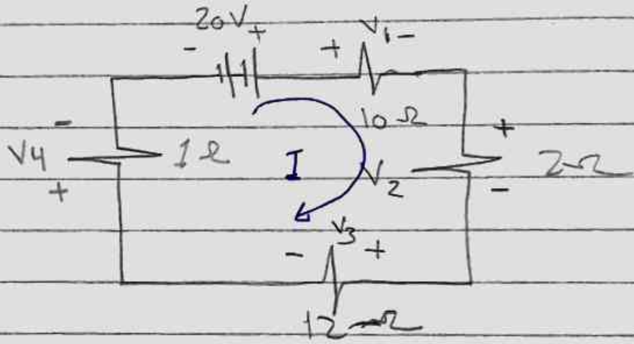
Examples

EX1: what is the total resistance of $4\Omega, 6\Omega, 7\Omega, 10\Omega$ and $3\,\Omega$ resistors in series?

Sol/

$$R_T = R_1 + R_2 + R_3 + R_4 + R_5$$
$$= 4 + 6 + 7 + 10 + 3 = 30\,\Omega$$

EX2: In the circuit in the figure, find the current and all the unknown voltages.



$$R_T = R_1 + R_2 + R_3 + R_4$$
$$= 10 + 2 + 12 + 1$$
$$R_T = 25\,\Omega$$

$$I = V_s / R_T = 20/25$$

$$I = 0{,}8\ A$$

احسب R_T ①

احسب V_s ②

$$V_1 = I R_1 = 0{,}8 * 10 = 8\,V$$

$$V_2 = I R_2 = 0{,}8 * 2 = 1{,}6\,V$$

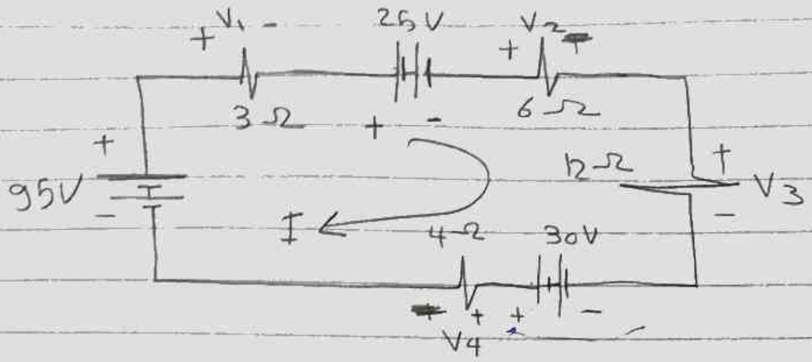
$$V_3 = I R_3 = 0{,}8 * 12 = 9{,}6\,V$$

$$V_4 = I R_4 = 0{,}8 * 1 = 0{,}8\,V$$

$$-1I + 20 - 10I - 2I$$
$$-12I$$
$$+20 - 25I = 0$$
$$I = \frac{20}{25} = 0{,}8A$$

$$V_s = +8 + 1{,}6 + 9{,}6 + 0{,}8 = 20\,V$$

Find the current and the unknown voltages in the circuit



$95 - 3I - 25 - 6I$
$-12I + 30 - 4I = 0$
$100 - 25I$
$I = 4$

$R_T = R_1 + R_2 + R_3 + R_4$

$= 3 + 6 + 12 + 4 = 25\ \Omega$

$V_T = 95 - 25 + 30 = 100\ V$

$I = V_T / R_T = \frac{100}{25} = 4\ A$

$V_1 = I R_1 = 4 * 3 = +12\ V$

$V_2 = I R_2 = 4 * 6 = -24\ V$

$V_3 = I R_3 = 4 * 12 = +48\ V$

$V_4 = I R_4 = 4 * 4 = -16\ V$

أولاً :- احسب $\sum R_T$
ثانياً :- احسب $\sum V_s$
التيار + لو انه يمر في البطارية
من - الى +
والتيار - لو انه يمر في البطارية
من + الى -
ثالثاً
احسب I من $\frac{V_T}{R_T}$
رابعاً
احسب الجهد على كل مقاومة
لو ان التيار بيدخل المقاومة من الطرف
الموجب فالجهد على المقاومة +
ولو ان التيار بيدخل المقاومة من الطرف
السالب فالجهد على المقاومة -

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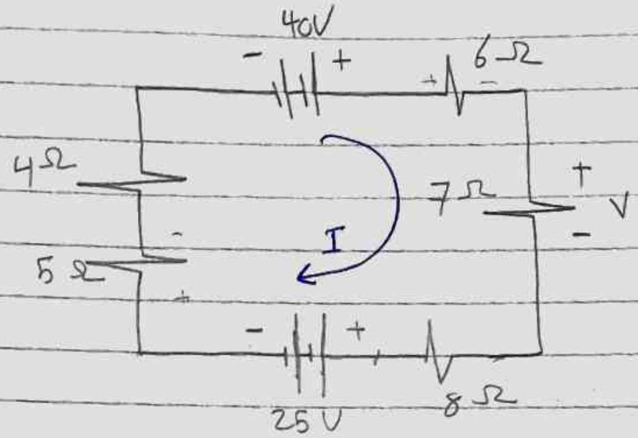
$V_T = 12 - (-24) + 48 + (-16) = 100\ V$

EX: 4 → In the circuit in the Figure find the current and the voltage at ~~of / all~~ the resistance 7 Ω (V)



$$R_T = 6 + \overset{13}{7} + \overset{21}{8} + \overset{26}{5} + 4 = 30\ \Omega$$

$$V_T = 40 - 25 = 15\ V$$

$$I = \frac{15}{30} = \frac{V_T}{R_T} = 0{,}5\ A$$

$$V = I R = + 0{,}5 * 7 = 3{,}5\ V$$

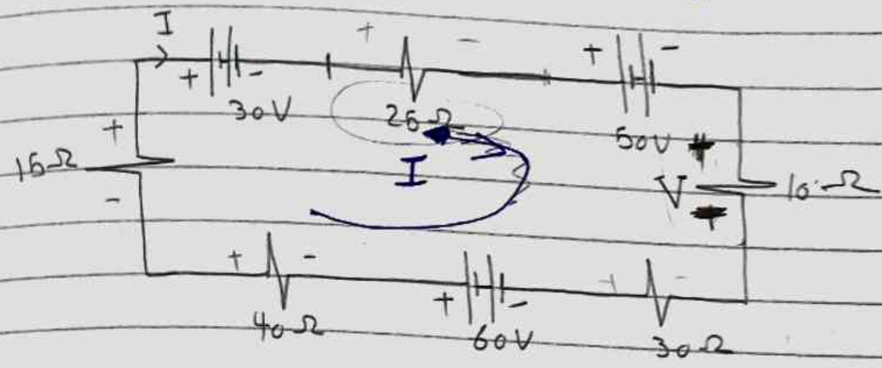
$$-25 - 5I - 4I + 40 - 6I - 7I - 8I = 0$$

$$-30 I = -15$$

$$I = 0{,}5\ A$$

$$V = 0{,}5 * 7 = 3{,}5\ V$$

Repeat EX4 for the circuit in the Figure



$$R_T = 25 + 10 + 30 + 40 + 15 = 120\ \Omega$$

$$V_T = -30 - 50 + 60 = -20\ V$$

$$I = V_T / R_T = -20 / 120 = -0{,}167\ A$$

$$V = I R = -(-0{,}167 * 10) = 1{,}67\ V$$

$$30 - 15I - 40I - 60 - 30I \overset{-25I}{\cancel{+10I}} + 50 = 0$$

$$-120I = -20$$

$$-50 - 10I - 30I + 60 - 40I - 15I - 30 - 25I = 0$$

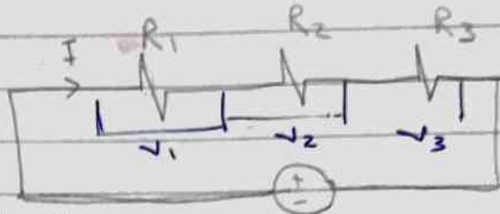
$$-20 - 120I = 0$$

$$I = -\frac{20}{120} = -0{,}167$$

L.3: Series and parallel DC Circuits

1. Resistors in Series

The figure shows an electric circuit in which Three resistors having resistances R_1, R_2, R_3 respectively.



The resistances are Joined end to end.

Here the resistors are said to be connected in series.

The potential difference V is equal to the sum of potential difference V_1, V_2, V_3

$$V = V_1 + V_2 + V_3$$

Applying ohm's law $\quad V = I R$

$$\cancel{I} R = \cancel{I} R_1 + \cancel{I} R_2 + \cancel{I} R_3$$

$$R_T = R_s = R_1 + R_2 + R_3$$

Ex: How much current will flow through a $2\ \Omega$ resistor connected in series with a $4\ \Omega$ resistor, and the combination connected across a $12\ V$ source? what is the voltage across each resistor?

sol/

$$R_s = R_1 + R_2 = 2 + 4 = 6$$

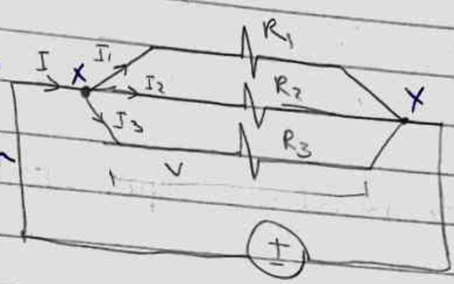
$$I = \frac{V_s}{R_s} = \frac{12}{6} = 2A$$

$$V_1 = I R_1 = 2 * 2 = 4V$$

$$V_2 = I R_2 = 2 * 4 = 8V$$

2. Resistors in parallel

The Figure shows a combination of resistors in which three resistors are connected together between points X and Y



Here, the resistors are said to be connected in parallel.

The total current I, is equal to the sum of the separate currents through each branch of the combination

$$I = I_1 + I_2 + I_3$$

Applying ohm's law $\quad I = V/R_p$

$$\frac{\cancel{V}}{R_p} = \frac{\cancel{V}}{R_1} + \frac{\cancel{V}}{R_2} + \frac{\cancel{V}}{R_3}$$

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

$$R_{eq} = \frac{R_1 * R_2}{R_1 + R_2}$$

في حالة ٢ مقاومة فقط

sol↓

$$R_s = R_1 + R_2 = 2 + 4 = 6$$

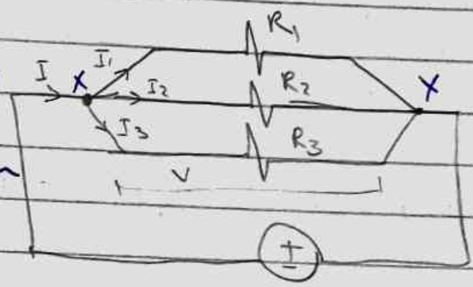
$$I = \frac{V_s}{R_s} = \frac{12}{6} = 2A$$

$$V_1 = I R_1 = 2 * 2 = 4V$$

$$V_2 = I R_2 = 2 * 4 = 8V$$

2. Resistors in parallel

The Figure shows a combination of resistors in which three resistors are connected together between points X and Y



Here, the resistors are said to be connected in parallel.

The total current I, is equal to the sum of the separate currents through each branch of the combination

$$I = I_1 + I_2 + I_3$$

Applying ohm's law $I = V/R_p$

$$\frac{\cancel{V}}{R_p} = \frac{\cancel{V}}{R_1} + \frac{\cancel{V}}{R_2} + \frac{\cancel{V}}{R_3}$$

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

$$R_{eq} = \frac{R_1 * R_2}{R_1 + R_2}$$

في حالة ٢ مقاومة فقط

EX2: what is the total resistance of the combination of 2Ω and 4Ω resistance in parallel?
Calculate the current supplied by a 12V source connected across the combination.

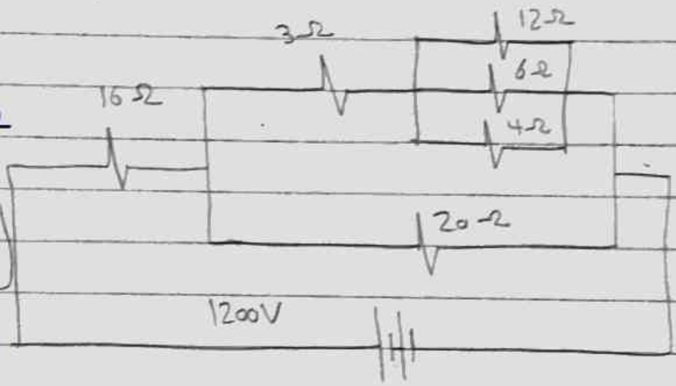
Sol↓

$$\frac{1}{R_P} = \frac{1}{2} + \frac{1}{4} = \frac{6}{8} = \frac{3}{4}$$

$$\frac{1}{R_P} = R_T = \frac{4}{3}\ \Omega$$

$$I = \frac{V_s}{R_T} = \frac{\cancel{12}^{\,3} \times 3}{\cancel{4}} = 9\ A$$

Find the resistance equ. of the circuit shown below

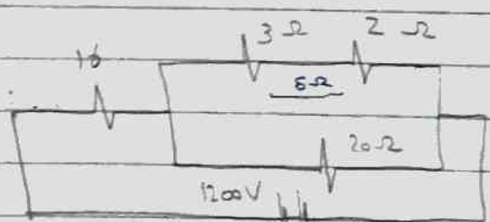


$R_1 \Rightarrow 12\Omega \parallel 6\Omega \parallel 4\Omega$

$$R_1 = \frac{1}{R_P} = \boxed{\frac{1}{12} + \frac{1}{6} + \frac{1}{4}}$$

$$R_P = \underline{0{,}5\ \Omega}$$

$R_1 = 2\ \Omega$



$R_2 = 2$ series $3\ \Omega$

$R_2 = 5\ \Omega$

$$R_3 = \frac{1}{R_{P_2}} = \frac{5 * 20}{5 + 20} = 4\ \Omega$$

$R_4 = 4\ \Omega$ series $16\ \Omega$ $\quad R_4 = 20\ \Omega$ $\quad \boxed{R_{eq} = 20\ \Omega}$

$$I = \frac{V_s}{R_{eq}} = \frac{1200}{20} = \boxed{60\ A}$$

3. Branches, Nodes, loops, Meshes.

Branch: a group of components that carry the same current

Node: is a connection point between two or more branches.

loop: is any simple closed path in a circuit

mesh: is a loop that does not have a closed path in its interior

No components are inside mesh.

A54

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3. Kirchhoff's law

Kirchhoff's law

- KCL — Junction or Node
- KVL — Mesh and loop

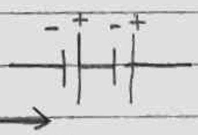
1. Kirchhoff's voltage law. (KVL)

At any instant around a loop, in either a clock wise or Counter clock wise direction.

✓ The algebraic sum of the voltage drops is Zero

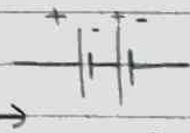
✓ The algebraic sum of the voltage rises is Zero

✓ The algebraic sum of the voltage drops equals the algebraic sum of the voltage rises.



Voltage rises

In sources, current moves From(-) to (+) is voltage rises



voltage falls

In sources, current move From (+) to (-) is voltage falls

Voltage fall

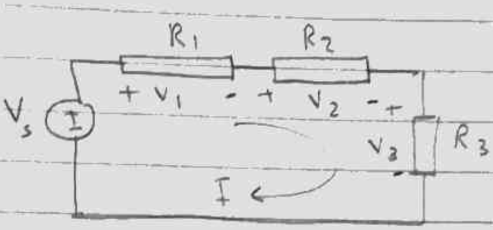
التيار يمر في المقاومة من + الى -
لو ان التيار المفروض لل loop لو بنفس الاتجاه
اذن ف الجهد بالسالب لانه تناقص

Voltage rises

التيار يمر في المقاومة من + الى -
لو ان التيار المفروض لل loop في عكس
هذا الاتجاه فان الجهد زاد ويكون موجب

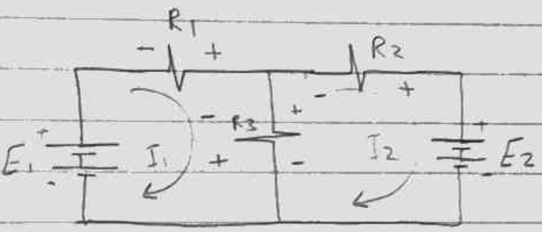
$$+V_s - V_1 - V_2 - V_3 = 0$$

$$V_s = V_1 + V_2 + V_3$$



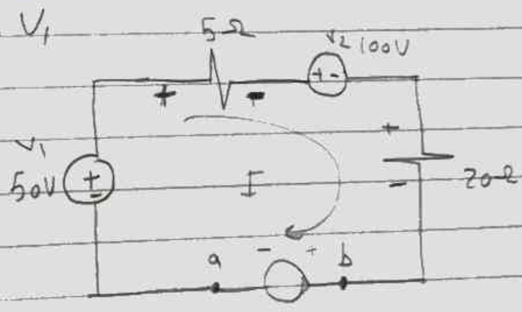
$$+E_1 + I_1 R_1 + I_1 R_3 = 0$$

$$I_2 R_3 + I_2 R_2 = E_2$$



Find V_3 and its polarity If the current I in the circuit = 0.4A

Assume V_3 has the same polarity as V_1



$$V_1 - I(5) - V_2 - I(20) + V_3 = 0$$

0.4   0.4

$$50 - 5I - 100 - 20I + V_3 = 0$$

$$V_3 = -30V$$

b is positive and a is negative

voltage divider

The voltage division or voltage divider rule applies to resistors in series.

$$V_s = I(R_1 + R_2 + R_3)$$

$$V_1 = I R_1$$

$$\frac{V_1}{V_s} = \frac{\cancel{I} R_1}{\cancel{I}(R_1 + R_2 + R_3)}$$

$$V_1 = \frac{R_1}{R_1 + R_2 + R_3} V_s$$

$$V_x = \frac{R_x}{R_T} V_s \quad \text{in general}$$

EX: $R_1 = 2\,\Omega$ $R_2 = 4\,\Omega$ in series $V_s = 12$

The voltage across each resistor??

$$V_1 = \frac{R_1}{R_1 + R_2} V_s = \frac{2}{2+4} * 12 = \frac{2}{6} * 12 = 4\,V$$

$$V_2 = \frac{R_2}{R_1 + R_2} V_s = \frac{4}{2+4} * 12 = \frac{4}{\cancel{6}} * \overset{2}{\cancel{12}} = 8\,V$$

Kirchhoff's Current Law

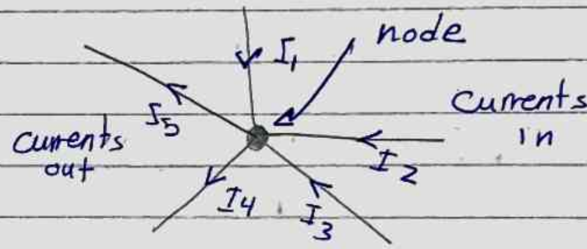
Kirchhoff's Current law abbreviated KCL, has three equivalent versions:

At any instant in a circuit.

The algebraic sum of the currents leaving a closed surface is Zero
The algebraic sum of the currents entering a closed surface is Zero

The algebraic sum of the currents entering a closed surface equals The algebraic sum of thoes leaving

* Currents entering the node equals current leaving the node.

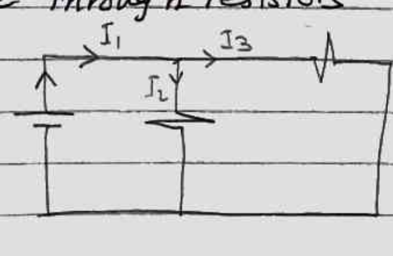


$$I_1 + I_2 + I_3 - I_4 - I_5 = 0$$

→ a current enternning is a negative Current leaving, and that a current leaving is a negative current entering.

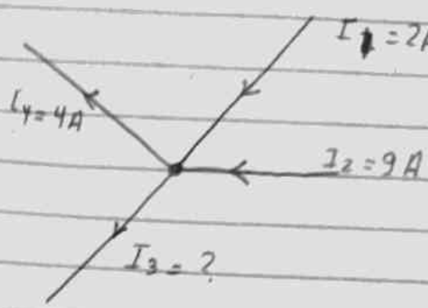
→ For a node that has no voltage source KCl is often the third one,

The currents enterning are From current source and the current leaving are through resistors



Find current I_3 at the node shown below.

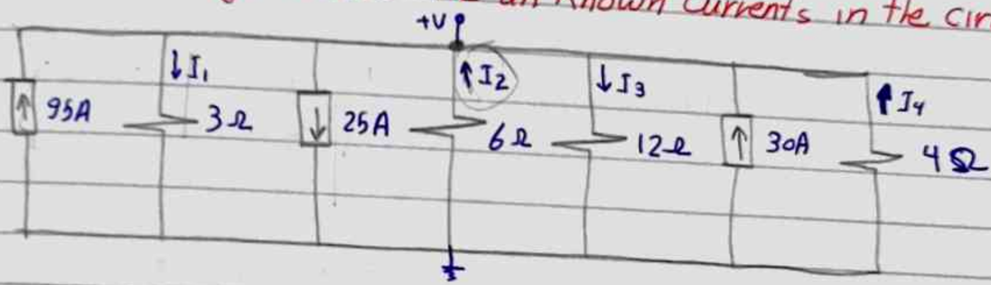
Currents i_1 and i_2 are flowing into the node
Currents i_3 and i_4 are flowing out of the node.



Apply KCl at the given node

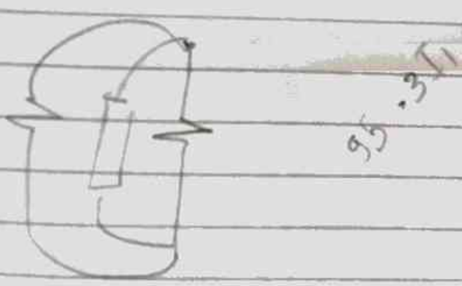
$$i_1 + i_2 = i_3 + i_4$$
$$2 + 9 = i_3 + 4 \qquad i_3 = 7A$$

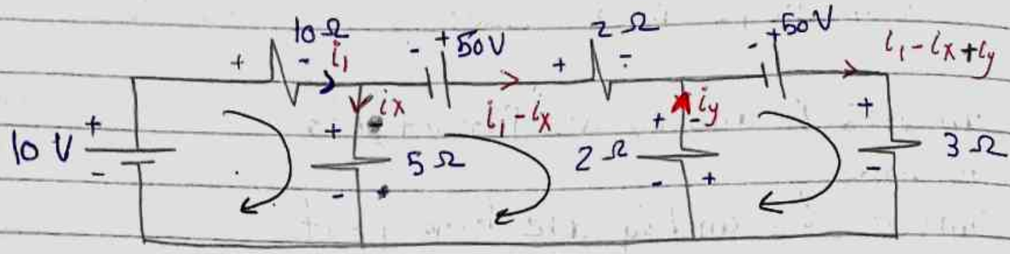
Find the voltage V and the unknown currents in the circuit



Sol↓

$$95 - 3I_1 - 25 + 6I_2 - 12I_3 + 30 + 4I_4 = 0$$





sol↓

$10 - 10 i_1 - 5 i_x = 0 \qquad 10 = 10 i_1 + 5 i_x \rightarrow ①$

$+5 i_x + 50 - 2(i_1 - i_x) + 2 i_y = 0$

$50 = 2 i_1 - 2 i_x - 2 i_y - 5 i_x$

$50 = 2 i_1 - 7 i_x - 2 i_y \rightarrow ②$

$-2 i_y + 50 - 3(i_1 - i_x + i_y) = 0$

$50 = 3(i_1 - i_x + i_y) + 2 i_y$

$50 = 3 i_1 - 3 i_x + 3 i_y + 2 i_y$

$50 = 3 i_1 - 3 i_x + 5 i_y \rightarrow ③$

$\cancel{10}^{2} = \cancel{10}^{2} i_1 + \cancel{5}^{1} i_x \rightarrow ①$

$2 = 2 i_1 + i_x \qquad (i_x = 2 - 2 i_1) \rightarrow ④$

$50 = 2 i_1 - 7(2 - 2 i_1) - 2 i_y$

$50 = 2 i_1 - 14 + 14 i_1 - 2 i_y$

$64 = 16 i_1 - 2 i_y \rightarrow (5)$

$50 = 3 i_1 - 3(2 - 2i_1) + 5 i_y$

$50 = 3 i_1 - 6 + 6 i_1 + 5 i_y$

$56 = 9 i_1 + 5 i_y \rightarrow (6)$

solving 5, 6

$\overset{32}{\cancel{64}} = \overset{8}{\cancel{16}} i_1 - \cancel{2} i_y \Rightarrow i_y = 8 i_1 - 32$

$56 = 9 i_1 + 5 i_y$

$56 = \cancel{9 i_1} + 5(8 i_1 - 32)$

$56 = 49 i_1 - 160$

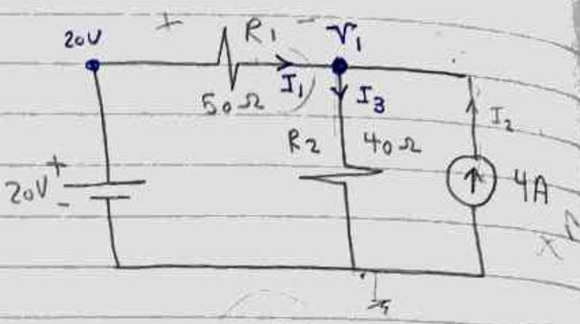
$216 = 49 i_1$

$$\boxed{i_1 = 4{,}41 \text{ A}}$$

$i_x = 2 - 2 i_1 = -6{,}82 \text{A}$

$i_y = 3{,}28 \text{ A}$

Ex.



$$KCL \rightarrow I_1 + I_2 - I_3 = 0$$

$$I_1 = \frac{20 - V_1}{50} \qquad I_2 = 4A$$

$$I_3 = \frac{V_1 - 0}{40}$$

$$\frac{20 - V_1}{50} + 4 - \left(\frac{V_1}{40}\right) = 0$$

$$\frac{4(20 - V_1) + 800 - 5V_1}{200} = 0$$

$$-4V_1 + 80 + 800 - 5V_1 = 0$$

$$9V_1 = 880 \qquad V_1 = 97{,}78$$

$$I_1 = \frac{20 - 97{,}78}{50} = -1{,}556\,A$$

$$I_3 = \frac{V_1}{40} = \frac{97{,}78}{40} = 2{,}445\,A$$

$$KCL \Rightarrow -1{,}554 + 4 = 2{,}445$$

$$I_1 + I_2 = I_3$$

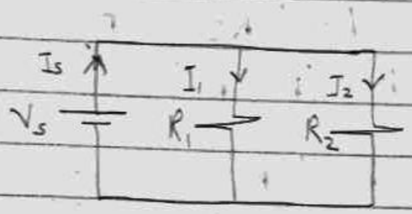
✓

Current Division

→ The current Division or current Divider rule applies to resistors in parallel.

It gives the current through any ~~terms~~ resistors into the parallel Combination

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



$$I_2 = \frac{R_1}{R_1 + R_2} I_s.$$

$$V = IR \Rightarrow I = \frac{V}{R}$$

$$I_1 = \frac{V_1}{R_1} \qquad I_2 = \frac{V}{R_2}$$

$$R = \frac{R_1 * R_2}{R_1 + R_2}$$

$$I = \frac{V(R_1 + R_2)}{R_1 * R_2} \qquad V = I_1 R_1 = I_2 R_2$$

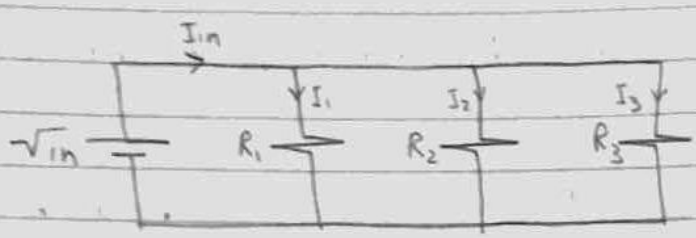
$$I = \frac{I_1 \cancel{R_1} (R_1 + R_2)}{\cancel{R_1} R_2} = \frac{I_1}{R_2}(R_1 + R_2)$$

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

$$I = \frac{I_2 \cancel{R_2} (R_1 + R_2)}{R_1 \cancel{R_2}} = \frac{I_2}{R_1}(R_1 + R_2)$$

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

All resistors in parallel share the same voltage

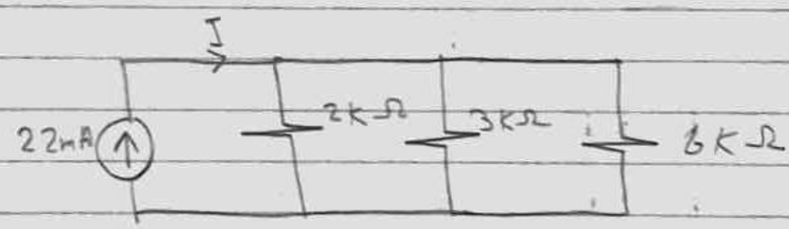


$$I_1 = \frac{R_2 \parallel R_3}{R_1 + (R_2 \parallel R_3)} I_{in}$$

$$I_2 = \frac{R_1 \parallel R_3}{R_2 + (R_1 \parallel R_3)} I_{in}$$

$$I_3 = \frac{R_1 \parallel R_2}{R_3 + (R_1 \parallel R_2)} I_{in}$$

EX:



$$I_1 = \frac{2\,k\Omega * 22\,mA}{2+2} = 0{,}5 * 22 * 10^{-3} = 11\,mA$$

$$I_2 = \frac{1{,}5\,k\Omega * 22\,mA}{3+1{,}5} = 0{,}33 * 22 * 10^{-3} = 7{,}26\,mA$$

$$I_3 = \frac{1{,}2\,k\Omega * 22\,mA}{6+1{,}2} = 0{,}1667 * 22 * 10^{-3} = 3{,}67\,mA$$

22 mA

Source transformation

Figure (a) shows the transformation from a voltage source to an equivalent current source

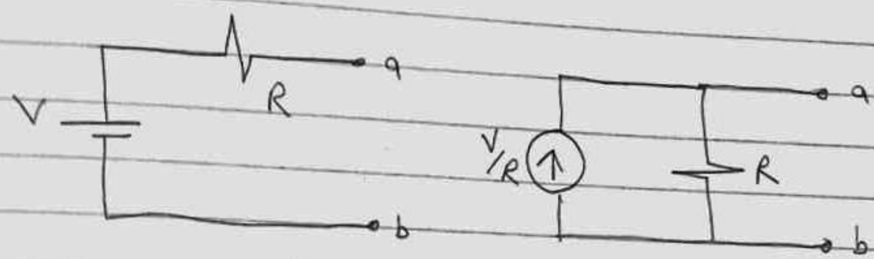
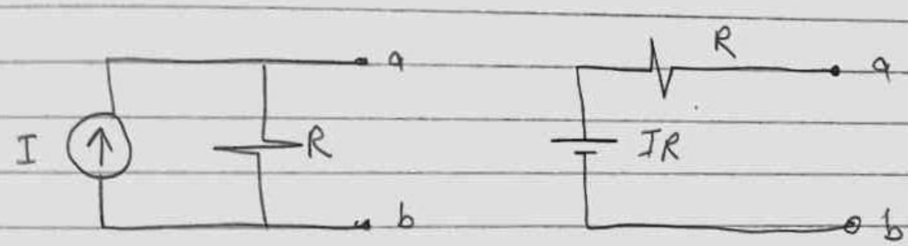


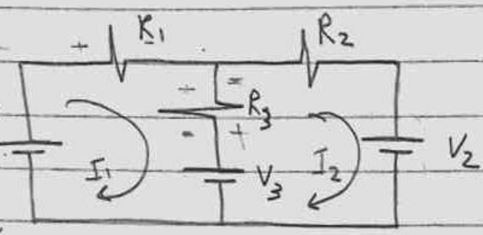
Figure (b) shows the transformation from a current source to an equivalent voltage source



Mesh Analysis

Mesh Analysis: is defined as the method in which the current Flowing through a planar circuit is Calculated.

$$V_1 - V_3 = I_1 R_1 - (I_1 - I_2) R_2$$

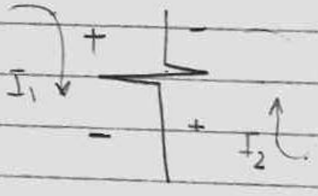


$$V_1 - V_3 = I_1 R_1 + (I_1 - I_2) R_2$$

$$V_3 - V_2 - (I_2 - I_1) R_3 - R_2 I_2 = 0$$

$$V_3 - V_2 = I_2 R_3 - I_1 R_3 + I_2 R_2$$

mesh 1

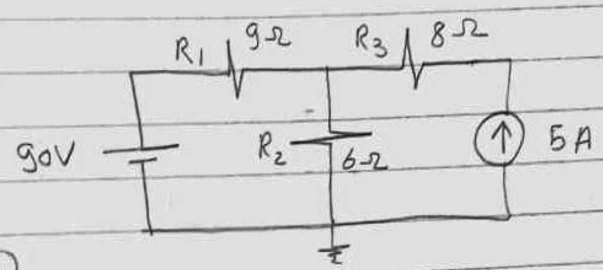


$$-(I_1 - I_2) R_1$$

mesh 2

$$-(I_2 - I_1) R_1$$

EX
Using mesh analysis, Determine the current across each resistor and potential difference



Sol↓

$90 - 9I_1 - 6(I_1 - I_2) = 0$

$90 = 15I_1 - 6I_2 \rightarrow (1)$

$I_2 = 5A$ - current source

$I_1 = 4A$

$V_1 = 4 * 9 = 36V$

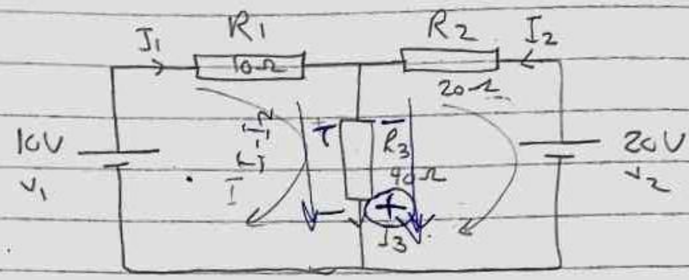
$V_2 = 6V$

$V_3 = 40V$

EX:

Determine the current across each resistor and potential difference

Sol↓



$$10 - 10I_1 - 40(I_1 - I_2) = 0$$

$+(I_2 - I_1)$

$$10 = 50I_1 - 40I_2 \longrightarrow 1$$

$$-20 - 40(I_2 - I_1) - I_2 20 = 0$$

$$-20 = 60I_2 - 40I_1 \longrightarrow 2$$

$$\cancel{10} = 5\cancel{0}I_1 - 4\cancel{0}I_2$$
$$-2\cancel{0} = -4\cancel{0}I_1 + 6\cancel{0}I_2$$

$$I_2 = -0{,}25 + 1{,}25\,I_1$$

$$\boxed{I_2 = 1{,}25\,I_1 - 0{,}25}$$

$$-2 = -4I_1 + 7{,}5\,I_1 - 1{,}5$$

$$-0{,}5 = 3{,}5\,I_1 \qquad I_1 = -0{,}143\,A$$

$$I_2 = -0{,}429\,A$$

Nodal analysis

is used for solving any electrical network, and it is defined as The mathematical method for calculating the voltage distribution between the circuit Nodes.

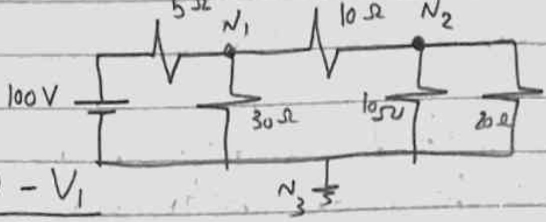
. This method is also known as the node voltage method since the node voltages are with respect to the ground.

The following are the three laws that define the equation related to the voltage that is measured between each circuit node:

1- ohm's law
2- Kirchoff's voltage law
3- Kirchoff's current law

EX: using the Node analysis
Determine the voltage at each node of the given circuit

sol/



at Node 1

$$\frac{V_1}{\cancel{30}\ 6} + \frac{V_1 - V_2}{\cancel{10}\ 2} = \frac{100 - V_1}{\cancel{5}}$$

$$2V_1 + 6(V_1 - V_2) = 12(100 - V_1)$$

$$20V_1 - 6V_2 = 1200 \rightarrow 1$$

at Node 2

$$\frac{V_2}{\underset{2}{20}} + \frac{V_2}{\cancel{10}} = \frac{V_1 - V_2}{\cancel{10}}$$

$$V_2 + 2V_2 = 2V_1 - 2V_2$$

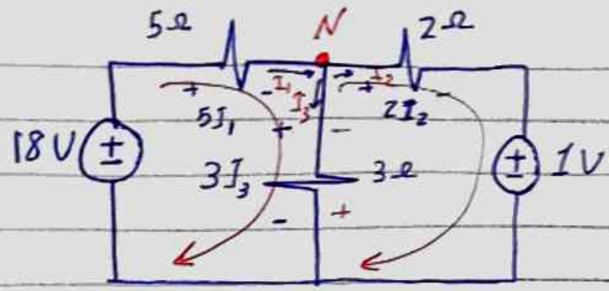
$$5V_2 = 2V_1$$

$$V_1 = 2{,}5\,V_2 \rightarrow 2$$

$$V_2 = 27{,}27\,V$$

$$V_1 = 68{,}18\,V$$

Find I_1, I_2, I_3



Sol↓

KCL $\quad I_1 = I_2 + I_3 \rightarrow (1)$

(1) اولاً نفرض اتجاهات التيار I_1 خارج من المصدر ويوزع الى النقطة

$$18 - 5I_1 - 3I_3 = 0 \Rightarrow \quad 18 = 5I_1 + 3I_3 \rightarrow (2)$$

$$+3I_3 - 2I_2 - 1 = 0 \quad\quad -1 = 2I_2 - 3I_3 \rightarrow (3)$$

(1) in (2)

(2) نفرض اتجاه التيار في mesh مع عقارب الساعة

(3) لو اعطى التيار I_1 و I_2 , I_3 في عكس اتجاه التيار المفروض الاشارة (−)

لو اعطى اتجاه التيارات I_1, I_2, I_3 في عكس الاتجاه في اشارة العنصر (+)

$$18 = 5(I_2 + I_3) + 3I_3$$

$$18 = 5I_2 + 8I_3$$

$$-1 = 2I_2 - 3I_3$$

$$36 = \cancel{10I_2} + 16I_3$$

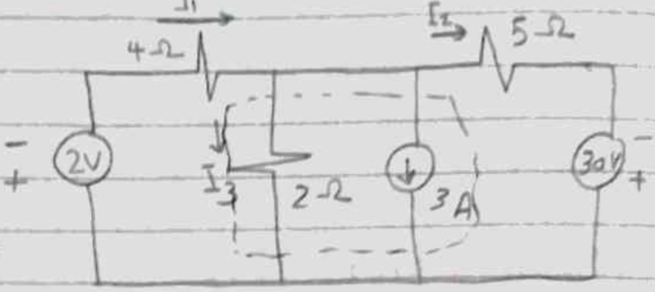
$$+5 = \cancel{-10I_2} - 15I_3$$

$$41 = I_3 \text{ A}$$

$$I_2 = \frac{-1 + 3I_3}{2} = \frac{-1 + 3 * 41}{2} = 61 \text{ A}$$

$$I_1 = 102 \text{ A}$$

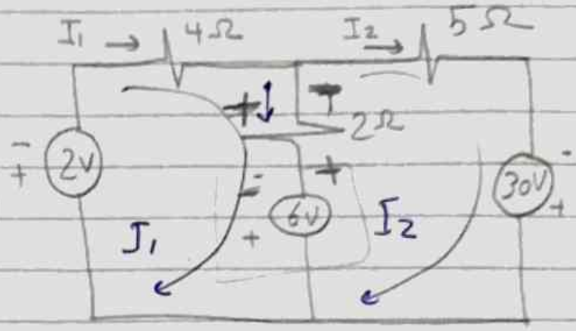
Example: use mesh analysis to find the currents in the circuit



Mesh 1

$-2-4I_1-2(I_1-I_2)$

$+6=0$



$6-2=2(I_1-I_2)+4I_1$

$4=6I_1-2I_2 \rightarrow (1)$

Mesh (2)

$-6-2(I_2-I_1)-5I_2+30V=0$

$30-6=5I_2+2(I_2-I_1)$

$24=7I_2-2I_1 \rightarrow (2)$

$4=6I_1-2I_2$

$3 \times 24=-2I_1+7I_2$

$72=-6I_1+21I_2$

$76=19I_2$

$I_2=4A$

solving (1),(2)

$I_2=4A$

$I_1=2A$

$I_1=I_3+3+I_2$

من رسم الدارة الأصلية

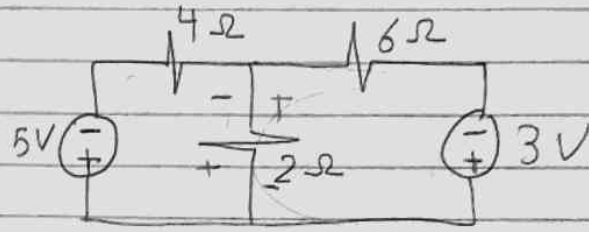
$2=I_3+3+4$

$\boxed{I_3=-5A}$ ↑

Determine a network from which the following mesh equations might have come.

$$6I_1 - 2I_2 = 5$$

$$-2I_1 + 8I_2 = -3$$



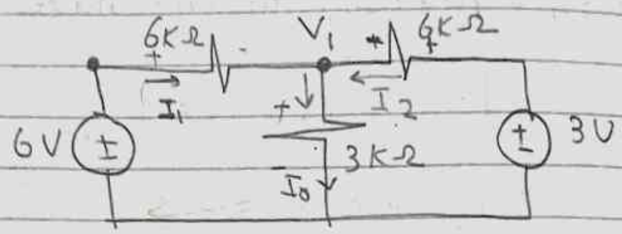
$$6I_1 - 2I_2 - 5 = 0$$

$$4I_1 + 2(I_1 - I_2) = 5$$

$$-2I_1 + 8I_2 + 3 = 0$$

$$6I_2 + 2(I_2 - I_1) = -3$$

Using Nodal analysis. Find V_1 and I_o



At Node V_1

$$I_1 + I_2 = I_o$$

$$\frac{6 - V_1}{6} + \frac{3 - V_1}{6} = \frac{V_1}{3}$$

$$6 - V_1 + 3 - V_1 = 2V_1$$

$$9 - 2V_1 = 2V_1 \qquad 9 = 4V_1 \qquad V_1 = 9/4\ V$$

$$I_o = \frac{9/4}{3K} = 3/4\ mA$$

اولاً يتم عمل معادلة Kcl

ويتم تحديد قطبية المقاومات بناء على مرور التيار بها
التيار في المقاومات يمر من + الى −

يتم ~~عمل~~ تحديد النقطة موضع التحليل

يتم التحليل بناء على قطبية المقاومات النقطة ناحية الاشارة +
تكون موجبة والنقطة ناحية الاشارة السالبة بالسالب