EEE-121

(1) DC Circuits

[Definition আকারে না]

Electric Circuit: Electrical elements গুলোকে connecting wire দিয়ে যুক্ত করলে Electric Circuit বলে।

Charge: Atomic Particle এর মধ্যে, ইলেকট্রন দ্বারা সৃষ্টিত। (C)

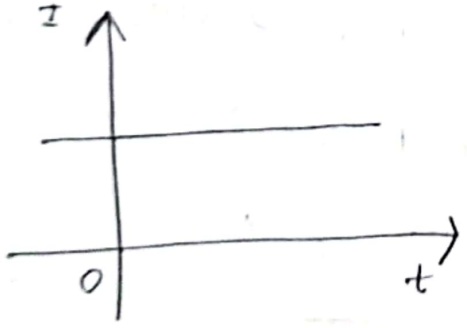
Current: সময়ের পরিবর্তনে charge move করলে current বলে।

$$i = \frac{dq}{dt}$$

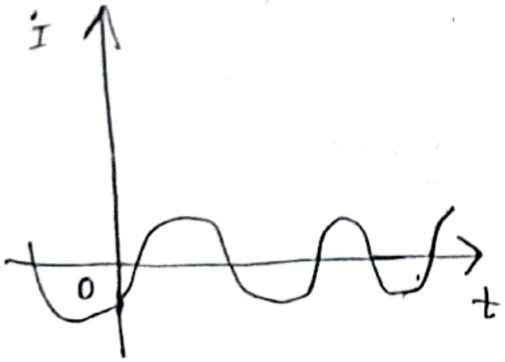
i = কারেন্ট
q = চার্জ
t = সময়

$$q = \int_{t_0}^{t} i\,dt$$

Direct Current (DC): একমুখী কারেন্ট যা সময়ের পরিবর্তনে ধ্রুবক থাকে।



DC



Sinusoidal waveshape

AC

Voltage: একক [illegible] কে কোন [illegible] [illegible] [illegible] প্রয়োজন, একে V। একে Potential Difference ও বলা হয়।

$$V_{ab} = \frac{dw}{dq}$$

এখানে,
w = energy (Joule)
q = change (coulombs)
V = Voltage

এখানে V_b সাধারণত [illegible] [illegible] 0 বা Ground হয়।

Power: প্রতি [illegible] energy শোষণ / বিকিরণ হওয়ার [illegible] [illegible]। Watts (W)

$$P = \frac{dw}{dt}$$

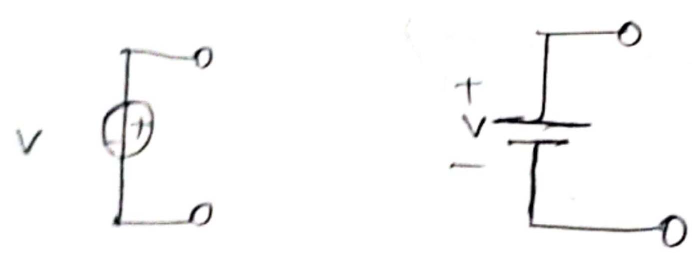
$$= \frac{dw}{dq} \cdot \frac{dq}{dt}$$

$$= vi$$

Energy: কাজ করার ক্ষমতা, Joules (J)

Circuit Elements

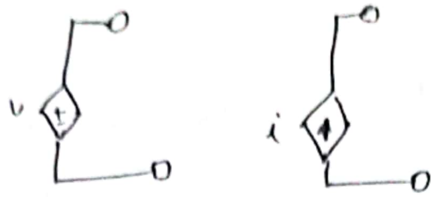
Source:



(a) (b)

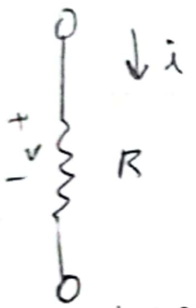
এরকম capacitor বা ব্যাটারি

DC Source



Dependent source থাকবে না। Independent অবশ্যই থাকতে হবে।

(2) Basic Laws



Resistance
একক OHM

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

ρ = Resistivity (Ω-m)
l = length
A = Area

$A = \pi r^2$

Resistance: যা current কে বাধা দেয়,
Resistivity: একটি material কত ভালো/খারাপভাবে electric current তাদের মধ্যে দিয়ে pass করবে।

যার conductivity যত বেশি তার Resistivity তত কম।

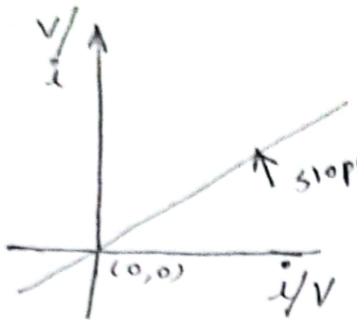
Insulator: current pass করতে দেয় না।

Conductor: current flow করতে সাহায্য করে।

Semiconductor: specific শর্ত fullfill করলে current flow করতে দেয়। (যেমন - Heat, Pressure, high voltage)

Ohm's Law: Voltage সমানুপাতিক current। $V \propto i$

$V = iR$



: Ohm's Law Graph (i/v)

$$\text{Slope} = \frac{\Delta i}{\Delta V} = \frac{1}{R}$$

$V = iR$ হলে,

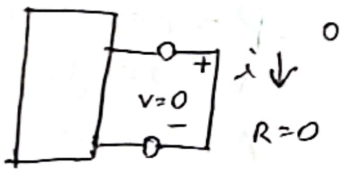
$$\frac{i}{V} = \frac{1}{R}$$

$$\text{Conductance} = \frac{1}{R} = G$$

একক (mho বা ℧ or siemens S)

V, Vo

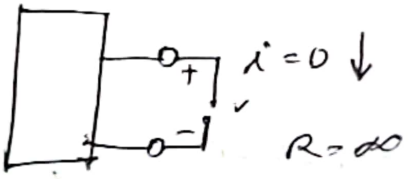
Short Circuit:



o = Terminal

কারেন্ট যেতে পারে

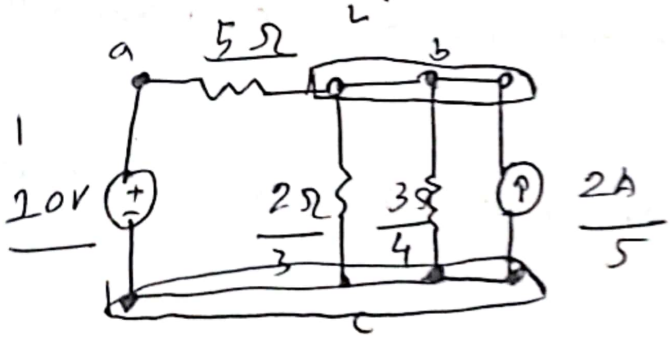
open Circuit:



$$P = Vi = i^2R = \frac{V^2}{R} \quad [P = \text{Power}]$$

$5K\Omega = 5000 = 5 \times 10^3$, $mA = 10^{-3}$

Branch: সার্কিটে যে কয়টি উপাদান বা কয়টি Branch



5টি Branch

Note: দুইটি প্রান্তের অবিচ্ছিন্ন সংযোগ। • নোডগুলোর পার্থক্য হচ্ছে,

যদি Element (a এবং b এর মাঝে 5Ω) থাকে তবে কোন ভোল্টেজ হবে, কি হিসাবে কোন নোড।

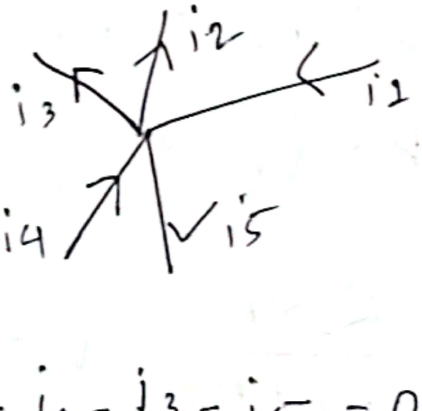
Loop: Starting Point থেকে শুরু করে আবার একই জায়গায় ফেরত আসে, কিন্তু হিসাবে তিনটি নোড, দুবার অতিক্রম করবে না।

লুপ / মেশ

৩টি নোড

branch = loop + node − 1

KCl বা কার্শফের কারেন্ট ল: কারেন্ট (নোডে) প্রবেশ ও বাহিরগামী কারেন্টের Algebraic Sum হচ্ছে শূন্য।



i_1, i_4 Enter

i_3, i_4, i_5 Exit

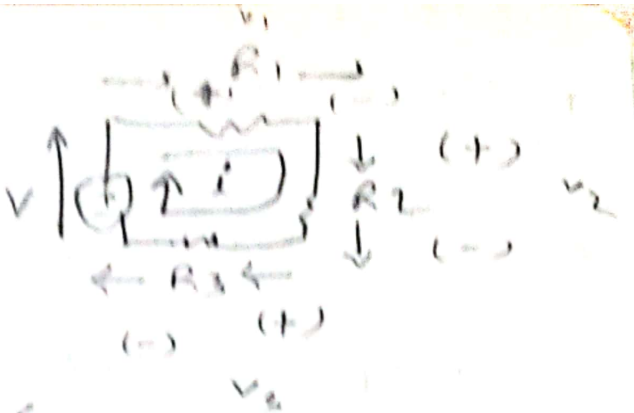
$$i_1 + i_4 - i_2 - i_3 - i_5 = 0$$

$$i_1 + i_4 = i_2 + i_3 + i_5$$

Enter Exit

KVL এর সংজ্ঞা লেখো এবং

[Algebraic sum of Voltage in a loop = zero]



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

$V = V_1 + V_2 + V_3$

+, - এর সূত্র ব্যবহার

Source এর ক্ষেত্রে - to + এ

Resistance এর ক্ষেত্রে + to - এ

- ⟶ + : Voltage rise

+ ⟶ - : Voltage drop

Series: একাধিক Resistance, যারা একটি শেষ থেকে অন্যটি যুক্ত হয়,

$$R_{eq} = R_1 + R_2 + \cdots + N$$

Parallel: একই Node এর মধ্যে যতগুলো Resistance থাকবে, Node এর Starting ও Ending Point একসাথে,

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

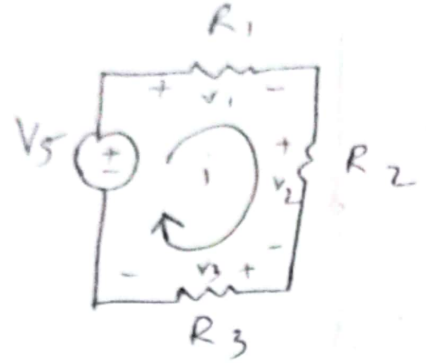
$$\Rightarrow R_{eq} = \left(\frac{1}{R_2} + \frac{1}{R_2} + \cdots + \frac{1}{R_N}\right)^{-1}$$

$$R_{eq} = \frac{R_1 \times R_2}{R_1 + R_2}$$ [শুধুমাত্র ২টি Resistance থাকলে]

EEE-122

(2) Basic Laws

Voltage Divider Rule: Came from series, KVL

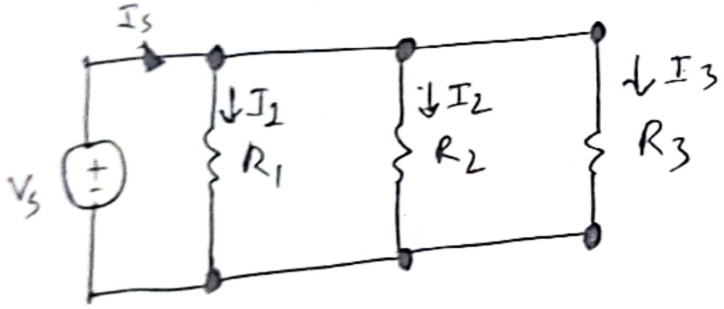


$$V_1 = \frac{R_1}{R_1+R_2+R_3} \times V_s$$

$$V_2 = \frac{R_2}{R_1+R_2+R_3} \times V_s$$

$$V_3 = \frac{R_3}{R_1+R_2+R_3} \times V_s$$

Current Divider Rule: Came from Parallel, KCL

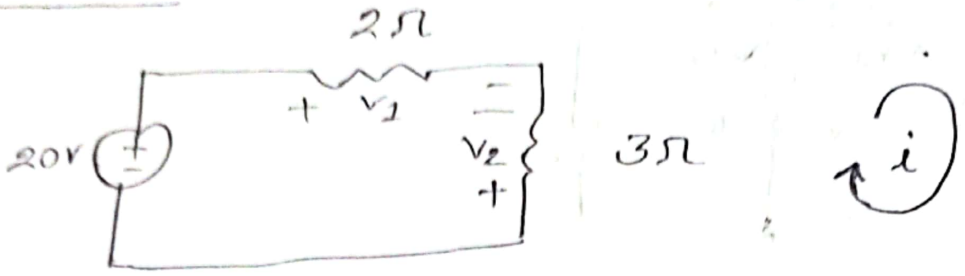


$$I_1 = \frac{1/R_1}{1/R_1+1/R_2+1/R_3} \times I_s$$

$$I_2 = \frac{1/R_2}{1/R_1+1/R_2+1/R_3} \times I_s$$

$$I_3 = \frac{1/R_3}{1/R_1+1/R_2+1/R_3} \times I_s$$

Ex - 2.5



Find V_1 & V_2

Ans: ওহমের সূত্র হতে,

$$V = IR$$

So, $V_1 = 2i$

$V_2 = 3i$

KVL দিয়ে,

$-20 + V_1 - V_2 = 0$ [starting Point অনুসারে sign]

$\Rightarrow -20 + 2i - 3i = 0$

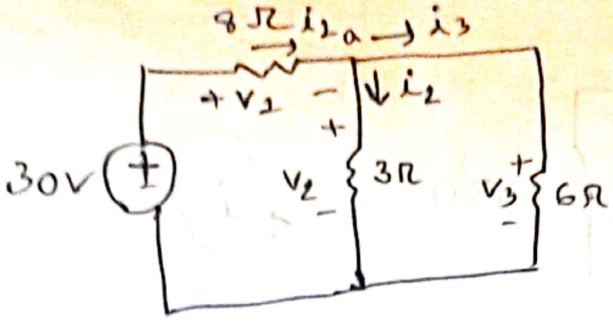
$\Rightarrow 5i = 20 \quad \therefore i = 4A$

i এর মান বসিয়ে,

$V_1 = 2 \times 4 = 8V$

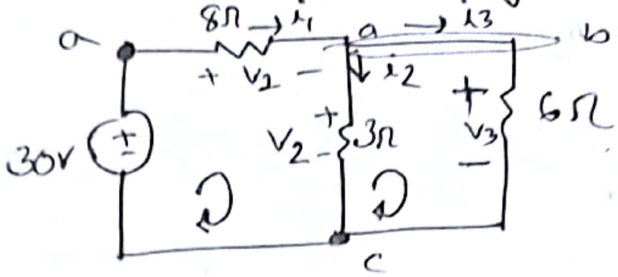
$V_2 = -3 \times 4 = -12V$ [সঙ্কীকরণের দিক অনুসারে]

Ex — 2.8



Find currents & Voltages

Ans:



branch = 3
Loop = 2

3 টের সূত্র হতে,

$$\boxed{V = IR}$$

$$V_1 = 8i_1$$
$$V_2 = 3i_2$$
$$V_3 = 6i_3$$

KCL দিয়ে,

$$i_1 = i_2 + i_3 \quad \text{[যোগ - যের হওয়া]}$$
$$\Rightarrow i_1 - i_2 - i_3 = 0$$

KVL দিয়ে,

Loop 1 % $\quad -30 + V_1 + V_2 = 0 \Rightarrow -8i_1 + 3i_2 + 6i_3 = 0$

Loop 2 % $\quad -V_2 + V_3 = 0 \Rightarrow -3i_2 + 6i_3 = 0$

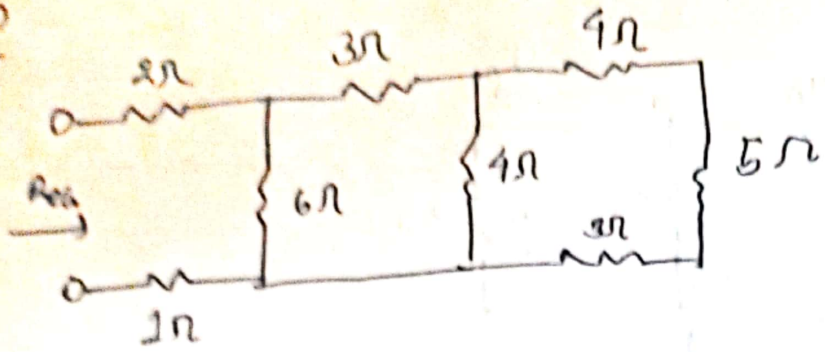
[একটা সূত্রে যা Rise তা সূত্রে তা drop হতে পারে]

ক্রামারস রুলে সমাধান করে,

$$i_1 = 3A,\ i_2 = 2A,\ i_3 = 1A$$
$$V_1 = 24V,\ V_2 = 6V,\ V_3 = 6V$$

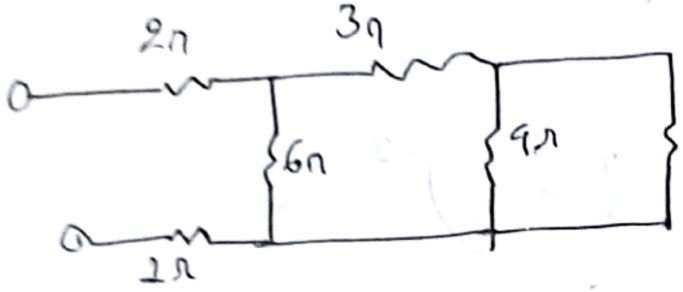
Ans.

Ex - 2.9



Find Req.

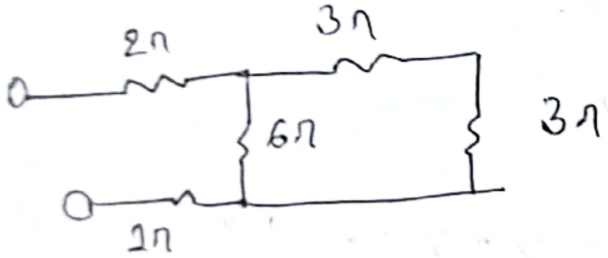
Ans:

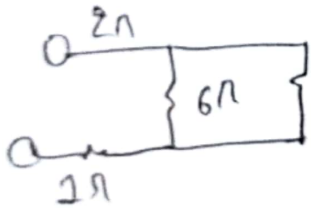


$4+5+3 = 12\Omega$

$12 \| 4$

$\Rightarrow \left(\frac{1}{12} + \frac{1}{4}\right)^{-1} \Rightarrow \left(\frac{3+1}{12}\right)^{-1} = \left(\frac{1}{3}\right)^{-1} = 3\Omega$

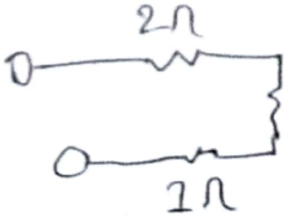




$3+3 = 6\Omega$

$6 \| 6$

$\Rightarrow \left(\frac{1}{6} + \frac{1}{6}\right)^{-1} = \left(\frac{1+1}{6}\right)^{-1} = \left(\frac{2}{6}\right)^{-1} = 3\Omega$



$2+3+1 = 6\ \Omega$

Ans.

2.10

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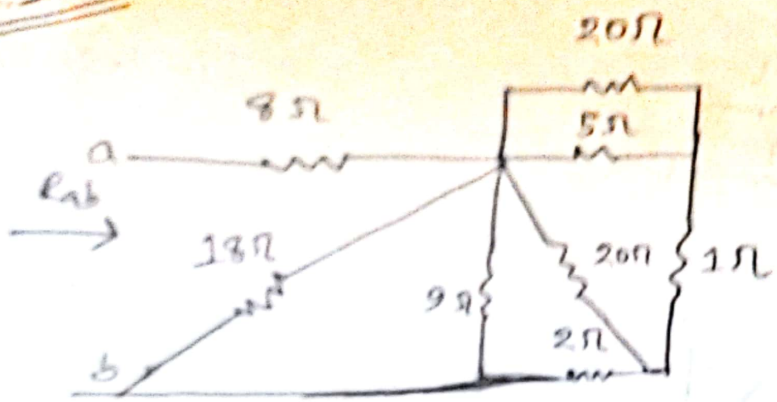
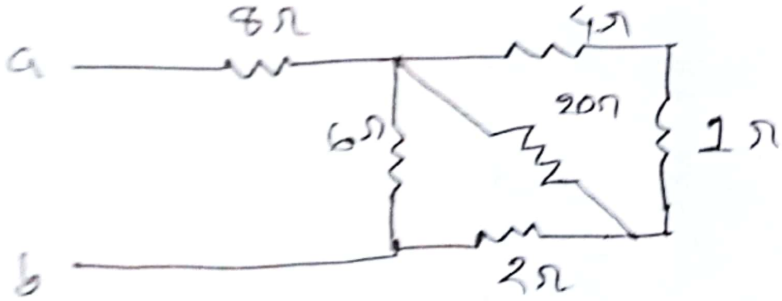


20Ω and 5Ω are parallel,

$$20\Omega \,||\, 5\Omega = \frac{20\times 5}{20+5} = 4$$

18Ω and 9Ω are parallel,

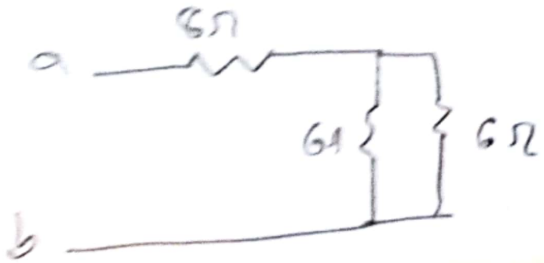
$$18 \,||\, 9 = \frac{18\times 9}{18+9} = 6$$



4Ω and 1Ω are in series, $(4+1) = 5$

20Ω and 5Ω are parallel, $20\Omega \,||\, 5\Omega = \frac{20\times 5}{20+5}$

$= 4$



6Ω and 6Ω are parallel,

$$6\Omega \,||\, 6\Omega = \frac{6\times 6}{6+6} = 3\Omega$$

8Ω and 3Ω are in series, $(8+3) = 11$

Ans| 11Ω

Ex – 2.12

Find i_o, V_o

Find Power dissipated in 3-Ω resistor

Ans:

$$6\|3 = \left(\frac{1}{6}+\frac{1}{3}\right)^{-1} = 2\Omega$$

$$i = \frac{V}{R}$$

$$= \frac{12}{4+2} = 2A$$

$$V_o = \frac{R_2}{R_1+R_2} \times V_s$$

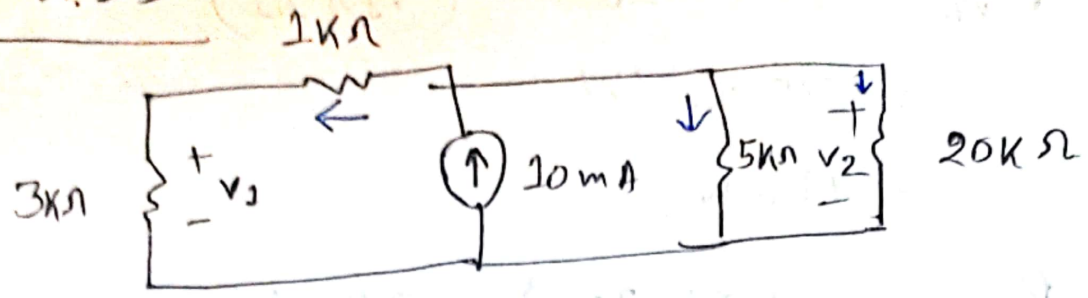
$$= \frac{2}{2+4} \times 12 = 4V$$

$$V_o = 3i_o$$

$$\Rightarrow i_o = \frac{4}{3} A$$

$$P_o = V_o i_o = 4 \times (4/3) = 5.333 W$$

P.P - 2.13



Find

(a) v_1, v_2

(b) dispated in 3KΩ & 20KΩ

(c) supplied by current source

absorved, $P = i^2R$

or, $P = \frac{v_0^2}{R}$

Ans: (a) Current Divider Rule (2KΩ,

$$i_1 = \frac{\frac{1}{(3+1)\times10^3}}{\frac{1}{4\times10^3} + \frac{1}{5\times10^3} + \frac{1}{20\times10^3}} \times 10\times10^{-3} \quad (mA)$$

(KΩ)

$$= \underset{i_R}{5\,mA} = 5\times10^{-3}\,A$$

$$V_1 = 3\times5 = 15\,V$$

$$i_2 = \frac{\frac{1}{20\times10^3}}{\frac{1}{4\times10^3} + \frac{1}{5\times10^3} + \frac{1}{20\times10^3}} \times 10\times10^{-3}$$

$$= 1\,mA = 1\times10^{-3}\,A$$

$$V_2 = 20\times1 = 20\,V$$

(b) $P_{3k\Omega} = 15 \times 5 \times 10^{-3} \quad (V_1 \times i_1)$

$= 75 \times 10^{-3} W$

$= 75 mW$

$P_{10k\Omega} = 20 \times 1 \times 10^{-3} = 20 mW$

(c) $P_{supply} = i \times R_{eq}$ [Voltage across]

$= (10 \times 10^{-3}) \times 2 \times 10^{3} = 200 \times 10^{-3} = 200 mW$

Y (source)

3+1, $5 \| 20$; $4 \| 5 \| 20$

$= \left(\frac{1}{4} + \frac{1}{5} + \frac{1}{20} \right)^{-1} = 2k\Omega$