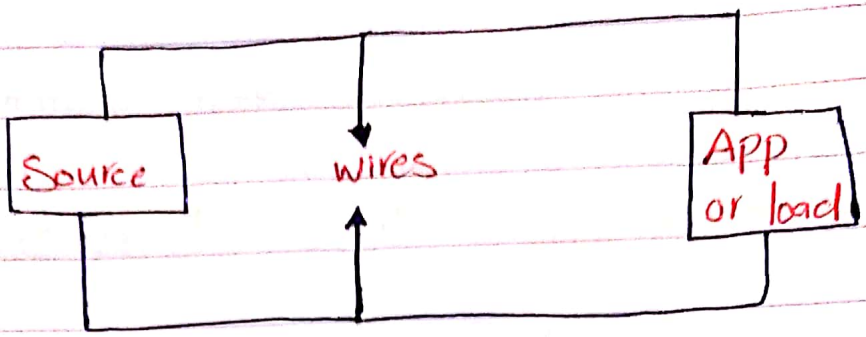
* chapter "1" →



* Sources ┌ generator
└ battery ⊣⊢

1- Voltage Source

$V_{ab} = \Delta V = V_a - V_b$

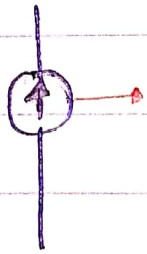
* Voltage of Source is DC or Independant Source
Direct Current

* الفولتية تكون ثابتة

* PV طاقة شمسية

* AC فولتية متغيرة

2- Current Source (C.S)



السهم يدل على اتجاه التيار

* اذا كانت قيمة التيار 5A- نحافظ على نفس الاتجاه ونعوض الاشارة

* Loads →

(R) Resistance —w— (يقاس بالأوم Ω)

(L) inductor (ملف) —ooo— (H يقاس بالهنري)

(C) Capacitor ⊣⊢ (F يقاس بالفاراد)

* Quantities →

* V (Volt) الجهد * Power (watt) القدرة

* I (Amber) التيار

$$P = \pm I.V$$

لـ اشارة التيار

* power (P) ⇒ + → Consume, absorb مستهلك

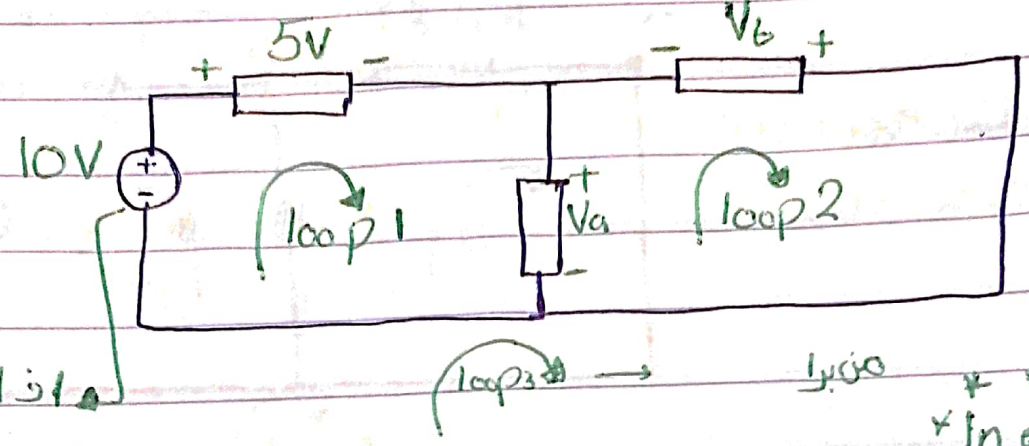
− → generate, deliver منتج

* Energy = Power . time

↳ (Kw.h)

كيلوواط لكل ساعة

* KVL (Kirchhoff's voltage law)



اذا دخلت بالسالب بعوض القيمة سالب
واذا دخلت بالموجب بعوض القيمة موجب

متغيرا

In a the loop
$\sum V = 0$

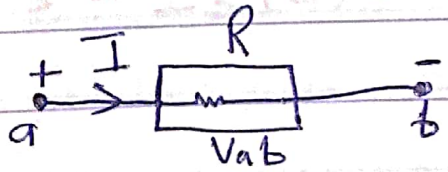
From loop1 ⇒ $-10 + 5 + Va = 0$

$Va = 5V$

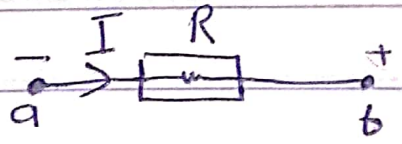
From loop2 ⇒ $-Va - Vb = 0$

$-5v = Vb \Rightarrow Vb = -5V$

* V = IR

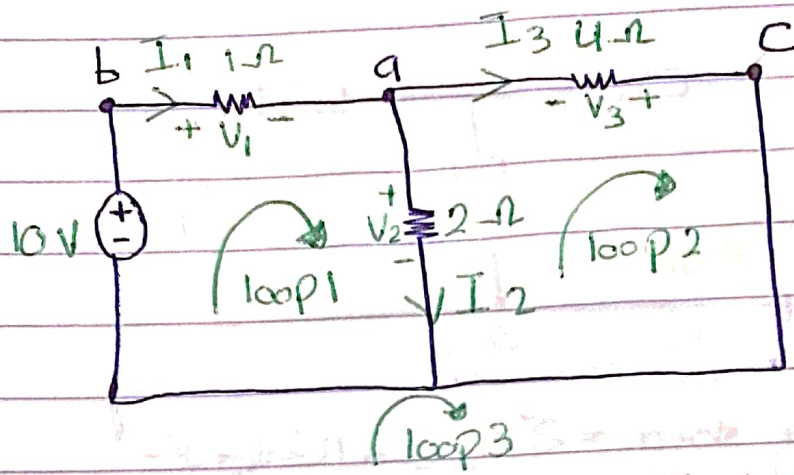


$V_{ab} = +IR$



$V_{ba} = -IR$

* Example:



* اذا اماشي مع التيار بعوض (+)
* اذا عكسه بعوض (−)

loop 1 ⇒ $-10 + I_1(1) + I_2(2) = 0$

loop 2 ⇒ $-2I_2 + 4I_3 = 0$

loop 3 ⇒ $-10 + I_1(1) + 4I_3 = 0$

at node a ⇒ $I_1 = I_2 + I_3$

بكمل حل معادلات

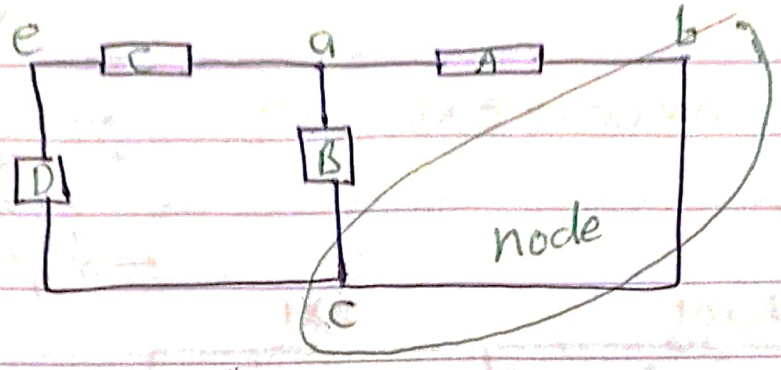
* Assume $I_1 = 10$, $I_2 = -3$, $I_3 = 13$

$V_1 = +I_1(1) = 10\,V$

$V_2 = +(-3)(2) = -6\,V$

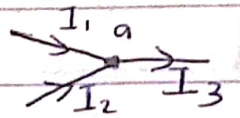
$V_3 = -I_3(4) = -52\,V$

* KCL (Kirchhoff's Current Law)



* node
هي النقطة التي يلتقي فيها أكثر من element

* Σ التيارات الداخلة في أي node = Σ التيارات الخارجة

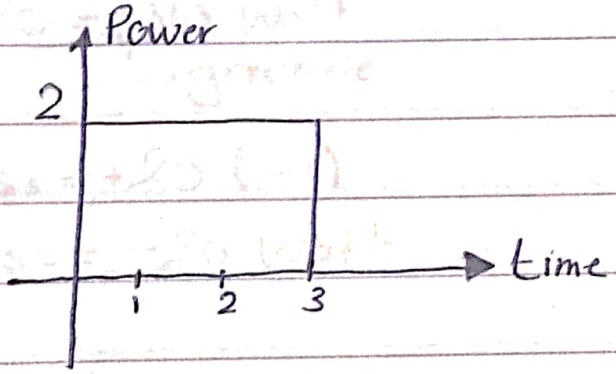


$I_3 = I_1 + I_2$

* Power ⇒ watt (w)

$$Energy = \int_0^{\Delta t} P(t)\,dt$$

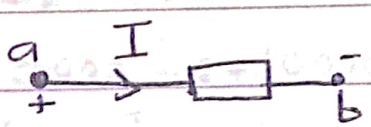
↳ (Joul)



$Energy = P \cdot \Delta t$

$= 2 \times 3 = 6 Kw.h$

* $P = V \cdot I$

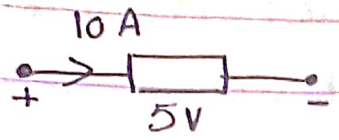


$P = +VI$

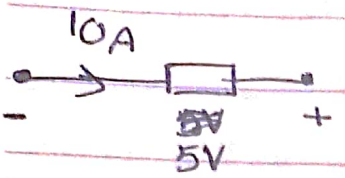
اذا التيار داخل الموجب

$P = -VI$

اذا التيار دخل السالب

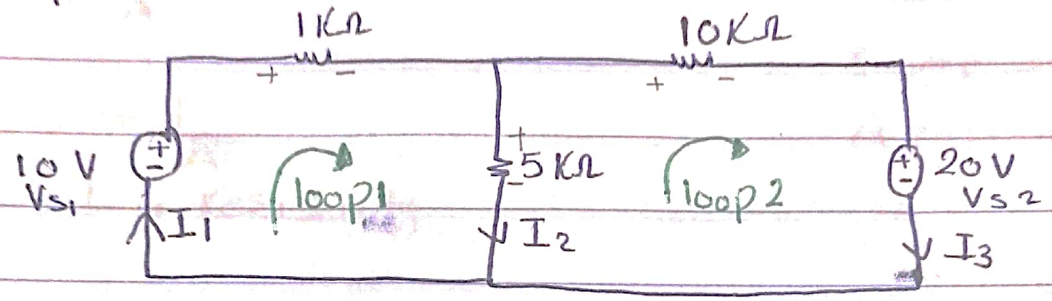


$P = +10 \times 5 = 50$ watt (absorbs, consumes Power)



$P = -10 \times 5 = -50$ watt (generates, delivers, Produce power)

* example →



find ① power absorbed/generated in V_{s1} and V_{s2}

② power absorbed by 5KΩ

① $P = \pm VI$

$P_{s1} = -1 \times 10$

$P_{s1} = \ominus 10$ watt

↳ generate

$P_{s2} = +20(-1)$

$P_{s2} = -20$ watt

② $P_{5k\Omega} = I^2 R$

$= (2)^2 \times 5K$

$= +20$ watt

$-10 + I_1(1K) + I_2(5K) = 0$

$-I_2(5K) + I_3(10K) + 20 = 0$

$I_1 = I_2 + I_3$

$-10 + (I_2 + I_3)1000 + 5000 I_2 = 0$

$20 - 5000 I_2 + 10000 I_3 = 0$

$\times 10 \; / \; -10 + 6000 I_2 + 1000 I_3 = 0$

$20 - 5000 I_2 + 10000 I_3 = 0$

$100 - 60000 I_2 - 10000 I_3 = 0$

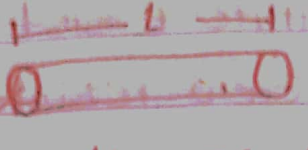
$20 - 5000 I_2 + 10000 I_3 = 0$

$120 - 65000 I_2 = 0$

$I_2 = 2mA$

$I_3 = -1 mA \; / I_1 = 1mA$

* Resistance →

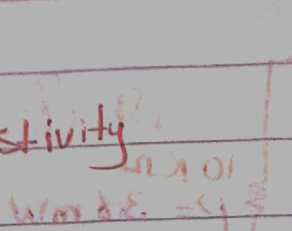


Cross section area (A) $= \pi r^2$

$R \propto \frac{L}{A}$

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

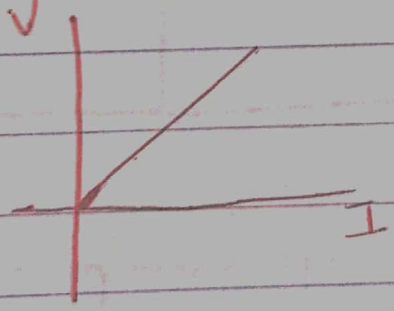
ρ → resistivity



* The resistance absorbs power ($P \geq 0$)

* Ohm's law →

$V = IR$



linear

Slope $= R$

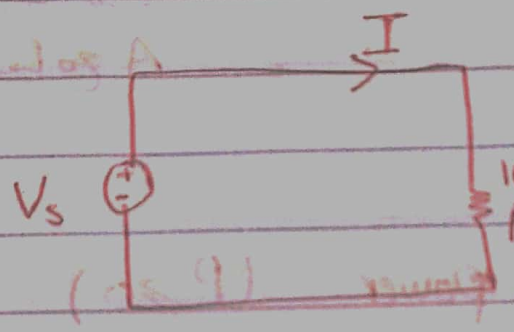
* Conductivity

$G = \frac{1}{R}$ (S / V)

* $P = VI = \frac{V^2}{R} = RI^2$

* Short and open Circuits
  - open circuit → infinite resistance ($I=0$)
  - short circuit → a device with zero resistance ($V=0$)

* The power absorbed by the 10-KΩ resistor in the following circuit is 3.6 mW. Determine the voltage and the current.



$P = I^2 R$

$3.6 = I^2 \times 10$

$I^2 = \frac{3.6}{10}$

$I = 0.6\ mA$

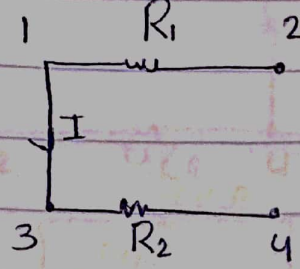
$V = IR$

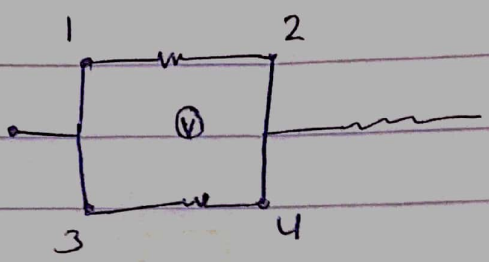
$V = 6 \times 10^{-4} \times 10$

$V = 6V$

* Connection between Resistance →

① Series ② parallel (//)



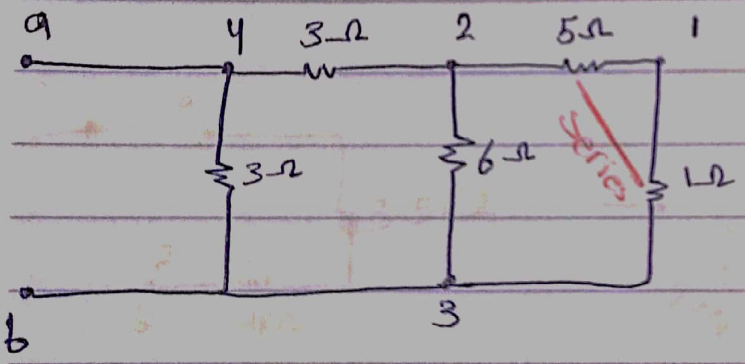


خط من طرف واحد مشبوكين $R_{eq} = R_1 + R_2$

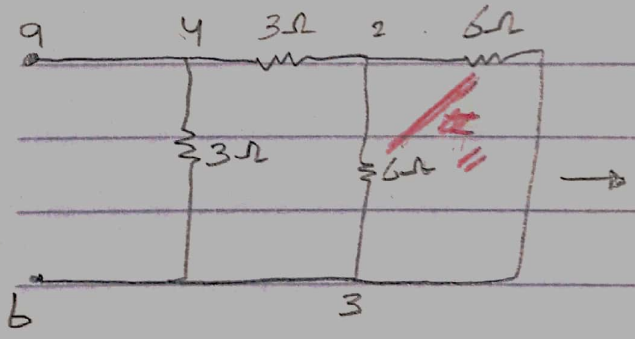
$$R_{eq} = \frac{1}{R_1} + \frac{1}{R_2}$$

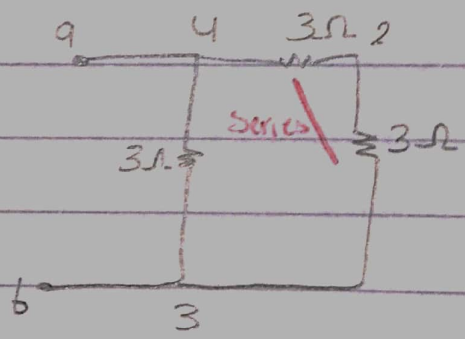
$$= \frac{R_1 R_2}{R_1 + R_2}$$

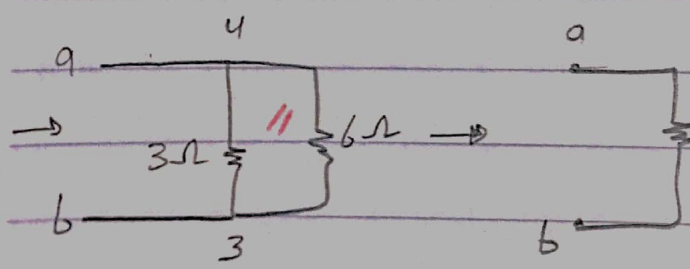
* equivalent Resistance



find R_{eq}

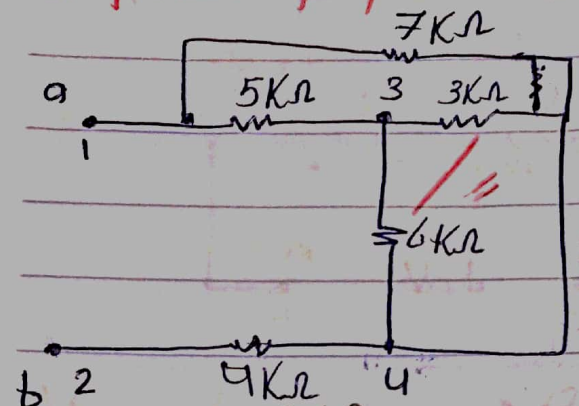


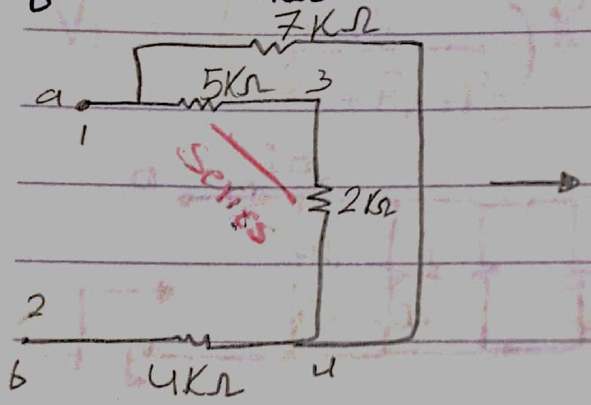


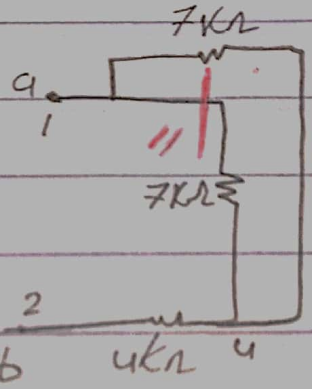


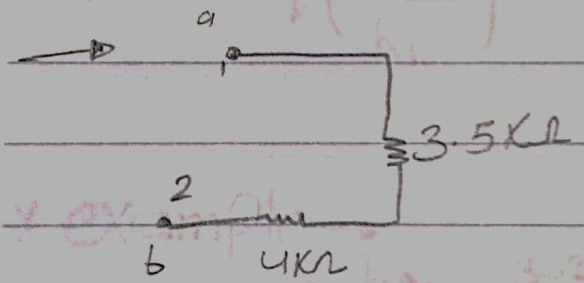
$\therefore R_{eq} = 2\Omega$

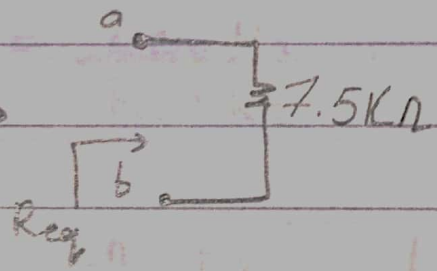
* Past paper (2019)





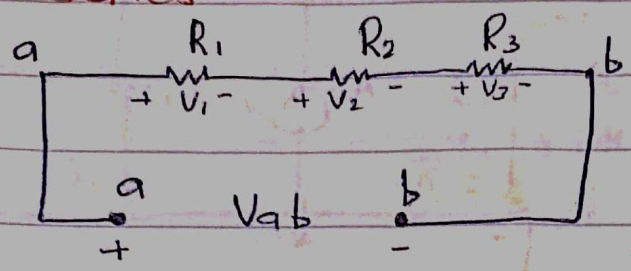




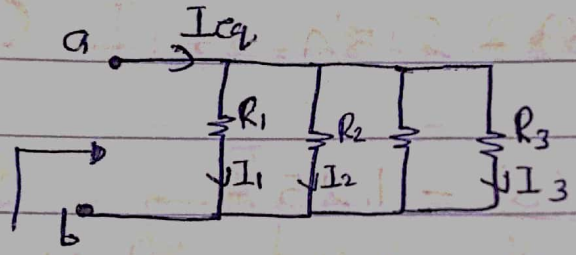


* Voltage division, Current division

series ↵ ↳ //



$$V_1 = \left(\frac{V_{ab}}{R_1+R_2+R_3}\right)R_1$$

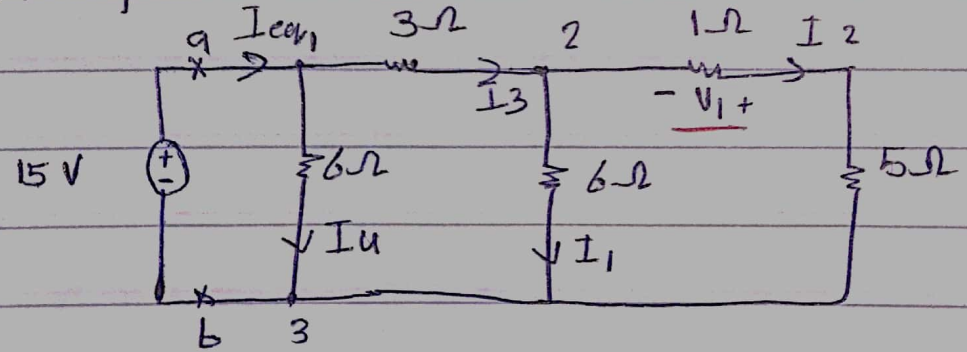


$$I_1 = I_{eq}\left(\frac{R_{eqv}}{R_1}\right)$$

for 2 resistance

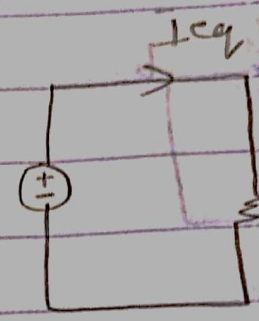
$$I_1 = \frac{I_{eq}\,R_2}{R_1+R_2}$$

* example →



find I_{eq} and I_1 and power absorbed by 5Ω and V_1

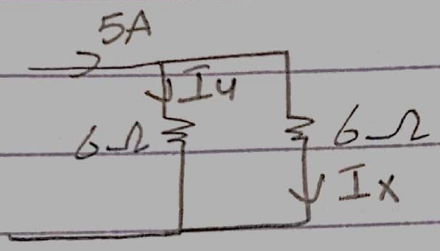
$R_{eq} = 3\,\Omega$



① $V = IR$

$15 = +I \times 3$

$I = +5\,A$

② 

$I_x = \frac{5(6)}{12} - 2.5A = I_3$

$I_1 = \frac{2.5(6)}{12} = 1.25\,A$

③ $P = I^2R$

$= (1.25)^2 \times 5$

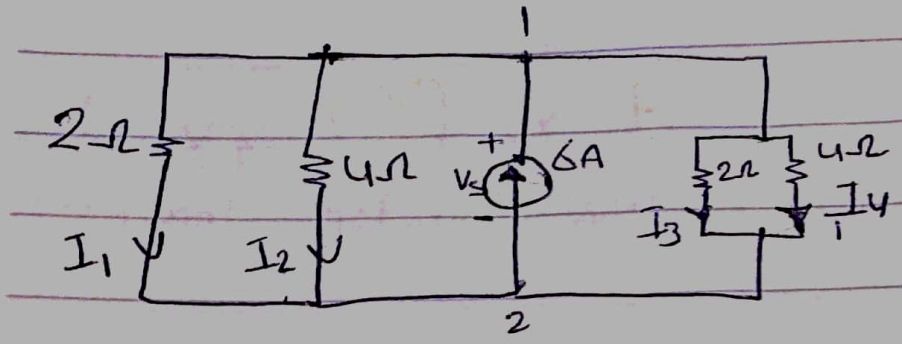
$= 12.5$ watt

④ $V_1 = -IR$

$= -1.25 \times 1$

$= -1.25\,V$

* example →

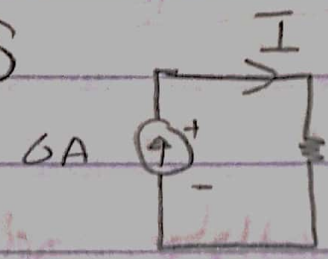


find I_1 and the Power generated by the current source

$$R_{eq} = \frac{4}{6}\ \Omega$$

① $$I_1 = \frac{6\left(\frac{4}{6}\right)}{2} = 2A$$

②



$$V_s = \frac{4}{6} \times 6 = 4V$$

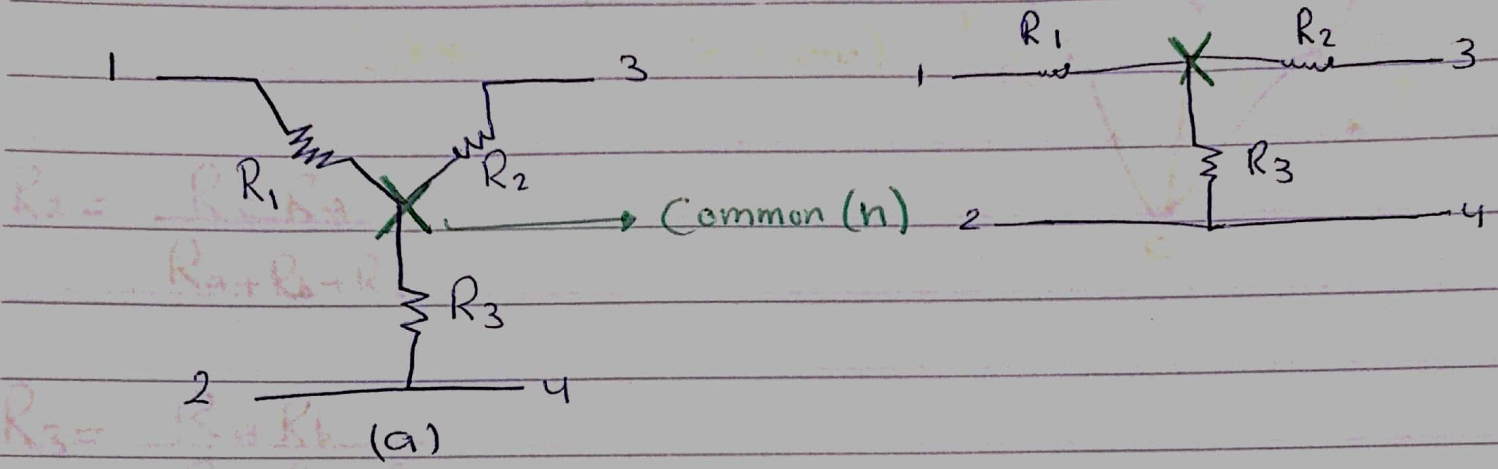
$$P = \pm VI$$

$$= -VI$$

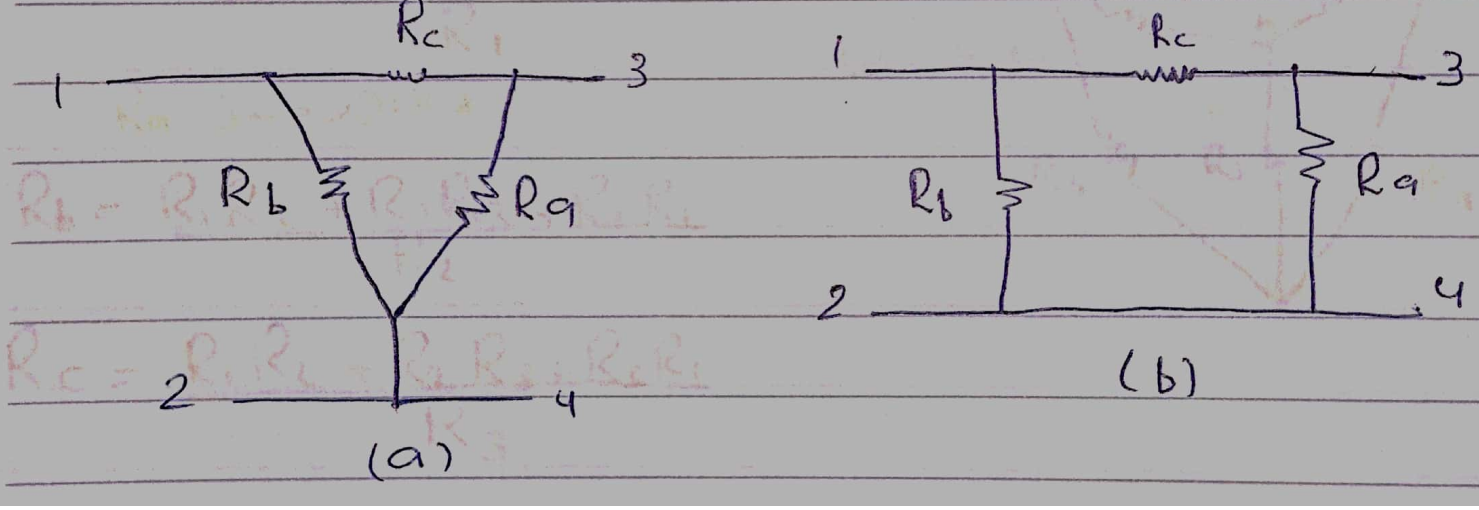
$$= -4(6) = -24 \text{ watt}$$

* Wye and Delta Networks →

- A wye (Y) or tee (T) network is a three-terminal network with the following general form:



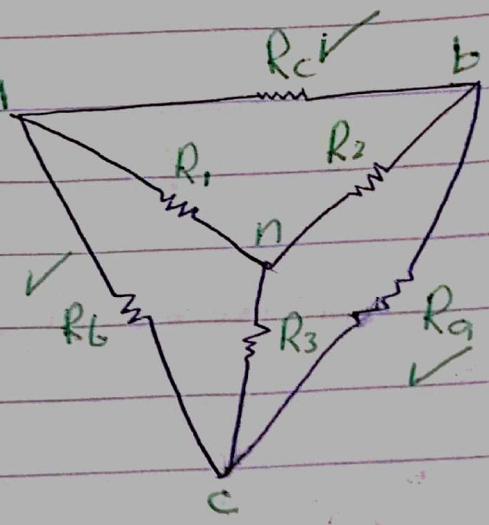
- The delta (Δ) or Pi (π) network has the following general form:



* Delta - Wye conversion

$$R_1 = \frac{R_b R_c}{R_a + R_b + R_c}$$ ← حاصل ضرب المقاومتين اللي بنا يكين مع المقاومة (R_1)

↳ دائما مجموعهم (مجموع مقاومات Delta)



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

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

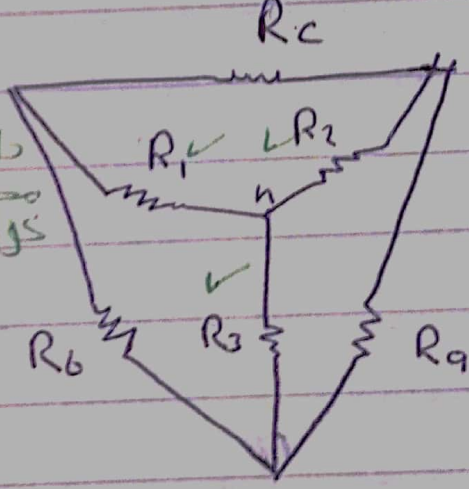
* Wye - Delta Conversion

$$R_a = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_1}$$ ← دائما بسط المجموع حيث كل مقاومتين

نسبة البعيدة عن R_a

$$R_b = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_2}$$

$$R_c = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_3}$$



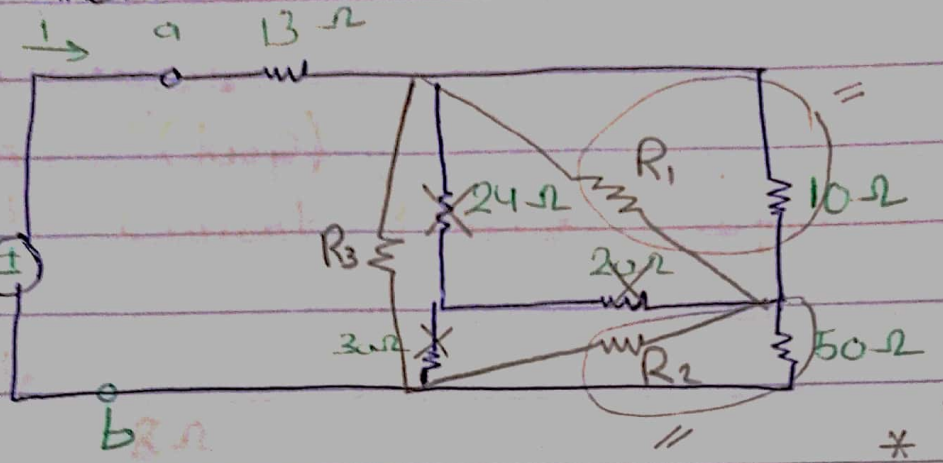
* Y and Δ networks are said to be balanced when:

$$R_1 = R_2 = R_3 = R_Y \text{ and } R_a = R_b = R_c = R_\Delta$$

* For balanced Y and Δ networks the conversion formulas become:

$$R_Y = \frac{R_\Delta}{3} \text{ and } R_\Delta = 3R_Y$$

* example : for the following bridge network find Rab and i.



* Y → Δ

$$R_1 = \frac{20\times24 + 24\times30 + 20\times30}{30} = 60$$ ← تقوض بالامتحان

$$R_2 = \frac{20\times24 + 24\times30 + 20\times30}{24} = 75$$

$$R_3 = \frac{20\times24 + 24\times30 + 20\times30}{20} = 90$$

* $(R_3 \,//\, (R_1 \,||\, 10\Omega + R_2 \,||\, 50))$ Series with 13Ω

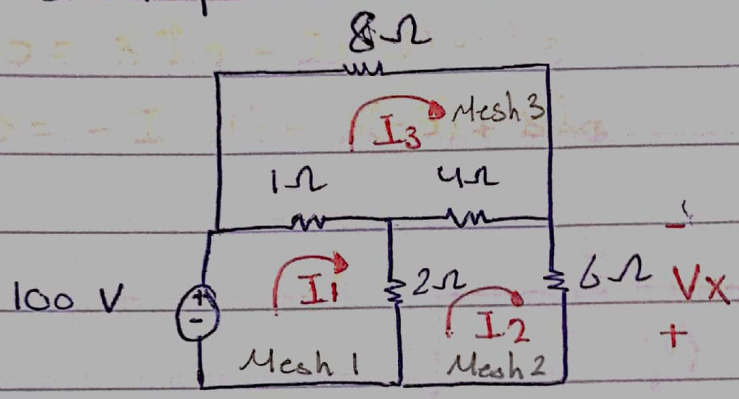
* Chapter "3" ⟶

* Mesh analysis

① Mesh (loop)

② Mesh Current (تيار الشبكة)

* example



4 loops / 3 Meshes

$-100+1(I_1-I_3)+2(I_1-I_2)=0$ from Mesh 1

$3I_1-2I_2-I_3=100$ -- ①

$4(I_2-I_3)+6I_2+2(I_2-I_1)=0$ from Mesh 2

$-2I_1+12I_2-4I_3=0$ -- ②

$8I_3+4(I_3-I_2)+1(I_3-I_1)=0$ from Mesh 3

$-I_1-4I_2+13I_3=0$ -- ③

* Inspection ⟶

Mesh 1

$+I_1(3)-I_2(2)-I_3(1)=100$

Mesh 2

$-I_1(2)+I_2(12)-I_3(4)=0$

Mesh 3 ⟶ $-I_1(1)-I_2(4)+I_3(13)=0$

* $V_x = I_x R$

$V_x = -I_x(6)$

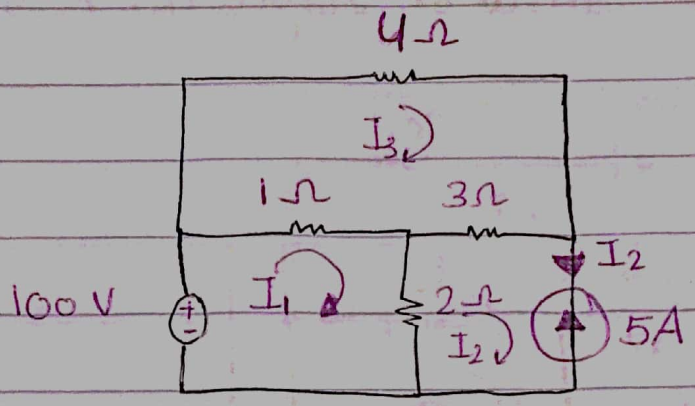
* Power in 2Ω

$P = I^2(2)$

$P = (I_1-I_2)^2(2)$ watt

* Mesh ⇒ KVL

* C.S



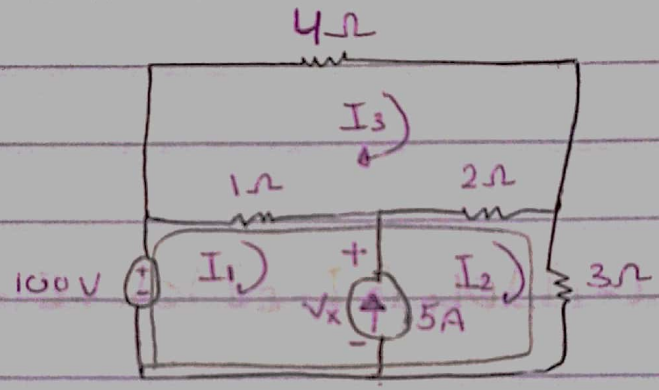
$I_2 = -5A$

لأنه عكس اتجاه

$100 = 3I_2 - 2(-5) - I_3$

$0 = -I_1(1) - 3(-5) + 8I_3$

* لا تنطبق طريقة Mesh في حال وجود C.S



$5 = I_2 - I_1$

Mesh 3 ⟶ $-I_1 - 2I_2 + 7I_3 = 0$

* يبقى الذي loop ما فيه current Source وانطبق KVL (Super Mish)

$-100 + 1(I_1 - I_3) + 2(I_2 - I_3) + 3I_2 = 0$

OR

$-100 + 4I_3 + 3I_2 = 0$ ⟶ من loop خارجي

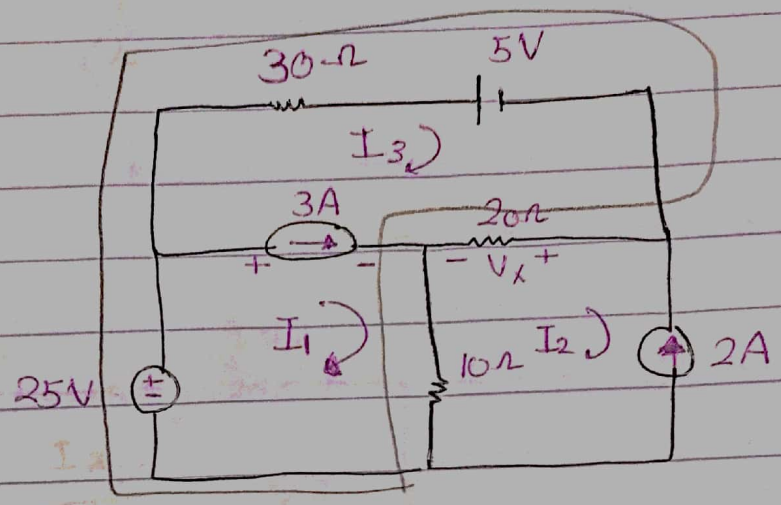
* Power delivered / Consumed in the current Source

$P = \pm V \cdot I = -V \cdot I = -5V_x$

⟶ $-100 + 1(I_1 - I_3) + V_x = 0$

*Past paper

Use Mesh analysis to write the mesh equations



$I_2 = -2A$

$I_1 - I_3 = 3$

KVL (loop)

$-25 + 30I_3 + 5 + 20(I_3 - I_2) + 10(I_1 - I_2) = 0$

$-20 - 40 + 20 = 50I_3 + 10I_1$

$-40 = 50I_3 + 10I_1$

$-40 = 50I_3 + 10(3 + I_3)$

$I_1 = 3 - \frac{7}{6}$

$I_2 = -2$

$I_3 = -\frac{7}{6}$

* $V_x = -20(I_x)$

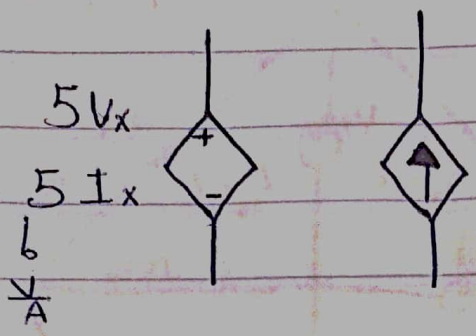
$= -20(I_2 - I_3)$

* $P_{3A} = VI$

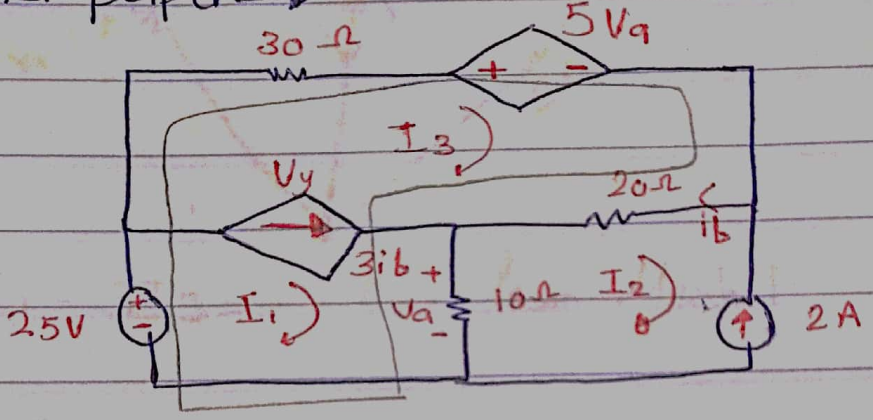
$= +3V_y$

$\hookrightarrow -25 + V_y + 10(I_1 - I_2) = 0$

* Dependent Source element يؤثر على



*Past paper →



$I_2 = -2A$

$3i_b = I_1 - I_3$

$i_b = I_3 - I_2$

$3(I_3 - I_2) = I_1 - I_3$

$4I_3 - 3I_2 - I_1 = 0$

$4I_3 - I_1 = -6$

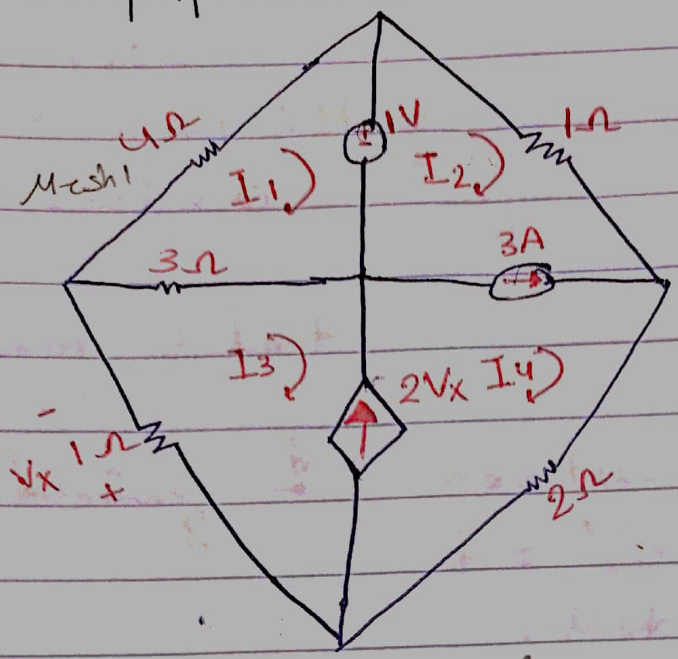
$-25 + 30I_3 + 5V_a + 20(I_3 - I_2) + 10(I_1 - I_2) = 0$

* $V_a = +(I_1 - I_2)(10)$

* $P_{3i_b} = +V_y(3i_b)$

$\longrightarrow -25 + V_y + 10(I_1 - I_2) = 0$

* past paper



$7I_1 - 3I_3 = -10$ → from Mesh 1

$3 = I_4 - I_2$ -- ②

$2V_x = I_4 - I_3$

$2(+I_3(1)) = I_4 - I_3$

$2I_3 = I_4 - I_3$

$I_4 - 3I_3 = 0$ -- ③

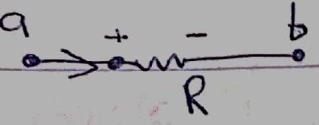
$I_3 + 4I_1 + I_2 + 4I_4 = 0$ -- ④

* Nodal analysis

* Nodes
* KCL ⇒ Voltage
* Vref = 0

$\equiv V=0$

$\sum I_{in} = \sum I_{out}$



$V_{ab} = V_a - V_b = +IR$

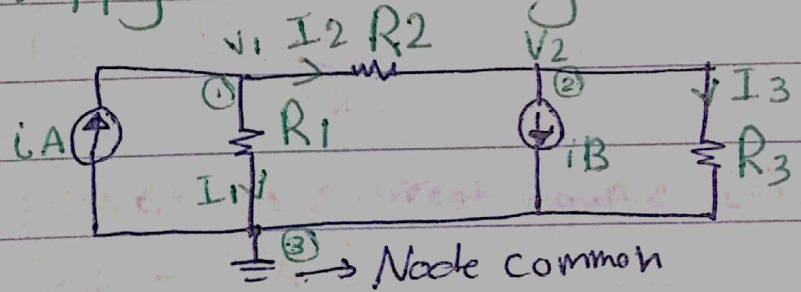
$I = \frac{V_a - V_b}{R}$

* جميع التيارات تكون out من Node.

* $\frac{1}{R} = G$ (ʊ, S)

$I = G(V_a - V_b)$

* Apply Nodal analysis to write Nodal equations.



at node 1 $\Rightarrow \frac{V_1 - V_3}{R_1} + \frac{V_1 - V_2}{R_2} = iA$

$V_1\left(\frac{1}{R_1} + \frac{1}{R_2}\right) - V_2\left(\frac{1}{R_2}\right) - V_3\left(\frac{1}{R_1}\right) = iA$

$V_3 = 0$

at node 2

$$\frac{V_2 - V_1}{R_2} + \frac{V_2 - V_3}{R_3} + iB = 0$$

$$V_2\left(\frac{1}{R_2} + \frac{1}{R_3}\right) - \frac{V_1}{R_2} + iB = 0$$

*inspection

* التيار في Current Source

at node 1

$$+V_1\left(\frac{1}{R_1} + \frac{1}{R_2}\right) - V_2\left(\frac{1}{R_2}\right) - V_3\left(\frac{1}{R_1}\right) = iA$$

at node 2

$$-V_1\left(\frac{1}{R_2}\right) + V_2\left(\frac{1}{R_2} + \frac{1}{R_3}\right) + \cancel{V_3}^{0} + iB = 0$$

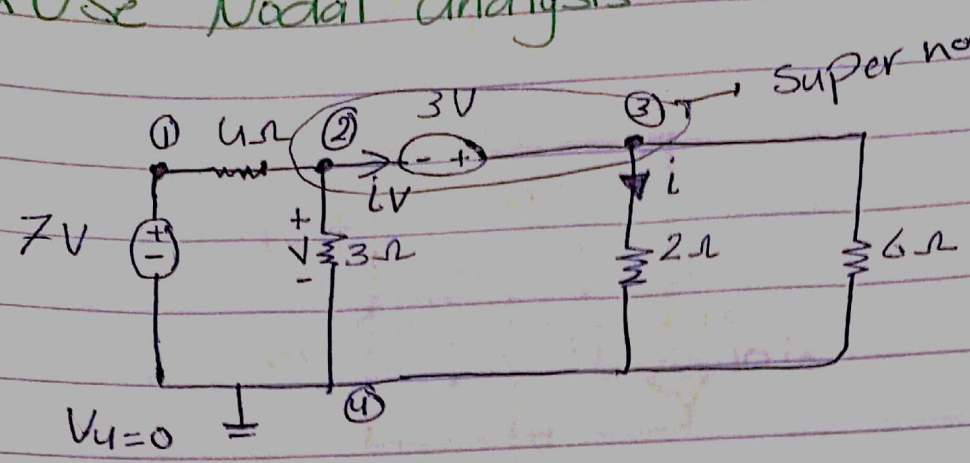
* $i_2 = \frac{V_1 - V_2}{R_2}$

* Power in current source iA

$$P = -V_A\, iA$$

$$= -(V_1 - V_3)\, iA$$

*Use Nodal analysis



$7 = V_1 - V_4$

$\boxed{V_1 = 7V}$

$3 = V_3 - V_2 \quad -①$

at node 2

$-V_1\left(\frac{1}{4}\right) + V_2\left(\frac{1}{4}+\frac{1}{3}\right) + iv = 0$

at node 3

$iv = +V_3\left(\frac{1}{2}+\frac{1}{6}\right)$

$\frac{-V_1}{4} + V_2\left(\frac{1}{4}+\frac{1}{3}\right) + V_3\left(\frac{1}{2}+\frac{1}{6}\right) = 0 \quad -②$

$V_2 = -0.2\,V \qquad V_3 = 2.8\,V$

① $V = ??$

$V = V_2 = -0.2\,V$

② $i = \frac{V_3 - V_4}{2} = 1.4\,A$

③ Power in 7V

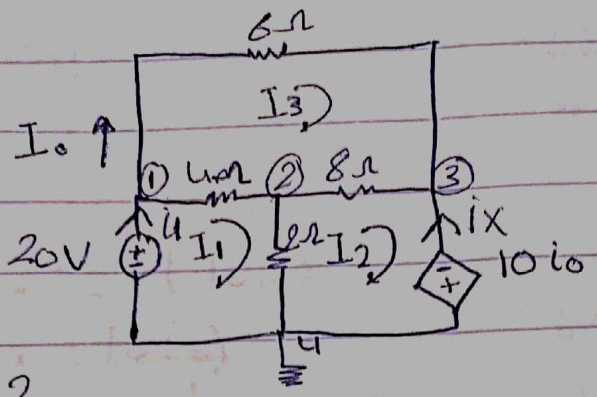
$P = \pm VI = \pm 7I = -7I_1$

$I_1 = \frac{V_1 - V_2}{4} = \frac{7.2}{4}$

$P = -7 \times \frac{7.2}{4}$ watt

(generate)

* Use Nodal anaylsis



at node 2

$$-V_1\left(\frac{1}{4}\right)+V_2\left(\frac{1}{4}+\frac{1}{8}+\frac{1}{2}\right)-V_3\left(\frac{1}{8}\right)=0$$

$$-\frac{V_1}{4}+V_2\left(\frac{7}{8}\right)-\frac{V_3}{8}=0 \quad -①$$

$$V_1 - V_4 = 20$$

$$\boxed{V_1 = 20\,V}$$

$$40 = 7V_2 - V_3 \quad -①$$ عند تعويض V_1 في ①

$$10\,i_o = V_4 - V_3$$

$$-V_3 = 10\,i_o$$

$$-V_3 = 10\left(\frac{V_1 - V_3}{6}\right)$$

$$I_o = \frac{V_1 - V_3}{6}$$

$$-6V_3 = 10V_1 - 10V_3$$

$$4V_3 = 10V_1$$

$$V_3 = 50\,V$$

$$40 = 7V_2 - 50$$

$$V_2 = \frac{90}{7}\,V$$

* find the power in the dependant source and independant

$P_{ind} = -i_1 (20)$

KCL

$\Rightarrow i_1 = V_1\left(\frac{1}{4}+\frac{1}{5}\right) - V_2\left(\frac{1}{4}\right) - V_3\left(\frac{1}{5}\right)$

$P_{dep} = +(-i_2)(10 i_0)$

$= +i_x (10 i_0)$

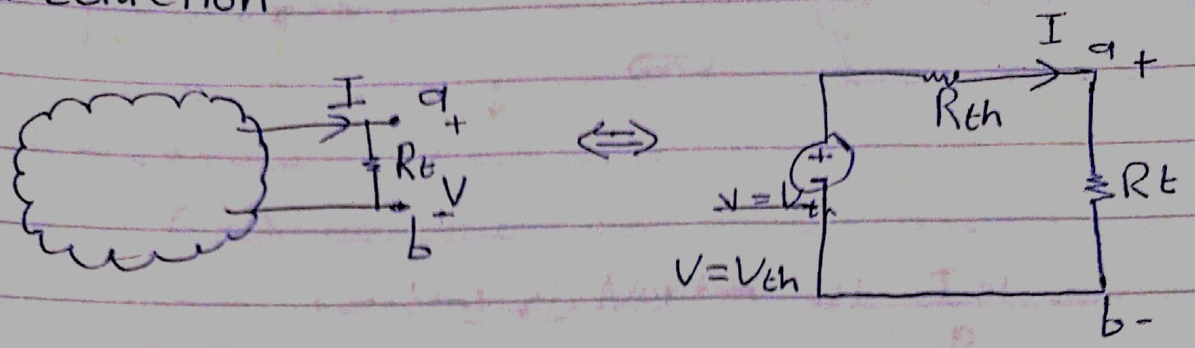
$\hookrightarrow \frac{V_1 - V_3}{5}$

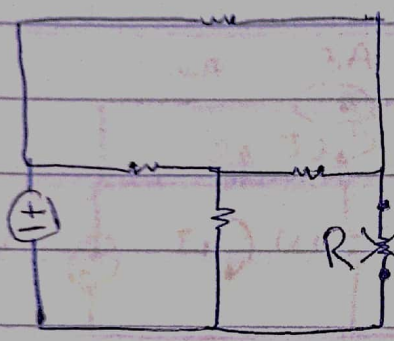
$i_x \Rightarrow$ KCL

$i_x = V_3\left(\frac{1}{8}+\frac{1}{8}\right) - V_2\left(\frac{1}{8}\right) - V_1\left(\frac{1}{5}\right)$

* The venin Eq. CKT

*Reduction





$V_{oc} = V_{th}$

* لما يطلب V_{th}
لازم بالسؤال يعطيني
الجهة اللي اطلع منها
لو كان في R ← بشيلها
وبحط مكانها
open circuit

$R_{th} = R_{eq}$ Seen a.b

Kill all the Sources
بيكون بس لل
independent Source

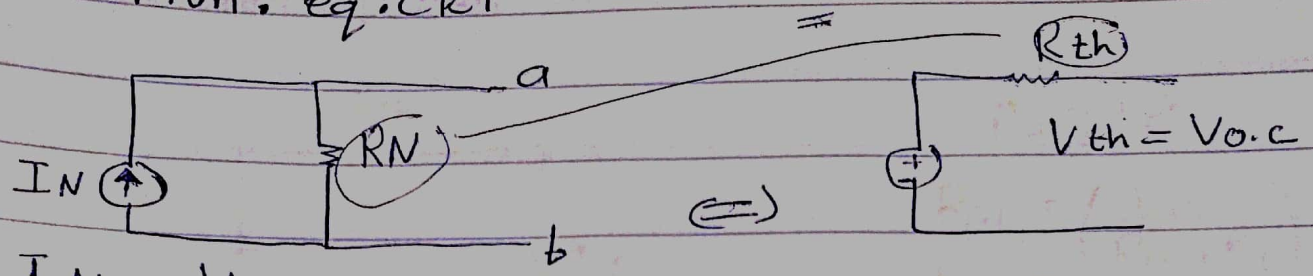
* V.S ⇒ zero ⇒ S.C
* C.S ⇒ O.C
open circuit

* $L = eff = \frac{P_{out}}{P_{in}} < 1$

* $P_{in} = P_{lost} + P_{R_{th}}$
* $P_{loss} = I^2 R_{th}$

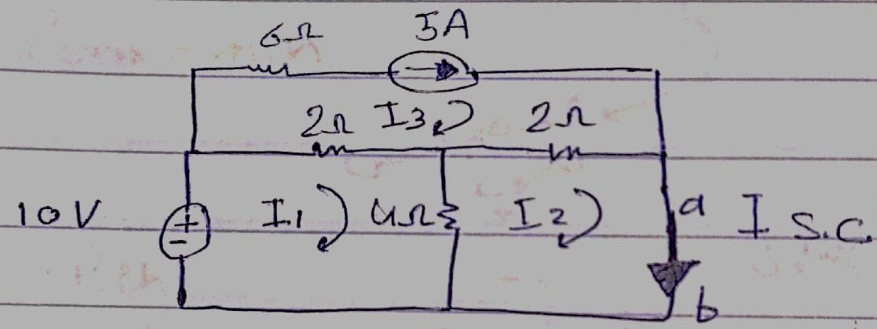
* بشيل ⊕ وبحط مكانها wire, بشيل ⊖ بحط مكانها o o

* Norton. eq. CKt



$$I_N = \frac{V_{o.c}}{R_{th}}$$

* لحساب I_N لـ Norton راح يحكيلي Seen from R_L لو كان في بشيلها وبحط مكانها سلك



* $I_{s.c} = I_N$

$$\frac{V_{o.c}}{I_{s.c}} = \frac{V_{th}}{I_N} = R_{th} = R_N$$

$$I_N = \frac{93}{135} N$$

$I_{s.c} = I_2$

$I_3 = 5\,A$

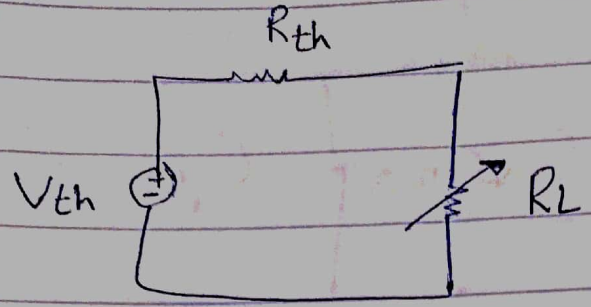
$10 = 6I_1 - 4I_2 - 2(5)$

$0 = -4I_1 + 12I_2 - 8(5)$

$I_1 = \frac{95}{14}$

$I_2 = \frac{145}{28} = I_N$

* Maximum power transfer



$P = I^2 R$

$P_{RL} = \left(\frac{V_{th}}{R_{th} + R_L}\right)^2 * R_L$

P_{RL} max

$f(x) = X$ ---

$\frac{d f'x}{dx} = 0 \rightarrow x$

$\frac{dP}{dRL} \Rightarrow RL$

RL ؟؟

① $P_{RL} = max$

② $P_{transfer\ from\ the\ source} = max$

③ $P_{loss} = min$

كلهم نفس الكوني

$R_L = R_{th}$

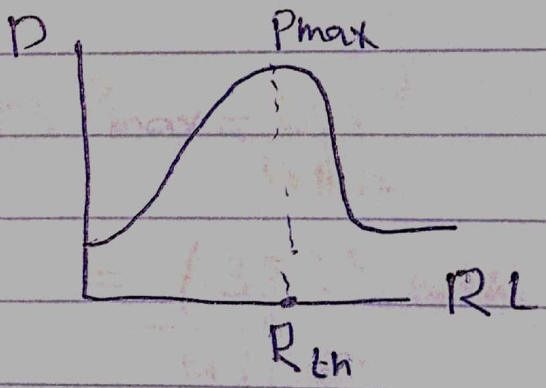
يكون $P_{RL} = Max$

$R_L = R_{th}$

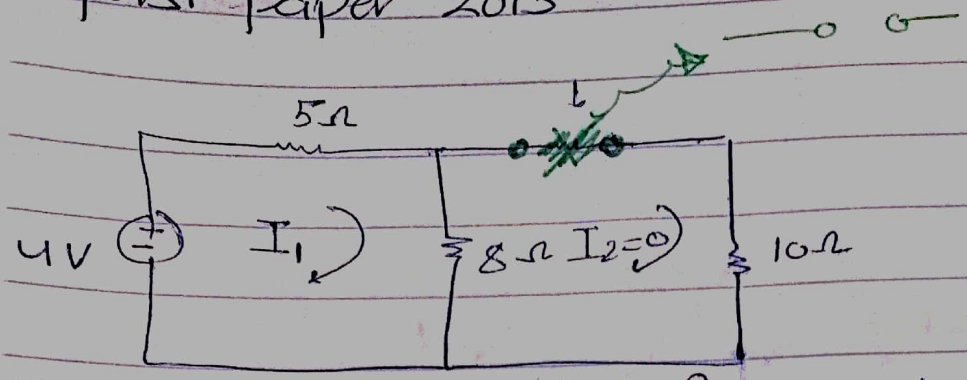
$P_{max} = \left(\frac{V_{th}}{R_{th} + R_{th}}\right) R_{th}$

$P_{max} = \frac{V_{th}^2}{4 R_{th}}$

القانون النهائي



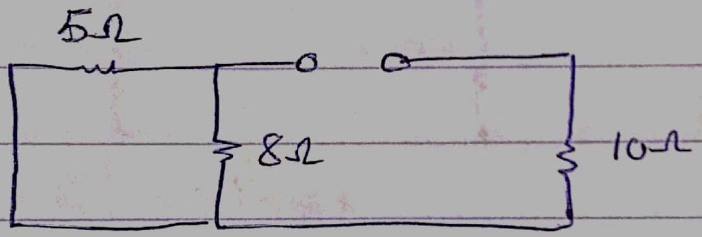
*Past Paper 2013



(A) Select a value for R_L to absourb Max power from the CKt ?

(B) Vth (C) Pmax (D) $R_L = 10\Omega \Rightarrow P_{R_L}$??

(a) $R_L = R_{th}$



$5 // 8 \Rightarrow \frac{5 \times 8}{5+8} = \frac{40}{13}\ \Omega$

$10 + \frac{40}{13} = R_{th}$

$R_L = R_{th} = 13\Omega$

(b) $I_1 = \frac{4}{13}$ A

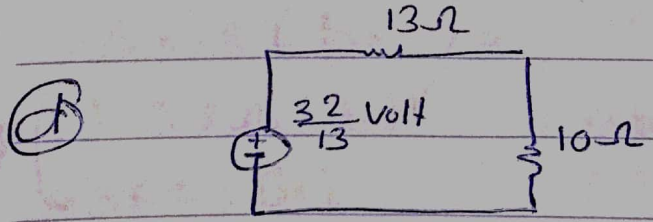
$+V_{o.c} - 8\left(\frac{4}{13}\right) = 0$

$V_{o.c} = \frac{32}{13}$ Volt $= V_{th}$

(c) $P_{max} = \frac{V_{th}^2}{4R_{th}}$

$= \frac{\left(\frac{32}{13}\right)^2}{4(13)}$ watt

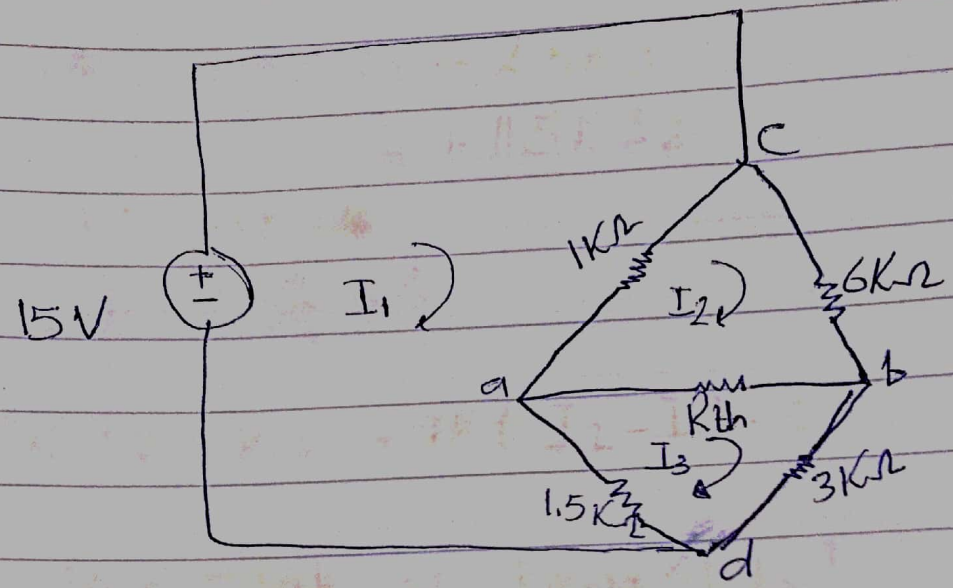
(d)

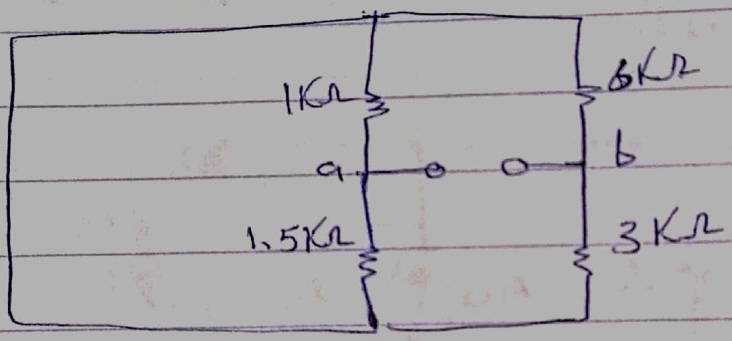


$P_{10\Omega} = I^2(10)$

$= \left(\frac{\frac{32}{13}}{13+10}\right)^2 * 10$ watt

*example





(a) RL ⇒ Pmax

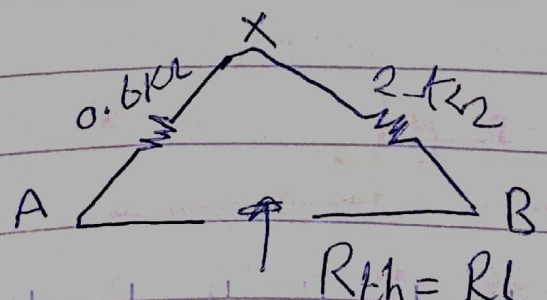
(b) Pmax

(c) If the Voltage Source is replaced with a current Source 15A

(a) 1 KΩ (Ax)
6 KΩ (Bx) //
1.5 KΩ (Ax) //
3KΩ (Bx)

$\frac{1 \times 1.5}{1+1.5} = 0.6\,K\Omega\,(Ax)$

$\frac{6 * 3}{6+3} = 2\,K\Omega\,(Bx)$



$R_L = R_{th} = 2 + 0.6 = 2.6\,K\Omega$

$R_{th} = R_L$

(b) $P_{max} = \frac{V_{th}^2}{4R_{th}}$

$15 = 2.5K I_1 - 2.5K I_2$

$0 = -2.5K I_1 + 11.5K I_2$

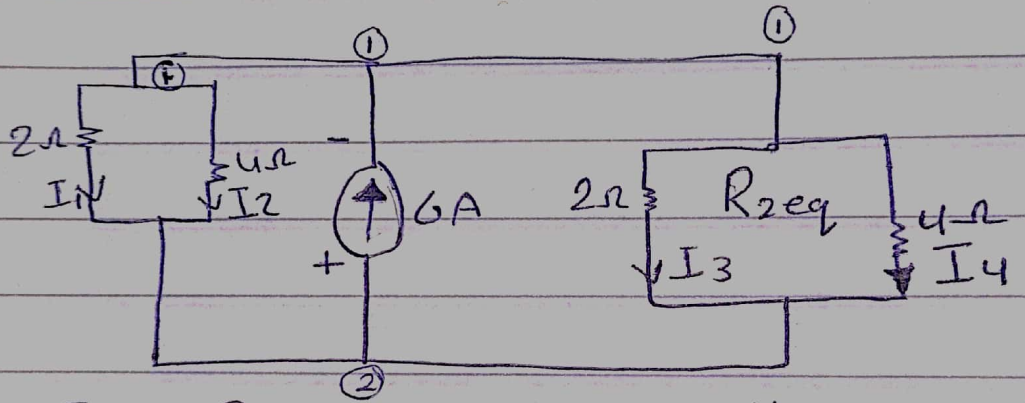
$18 = 9K I_1$

$I_2 = \frac{5}{3}\,mA$

$6K I_2 - V_{oc} + 1K(I_2 - I_1) = 0$

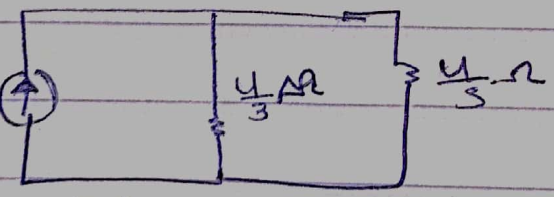
$V_{o.c} = V_{th} \Rightarrow P_{max} = \frac{V_{th}^2}{4R_{th}}$

*



Find ① I_1 ② Power generated by the current source

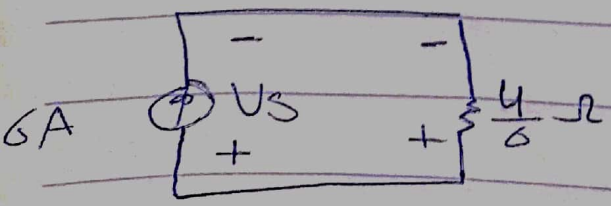
①



$I_1 = \frac{6(\frac{4}{6})}{} = 2A$

② $R_{eq} = \frac{2}{} \frac{4}{6}\,\Omega$

$V_S = \frac{4}{6} * 6 = 4V$



$P = + V_S (6) \Rightarrow$