

Sol.

$$\boxed{R_f = R_0\left[1+\alpha_0\left(T_f - T_0\right)\right]}$$

$$= 40\,[1 + 0.003\,(120 - 20)]$$

$$= 52\Omega$$

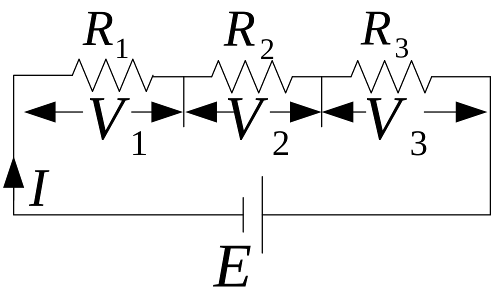
$$I_1 = \frac{V}{R_0} = \frac{220}{40} = 5.5\ A$$

$$I_2 = \frac{\text{v}}{R_f} = \frac{220}{52} = 4.23\ A$$

$$\therefore\ \Delta I = I_2 - I_1 = 5.5 - 4.23$$

$$= 1.27\ \text{A}$$

Series Connection



$$E = V_1 + V_2 + V_3$$

$$V_1 = IR_1, V_2 = IR_2, V_3 = IR_3$$

$$E = IR_1 + IR_2 + IR_3$$

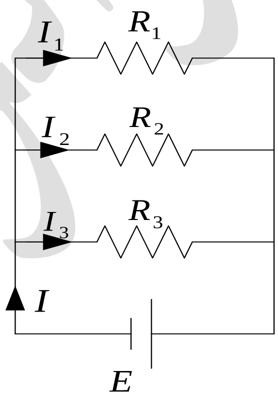
$$E = I\,(R_1 + R_2 + R_3)$$

$$\frac{E}{I} = R_T$$

$$\boxed{R_T = R_1 + R_2 + R_3}$$

Rt = Total Resistance
= Equivalent Resistance

Parallel Connection

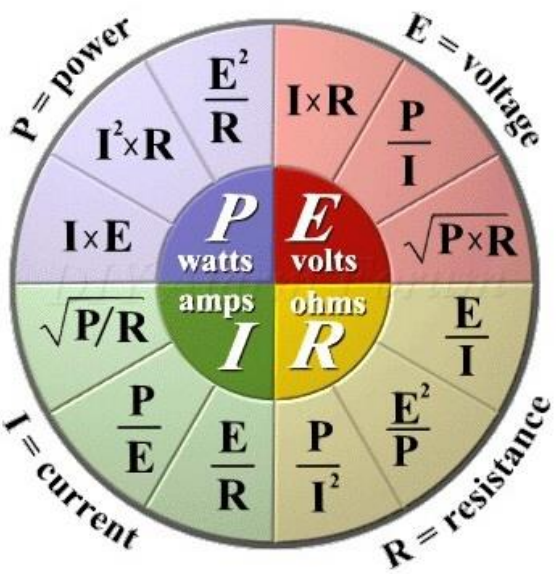


$$E = V_1 = V_2 = V_3$$

$$I = I_1 + I_2 + I_3$$

$$\frac{E}{R_T} = \frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}$$

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



Power in Resistance

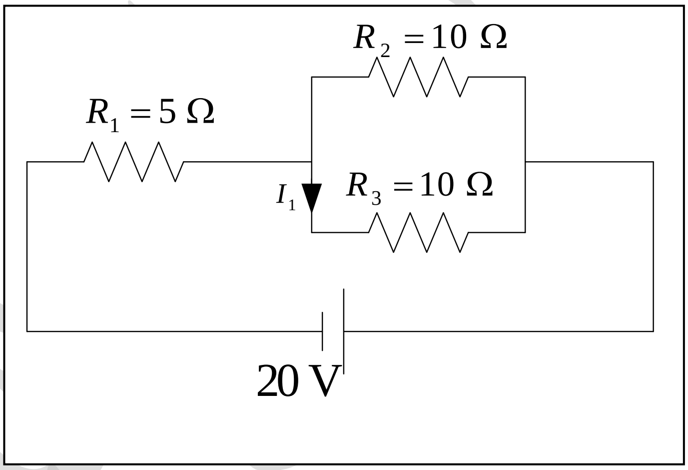
$$P = V \times I$$

$$= IR \times I = I^2 R \quad \text{Watt}$$

$$= V \times \frac{V}{R} = \frac{V^2}{R} \quad \text{Watt}$$

Ex: In the circuit showin below, find

1- Equivalent resistance (R_T)
2- Total current in the circuit (I_T)
3- Total Power drawn by circuit (P_T)
4- I_1



Sol

$$(1) R_T = R_1 + (R_2 \parallel R_3)$$

$$= 5 + \frac{10 \times 10}{10 + 10} = 10\ \Omega$$

$$(2) I_T = \frac{V}{R_T} = \frac{20}{10} = 2\ \text{A}$$

$$(3) P_T = V \times I = 20 \times 2 = 40\ \text{watt}$$

$$(4) I_1 = I_T \times \frac{10}{10 + 10} = 2 \times \frac{10}{20} = 1A$$

Ex: For the circuit shown find R_T, V_T, I_1, I_2

$$I_T = \frac{20}{8} = 2.5\ \text{A}$$

$$I_1 = I_T \times \frac{11}{28 + 11} = 0.7\ \text{A}$$

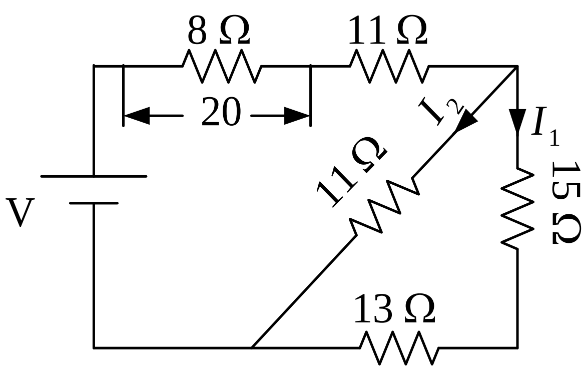
$$I_2 = I_T \times \frac{15 + 13}{(15 + 13) + 11} = 1.79\ \text{A}$$

$$R_T = (8 + 11) + \frac{28 \times 11}{28 + 11} = 26.9\ \Omega$$

$$V_T = I_T \times R_T$$

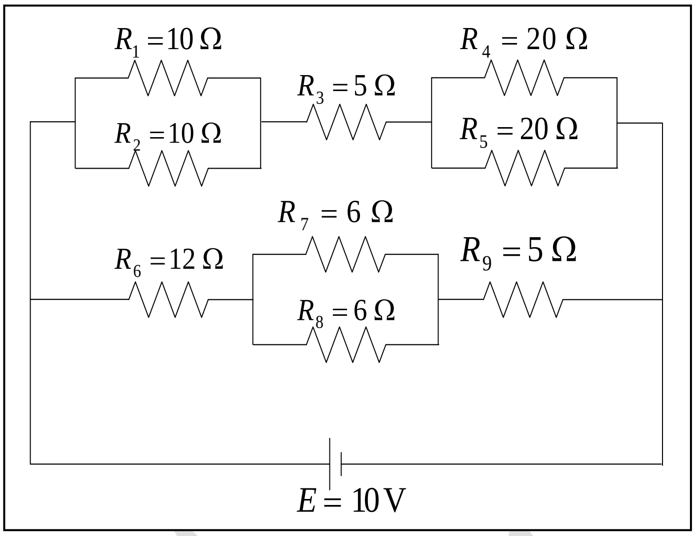
$$= 2.5 \times 26.9$$

$$= 67.25\ \text{V}$$

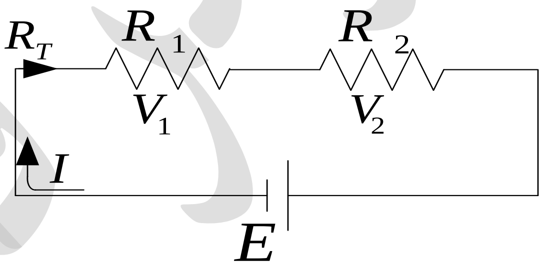


Ex (H.W.): For the circuit shown Find

1- Total Resistence
2- Current Pass throgh R_2
3- Total Power drawn by circuit
4- Current in R_7 and R_4



Voltage Divider Rule



$$R_T = R_1 + R_2$$

$$I = \frac{E}{R_T}$$

$$V_1 = IR_1 = \left(\frac{E}{R_T}\right)R_1 = \frac{R_1 E}{R_T}$$

$$V_2 = IR_2 = \left(\frac{E}{R_T}\right)R_2 = \frac{R_2 E}{R_T}$$

Note that the format for V_1 and V_2 is

$$\boxed{V_X = \frac{R_X E}{R_T}} \quad \text{(Voltage divider rule)}$$

Where V_X is the voltage across R_X, E is the impressed voltage across the series elements, and R_T is the total resistance of the series circuit

Ex: Determine the voltage V_1 for the network of Fig (1)

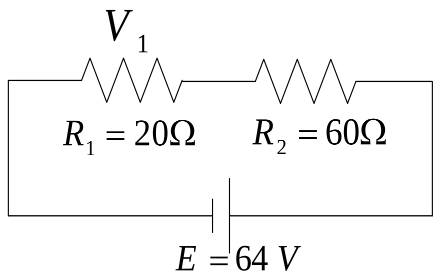


Fig (1)

Sol.

$$V_1 = \frac{R_1 E}{R_T} = \frac{R_1 E}{R_1 + R_2}$$

$$= \frac{(20)(64)}{20+60} = \frac{1280}{80} = 16\ \text{V}$$

Ex: Using the Voltage divider rule, determine the voltages V_1 and V_3 for the series circuit of Fig (2)

So

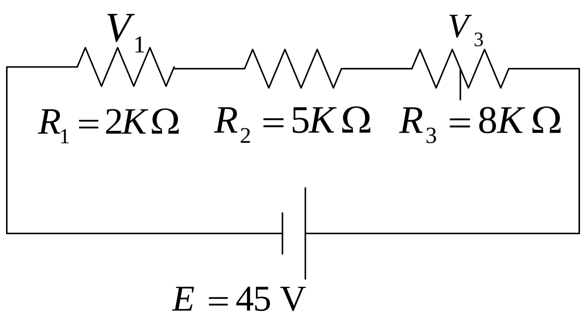


Fig (2)

$$V_1 = \frac{R_1 E}{R_T} = \frac{(2K\Omega)(45)}{2K\Omega + 5K\Omega + 8K\Omega} = \frac{(2K\Omega)(45)}{15K\Omega}$$

$$= \frac{(2\times10^3)(45)}{15\times10^3} = \frac{90}{15} = 6\ \text{V}$$

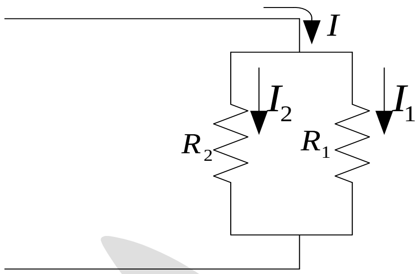
$$\text{V}_3 = \frac{R_3 E}{R_T} = \frac{(8K\Omega)(45)}{15K\Omega} = \frac{(8\times10^3)(45)}{15\times10^3}$$

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

Current Divider Rule

R_T is the total resistance of the parallel branches. Substituting $V = I_X R_X$ into above equation, where I_X refers to the current through a parallel braanch of resistance R_X, we have

$$I = \frac{V}{R_T} = \frac{I_X R_X}{R_T}$$



$$I_1 = \frac{R_T}{R_1} I \qquad \boxed{I_X = \frac{R_T}{R_X} I}$$

$$I_2 = \frac{R_T}{R_2} I$$

For the particular case of tow parallel resistors as shown in Fig

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

$$I_1 = \frac{R_T}{R_1} I = \frac{\frac{R_1 R_2}{R_1 + R_2}}{R_1} I$$

$$\boxed{I_1 = \frac{R_2 I}{R_1 + R_2} \qquad I_2 = \frac{R_1 I}{R_1 + R_2}}$$

Ex: Determine the current I_2 for the network of Fig (3) using the current divider rule.

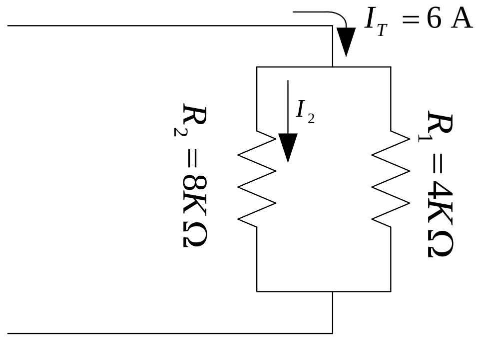


Fig (3)

Sol

$$I_2 = \frac{R_1 I_T}{R_1 + R_2} = \frac{(4K\Omega)(6A)}{4K\Omega + 8K\Omega}$$

$$= \frac{4}{12}(6) = \frac{1}{3}(6)$$

$$= 2A$$

Ex: Find the current I_1 for the network of Fig (4)

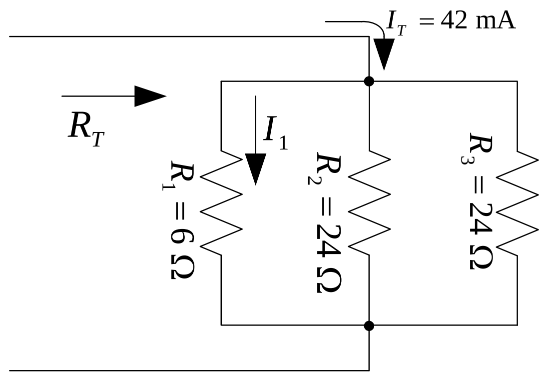


Fig (4)

Sol

$$R_T = 6 \parallel 24 \parallel 24 = 6 \parallel 12 = 4\ \Omega$$

$$I_1 = \frac{R_T}{R_1} I = \frac{(4)(42\times10^{-3})}{6} = 28\ \text{mA}$$

Delta-Star (Δ→Y) transformation

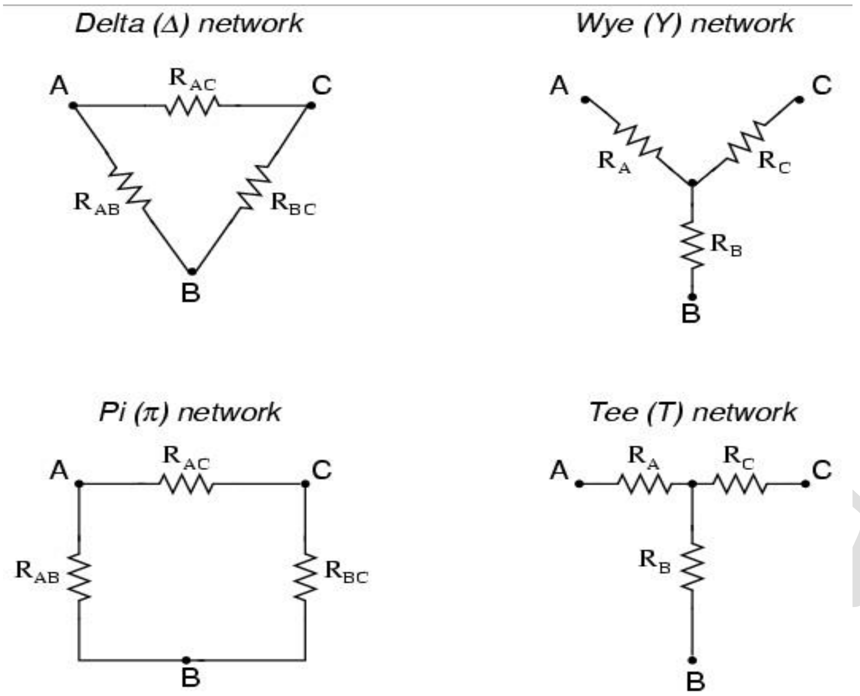
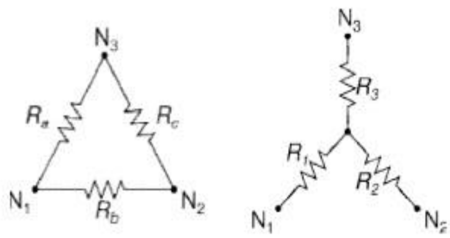


Fig (5)

Delta- Star- Delta Conversions



To convert from Delta to Star:

$$R_1 = \frac{R_a R_b}{R_a + R_b + R_c}, \qquad R_2 = \frac{R_b R_c}{R_a + R_b + R_c}, \qquad R_3 = \frac{R_a R_c}{R_a + R_b + R_c}.$$

To convert from Star to Delta:

$$R_a = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_2}, \qquad R_b = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_3}, \qquad R_c = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_1}.$$

<u>Ex</u>: In the circuit Shown in the figure. Find the Total Resistance and Total Current.

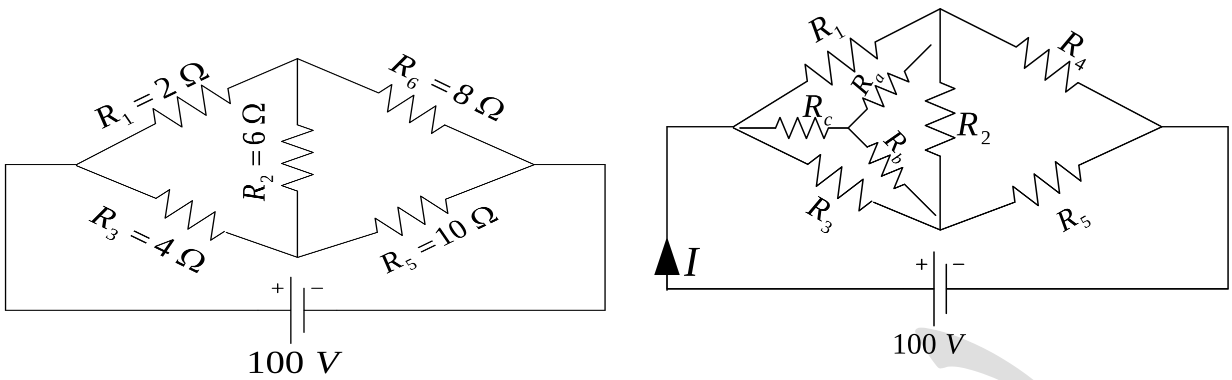
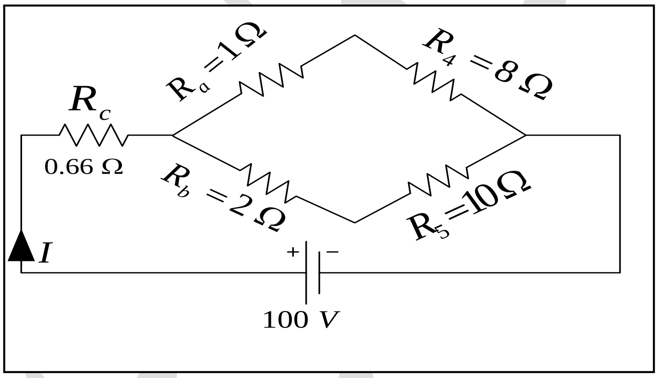


Fig (6)



$$R_a = \frac{R_1 R_2}{R_1 + R_2 + R_3} = \frac{2 \times 6}{2+6+4}$$

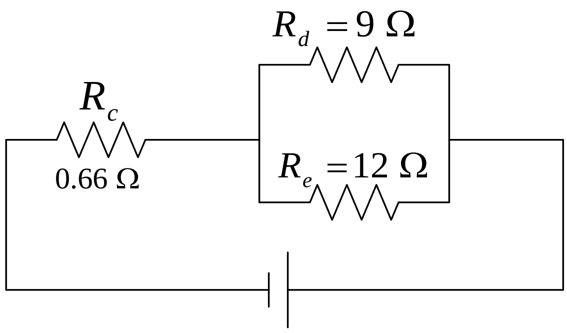
$$= \frac{12}{12} = 1\ \Omega$$

$$R_b = \frac{R_2 R_3}{R_1 + R_2 + R_3} = \frac{6 \times 4}{2+6+4}$$

$$= 2\ \Omega$$

$$R_c = \frac{R_1 R_3}{R_1 + R_2 + R_3} = \frac{4 \times 2}{2+6+4}$$

$$= \frac{8}{12} = 0.66\ \Omega$$



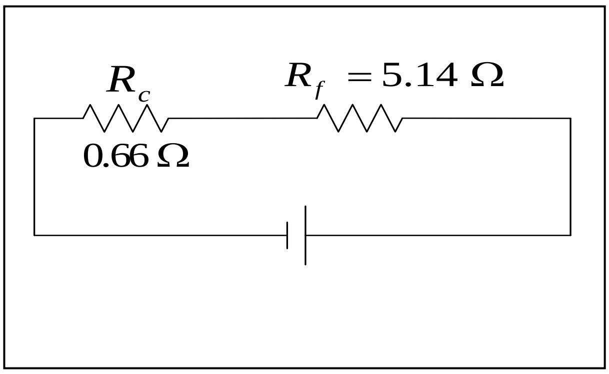
$$R_d = R_a + R_4 = 1 + 8 = 9\ \Omega$$

$$R_e = R_b + R_5 = 2 + 10 = 12\ \Omega$$

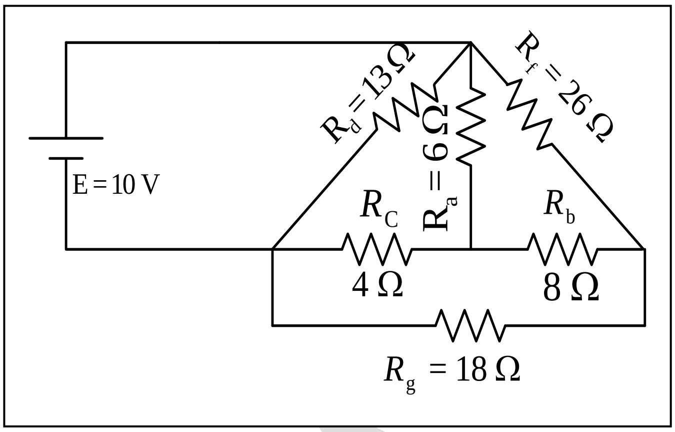
$$R_f = (R_d \parallel R_e) = \frac{9 \times 12}{9 + 12} = 5.14\ \Omega$$

$$R_t = R_f + R_c = 5.14 + 0.66 = 5.8\ \Omega$$

$$I = \frac{E}{R_t} = \frac{100}{5.8} = 17.24\ \text{A}$$



Ex: In the circuit Shown in the figure. Find the Total Resistance and Total Current by using Star- Delta transformation.



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

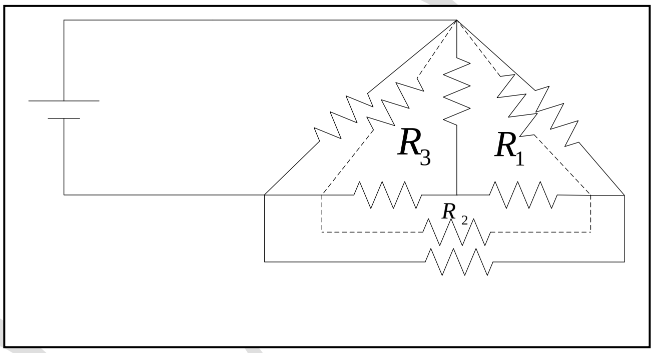
$$= 6 + 8 + \frac{6 \times 8}{4} = 26\ \Omega$$

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

$$= 8 + 4 + \frac{8 \times 4}{6} = 17.33\ \Omega$$

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

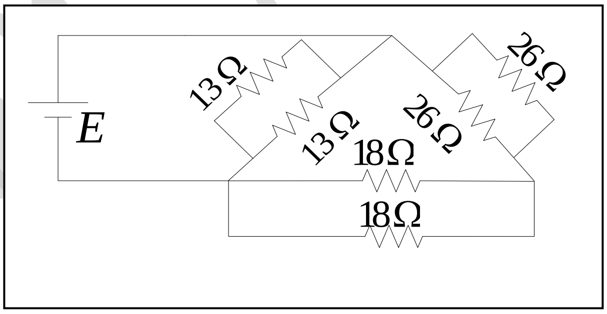
$$= 6 + 4 + \frac{6 \times 4}{8} = 13\ \Omega$$



$$R_1 \parallel R_f = \frac{26 \times 26}{26 + 26} = 13\ \Omega$$

$$R_2 \parallel R_g = \frac{18 \times 18}{18 + 18} = 9\ \Omega$$

$$R_3 \parallel R_d = \frac{13 \times 13}{13 + 13} = 6.5\ \Omega$$



13 Ω in series with 9 Ω

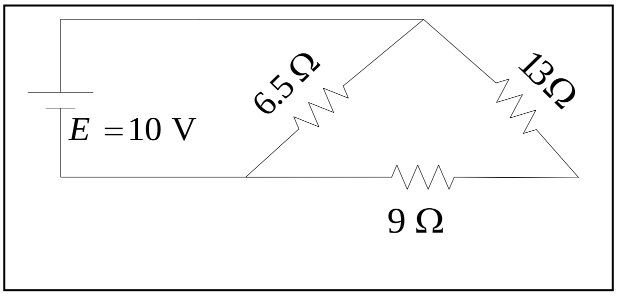
13+9=22 Ω

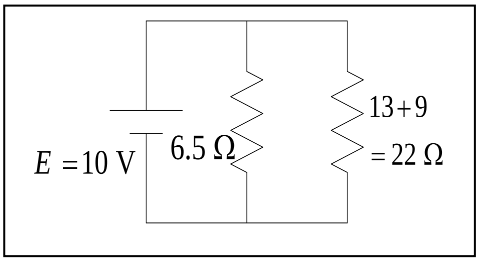
$$\therefore \ \text{Req} = \frac{22 \times 6.5}{28.5} = 5.017\ \Omega$$

$$I = \frac{E}{\text{Req}} = \frac{10}{5.017} = 1.993\ \text{A}$$

$$P_T = E \times I = 10 \times 1.993$$

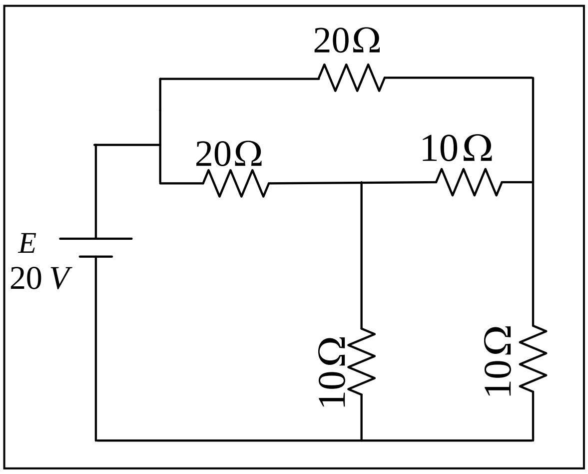
$$= 19.93 \text{ watt}$$





__Ex__ (H.W.): In the circuit shown below find:

1- Total Resistance.
2- Total Current pass through circuit.
3- Total power drawn by circuit.



Kirchoff's Law

1- Kirchoff's Current Law (KCL):

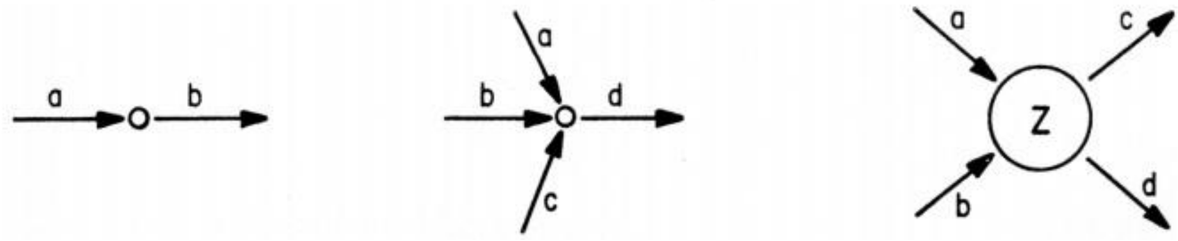
The first law, also called Kirchhoff's current law, states that the algebraic sum of currents entering and leaving any point in a circuit is equal to zero.

The sum of currents entering a node must equal equal the sum of the currents leaving a node.

İf all currents entered a single point in a circuit then we would have an equation

$$I_a + I_b = 0$$

•Here are some examples of currents entering and exiting a point in a circuit.



• Current I_a enters while I_b exits

$$I_a + I_b = 0$$

• Currents I_a , I_b and I_c enter while I_d exits.

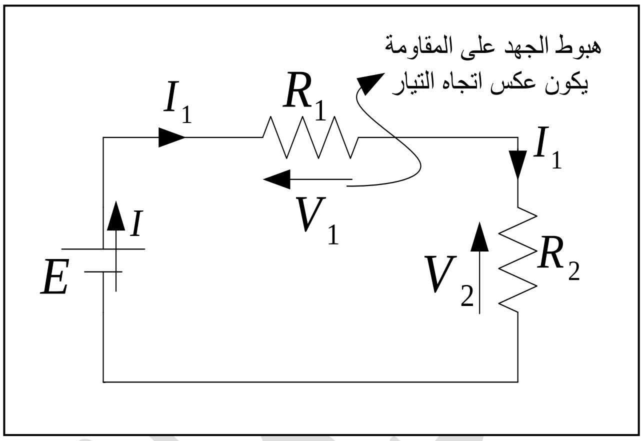
$$I_a + I_b + I_c – I_d = 0$$

Point Z or NODE Z has currents $I_a + I_b – I_c – I_d = 0$

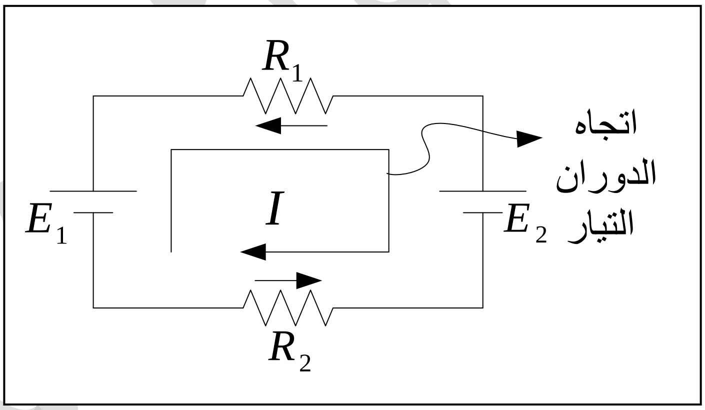
2- Kirchoff's Voltage Law (KVL)

The algebraic sum of the voltage across each resistance in any closed path in a network plus the algbric sum of the (E.m.f) (electro motive force)= Zero

$$E - VR_1 - VR_2 = 0$$
$$E = VR_1 + VR_2$$
$$E = IR_1 + IR_2$$



$$E_1 - E_2 - VR_1 - VR_2 = 0$$
$$E_1 - E_2 = VR_1 + VR_2$$
$$E_1 - E_2 = IR_1 + IR_2$$



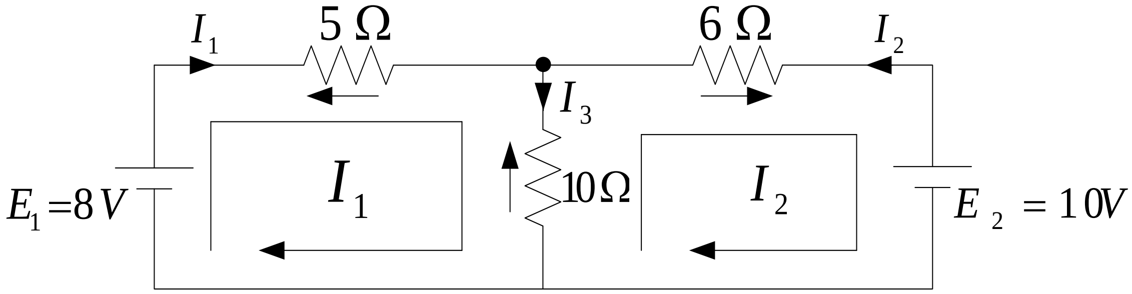
خطوات الحل

1- نقوم أولا بفرض وترميز التيارات وإعطاء الاتجاه المناسب لها.

2- نكتب المعادلة الأولى حسب قانون كيرشوف الأول للتيار.

3- نقوم بفرض اتجاهات الحلقات الدوران للتيار في الدائرة بشكل عشوائي.

Ex: Determine the current in each resistance using (K.V.L.) and (K.C.L)



Sol الطريقة الأولى

$I_3 = I_1 + I_2$

$8 - 5I_1 - 10I_3 = 0$

$8 - 5I_1 - 10(I_1 + I_2) = 0$

$8 - 5I_1 - 10I_1 - 10I_2 = 0$

$8 - 15I_1 - 10I_2 = 0$

$8 = 15I_1 + 10I_2$

$-10 + 6I_2 + 10(I_1 + I_2) = 0$

$-10 + 10I_1 + 16I_2 = 0$

$10 = 10I_1 + 16I_2$

by sowing eq.(1) & eq.(2)

$8 = 15I_1 + 10I_2$

$10 = 10I_1 + 16I_2$

$$\begin{vmatrix} 15 & 10 \\ 10 & 16 \end{vmatrix} \Rightarrow 240 - 100 = 140$$

$$I_1 = \frac{\begin{vmatrix} 8 & 10 \\ 10 & 16 \end{vmatrix}}{140} = \frac{128 - 100}{140} = \frac{28}{140} = 0.2\ \text{A}$$

$$I_2 = \frac{\begin{vmatrix} 15 & 8 \\ 10 & 10 \end{vmatrix}}{140} = \frac{150 - 80}{140} = \frac{70}{140} = 0.5\ \text{A}$$

$I_3 = 0.2 + 0.5 = 0.7\ \text{A}$

Sol طريقة الثانية

$$E_1 - 5I_1 - 10(I_1 + I_2) = 0$$
$$8 - 15I_1 - 10I_2 = 0..........(1)$$

$$E_2 - 6I_2 - 10(I_1 + I_2) = 0$$
$$10 - 10I_1 - 16I_2 = 0...........(2)$$

by solving eq.(1) & eq.(2)

$$15I_1 + 10I_2 = 8 \quad \times 2$$
$$10I_1 + 16I_2 = 10 \quad \times 3$$

$$30I_1 + 20I_2 = 16$$
$$\mp 30I_1 \mp 48I_2 = \mp 30$$
$$0 \; - \; 28I_2 = -14$$

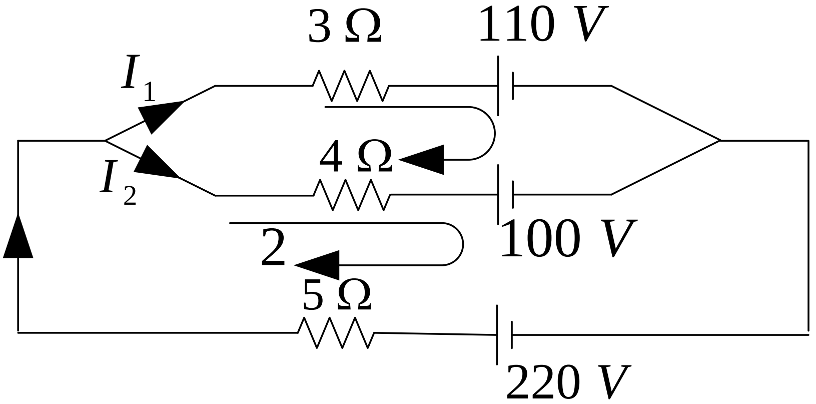
$$I_2 = \frac{14}{28} = 0.5 \text{ A}$$

(1) في المعادلة I_2 نعوض قيمة

$$8 - 15I_1\text{-}(10 \times 0.5) = 0 \Rightarrow I_1 = \frac{3}{15} = 0.2 \text{ A}$$

$$I_3 = I_1 + I_2 \Rightarrow 0.2 + 0.5 = 0.7 \text{ A}$$

Ex:Find the current in each branch by using Kirchoff law



__Sol__: For loop (1)

$$-3I_1 - 110 + 100 + 4I_2 = 0$$
$$-3I_1 + 4I_2 = 10 ....(1)$$

For loop (2)

$$220 - 5(I_1 + I_2) - 4I_2 - 100 = 0$$
$$220 - 5I_1 - 5I_2 - 4I_2 - 100 = 0$$
$$-5I_1 - 9I_2 + 120 = 0$$
$$-5I_1 - 9I_2 = -120 ....(2)$$

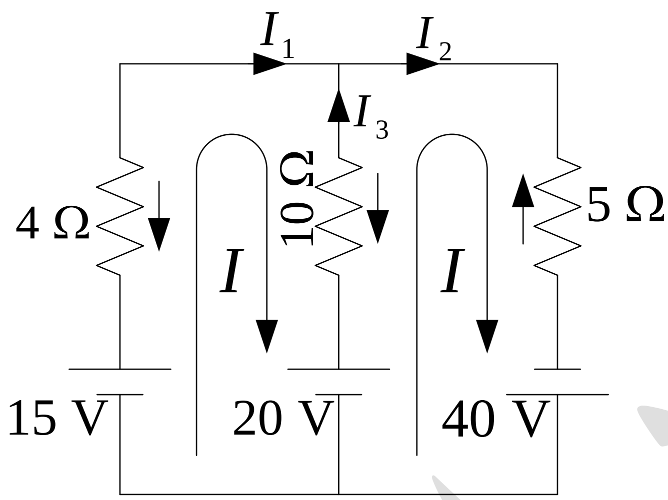
$$-3I_1 + 4I_2 = 10 \quad \times 5$$
$$\pm 5I_1 \pm 9I_2 = \pm 120 \quad \times 3$$
$$0 + 47I_2 = 410$$

$$I_2 = 8.7 \text{ A}$$

المعادلة (I) ب ال تعويض عن I_2 (1)

$$-3I_1 + 4(8.7) = 10$$
$$-3I_1 + 34.8 = 10$$
$$-3I_1 = 10 - 34.8$$
$$I_1 = \frac{-24.8}{-3}$$
$$I_1 = 8.3 \text{ A}$$
$$I_1 + I_2 \Rightarrow 8.3 + 8.7 = 17 \text{ A}$$

H.W. Apply branch-Current analysis to the network of Fig.



Source Conversions

It is often necessary or convenient to have a voitage source rather than a current source or a current source rather than a voltage source. If we consider the basic coltage source with its internal resistance as shown in Fig(7), we find that

$$I_L = \frac{E}{R_S + R_L}$$

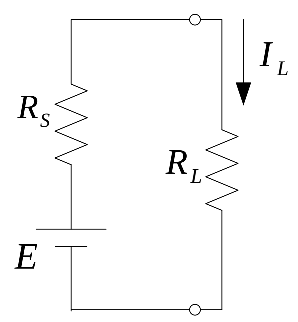


Fig (7)

Or by multiplying the numerator of the equation by a factor of (I) which we choose to be R_S / R_S . We obtain

$$I_L = \frac{(I)(E)}{R_S + R_L} = \frac{(R_S / R_S)E}{R_S + R_L} = \frac{R_S(E / R_S)}{R_S + R_L} = \frac{R_S I}{R_S + R_L}$$

if we define $I = E / R_S$. The resulting equation is actually an application of the current divider rule to the network of Fig (8).

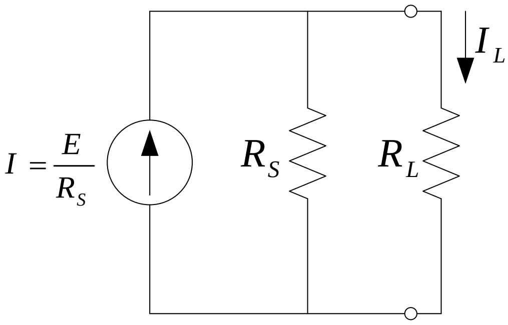


Fig (8)

For the load resistor R_L of Fig (7) or (8) it is immaterial which source is applied as long as each element has the corresponding value. That is, the voltage across or current through R_L will be the same for each network. For clarity, the equivalent sources are repeated in Fig (8) with equations necessary for the conversion. Note that the resistor $R_{S\_}$ is unchanged in magnitude and is simply brought form a series position for the voltage source to the parallel arrangement for the current source.

<u>*Ex*</u>: Convert the voltage source of Fig (9) to a current source and calculate the current through the load each source.

<u>*Sol*</u>:

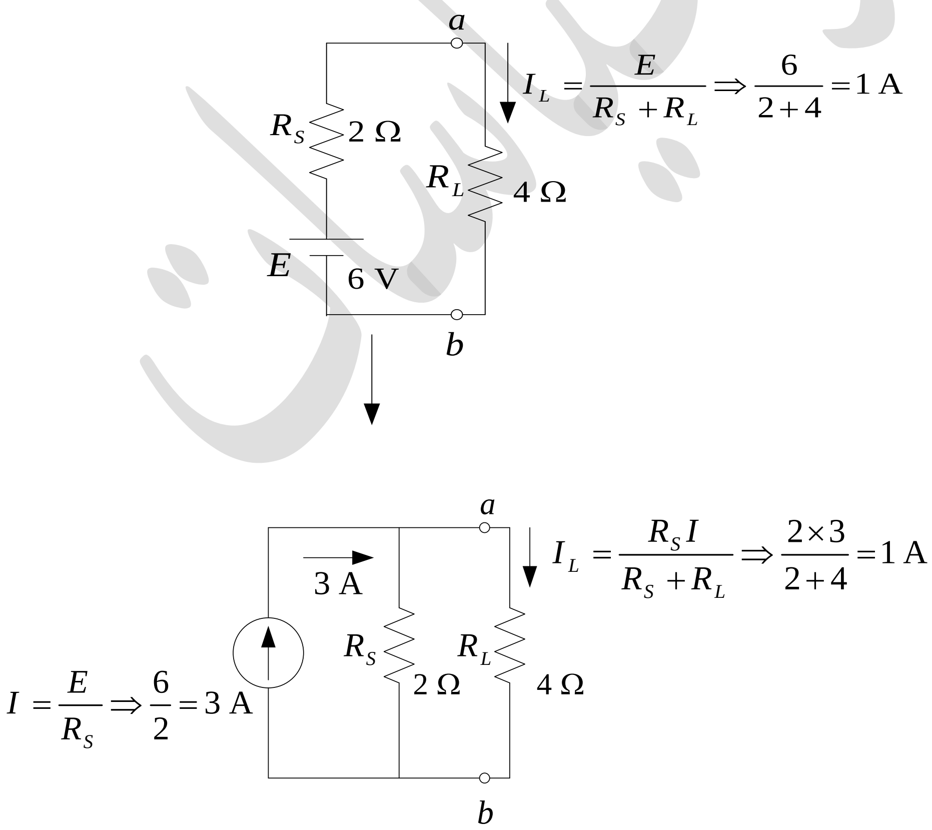
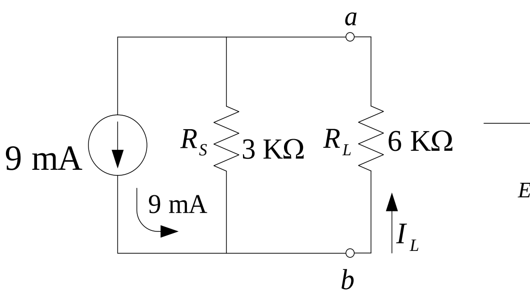
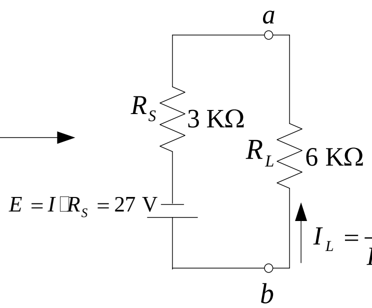


Fig (9)

<u>Ex</u>: Convert the current source of Fig (10) to a voltage source and find the current through the load for each source.

<u>Sol</u>:





$$I_L = \frac{E}{R_S + R_L} \Rightarrow \frac{27}{3\ K\Omega + 6\ K\Omega} = \frac{27}{9K\Omega} = 3\ \text{mA}$$

$$I_L = \frac{R_S I}{R_S + R_L} \Rightarrow \frac{3\times10^3 \times 9\times10^{-3}}{3\times10^3 \times 6\times10^3} = 3\ \text{mA}$$

Fig (10)

<u>Thevenin's theorems</u> نظرية ثفنن

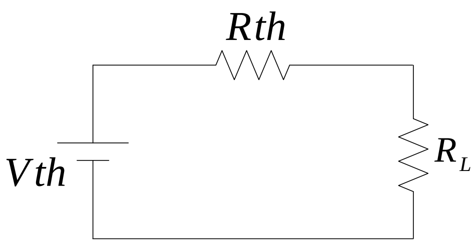
خطوات الحل

1-نرفع مقاومة المراد إيجاد التيار المار فيها ونجعله (open) ثم نوجد الجهد بين النقطتين A,B ونوجد Vth.

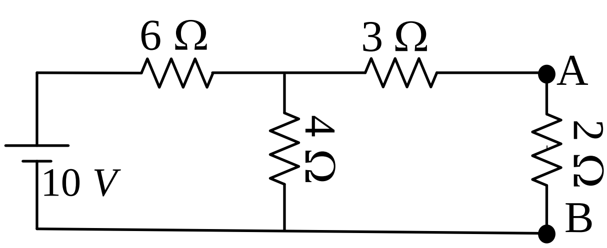
2-نوجد (Rth) عن طريق جعل مصادر الفولتية (Short) ومصادر التيار (Open) إن وجد في الدائرة وننظر إلى الدائرة من خلال هذه النقطة.

3-نربط دائرة ثفنن المكافئة

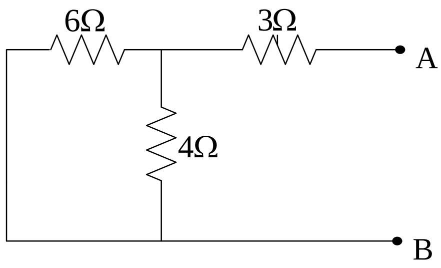
$$I_L = \frac{Vth}{Rth + R_L}$$



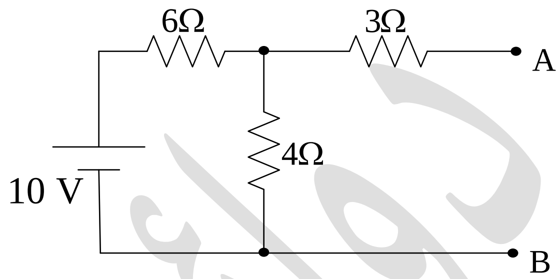
<u>Ex</u>: By using thevenin theorem find the current in 2Ω.



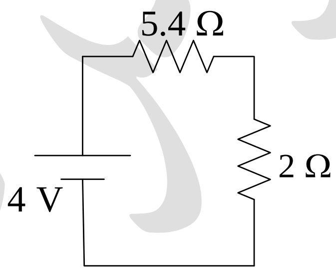
Sol:



$$Rth = (6 \parallel 4) + 3 = 5.4\ \Omega$$

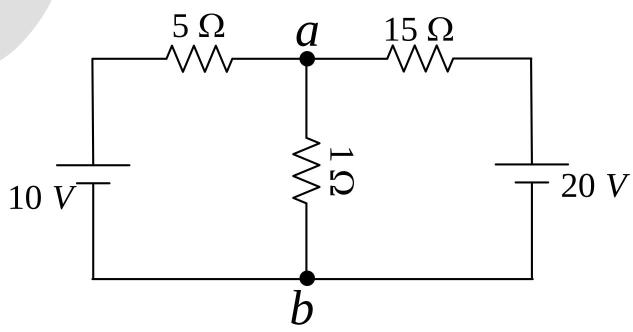


$$Vth = \frac{E \times 4}{6+4} = \frac{10 \times 4}{10} = 4\ \text{V}$$

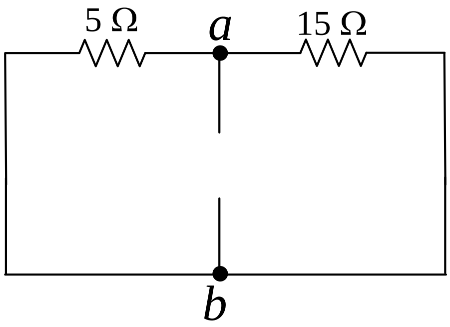


$$I_L = \frac{4}{5.4+2} = 0.5\ \text{A}$$

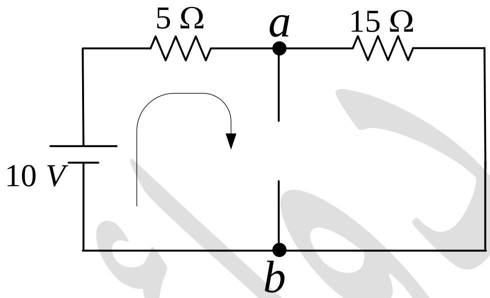
Ex:Find thevenin equivalent for the network shown.



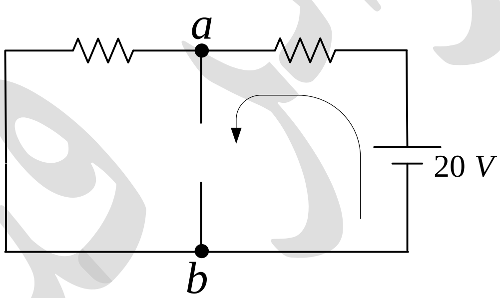
Sol:



$$Rth = \frac{5\times15}{5+15} = \frac{75}{20} = 3.75\ \Omega$$

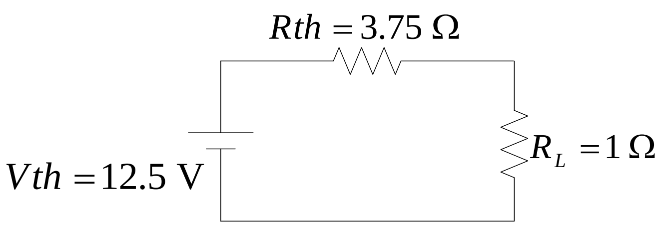


$$V_1 = \frac{10\times15}{5+15} = \frac{150}{20} = 7.5\ \text{V}$$



$$V_2 = \frac{20\times5}{5+15} = \frac{100}{20} = 5\ \text{V}$$

$$Vth = 7.5+5 = 12.5\ \text{V}$$



$$I_L = \frac{Vth}{Rth+R_L} \Rightarrow \frac{12.5}{3.75+1} = 2.6\ \text{A}$$

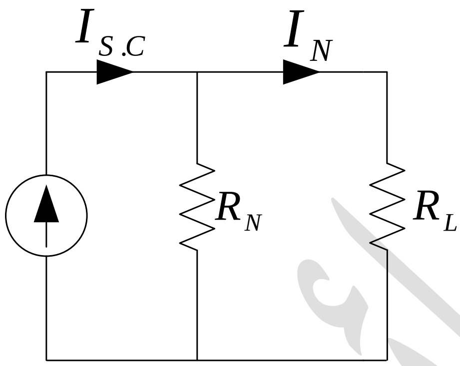
Noton Theorem

خـطــوات الــحــــل

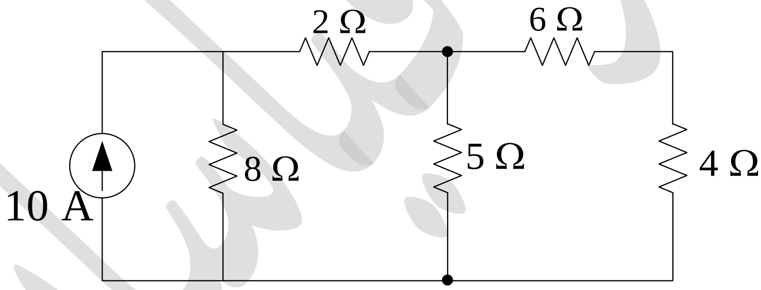
1- نوجد R_N عن طريق جعل مصادر التيار (Open) ومصادر الفولتية (Short) إن وجد في الدائرة

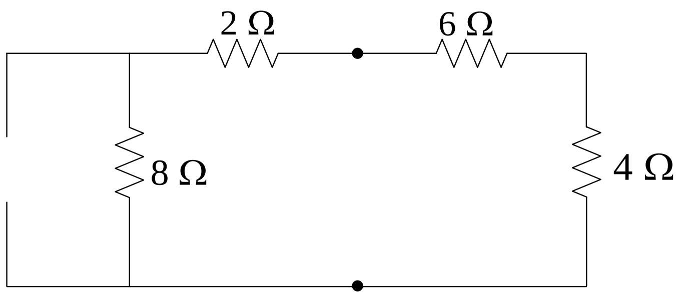
2- نجعل المقاومة المراد إيجاد التيار فيها (Short) ونوجد $I_{S.C}$

3- نرسم دائرة نورتن المكافئة ونوجد I_N



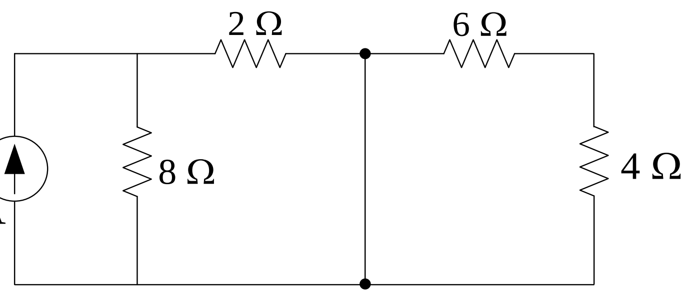
__Ex__:Find the Current in (5 Ω) by norton theorem.



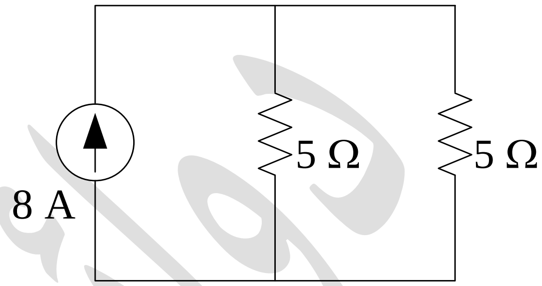


$$R_N = (6+4) \| (2+8)$$

$$= \frac{10 \times 10}{20} = \frac{100}{20} = 5\ \Omega$$

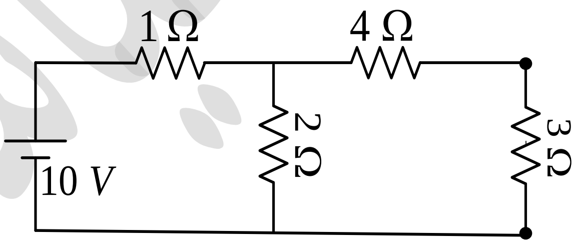


$$I_{S.C} = \frac{10\times 8}{8+2} = \frac{80}{10} = 8\ \text{A}$$



$$I_N = \frac{8\times 5}{5+5} = \frac{40}{10} = 4\ \text{A}$$

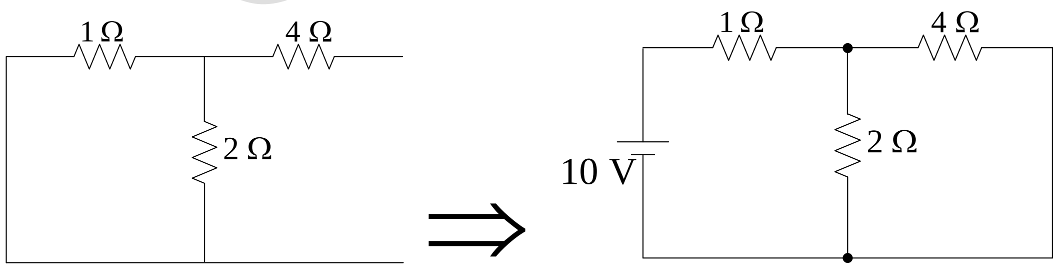
Ex: For the network Shown. Find the curren in (3Ω) by Norton theorm.

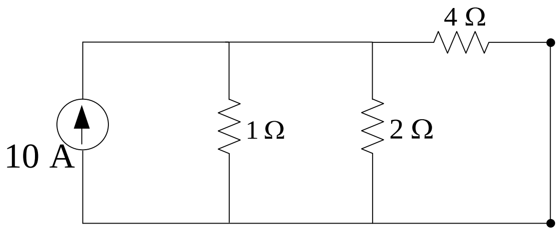


$$R_N = (1 \| 2) + 4$$

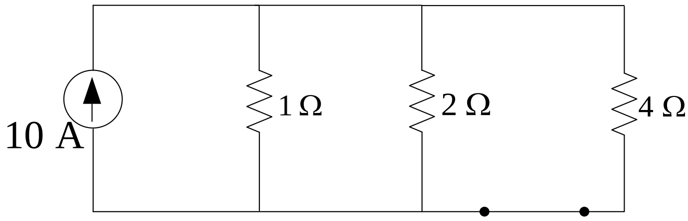
$$\left(\frac{1\times 2}{3}\right) + 4$$

$$\Rightarrow \frac{2}{3} + 4 = 4.66\ \Omega$$

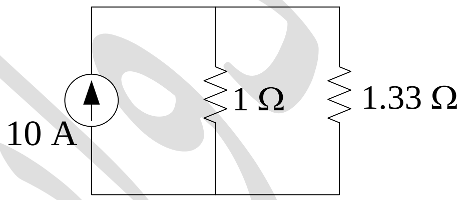




$\Rightarrow$

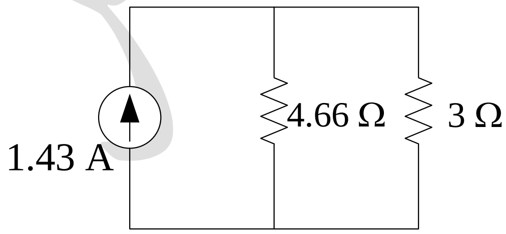


$$\frac{4\times 2}{4+2}=\frac{8}{6}=1.33\ \Omega$$



$$I_{1.33}=\frac{10\times 1}{2.33}=4.3\ \text{A}$$

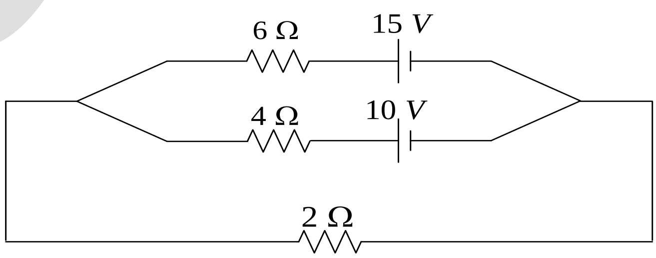
$$I_{S.C}=\frac{4.3\times 2}{2+4}=1.43\ \text{A}$$

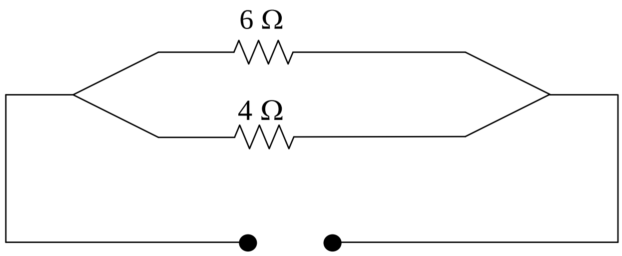


$$I_N=I_{S.C}\times\frac{R_N}{R_N+R_L}$$

$$\Rightarrow \frac{1.43\times 4.66}{4.66+3}=0.87\ \text{A}$$

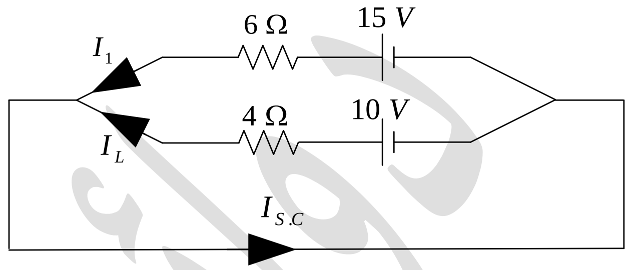
__Ex__: By using Norton theorem find the current in (2Ω).





$$R_N = 6 \| 4$$

$$\frac{6 \times 4}{6+4} = 2.4\ \Omega$$

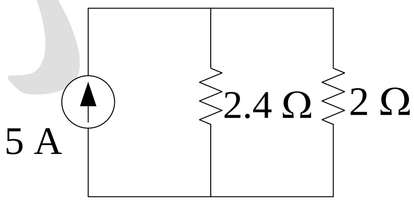


$$I_{S.C} = I_1 + I_2$$

$$I_1 = \frac{15}{6} = 2.5\ \text{A}$$

$$I_2 = \frac{10}{4} = 2.5\ \text{A}$$

$$I_{S.C} = 2.5 + 2.5 = 5\ \text{A}$$



$$I_N = 5 \times \frac{2.4}{2.4+2} = \frac{12}{4.4} = 2.73\ \text{A}$$

Superposition Therem

The superposition theorem, can be used to find the solution to networks with tow or more sources that are not in series or parallel. The most obvious advantage of this method is that it does not require the use of a mathematical technique such as determinants to find the required voltages or currents. Instead, each source is treated independently, and the algebraic sum is found to determine a particular unknown quantity of the network. In other words, for a network with *n* sources, *n* independent series-parallel networks would have to be considered before a solution could be obtained.

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Module 2 DC Circuit Version 2 EE IIT, Kharagpur

Chapter (2) Electric Circuits_. Dr. Mohamed Abd-Elrahman

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