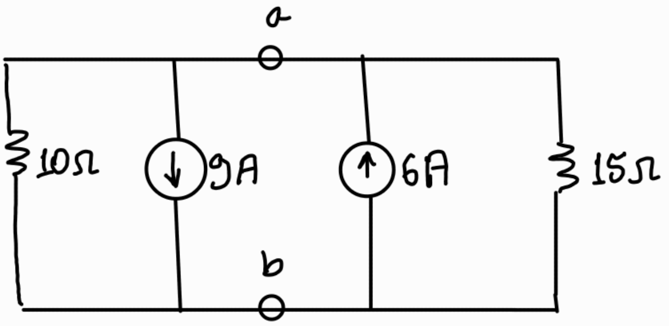
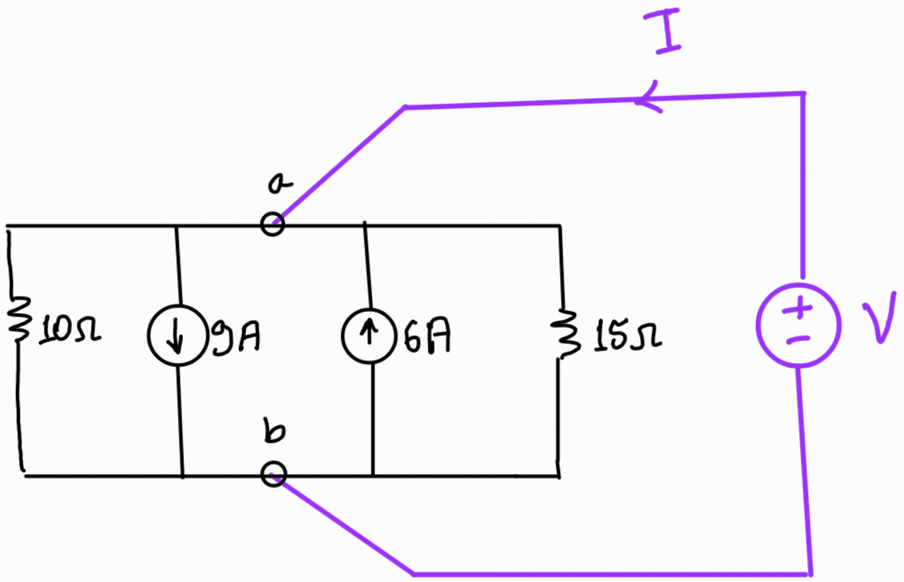
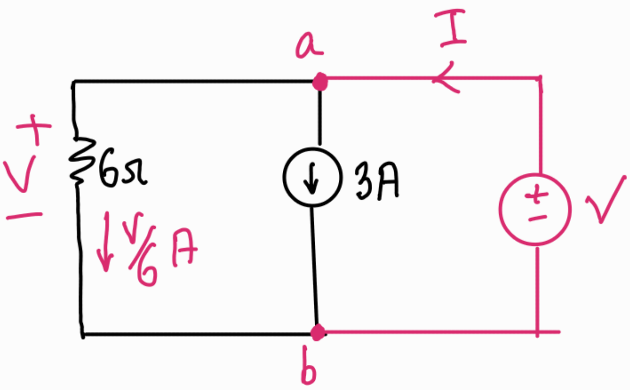
Problem 1



Derive I-V characteristics of the following circuit with respect to the terminals a-b



$\Rightarrow$

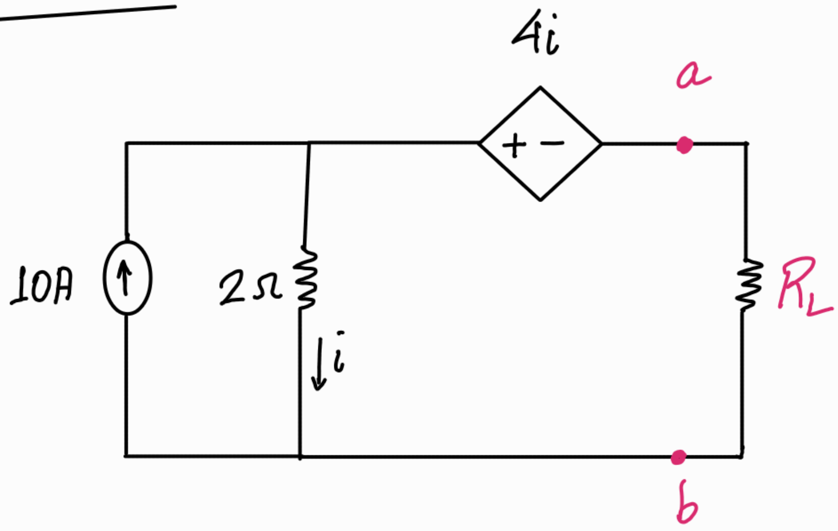


KCL @ a —

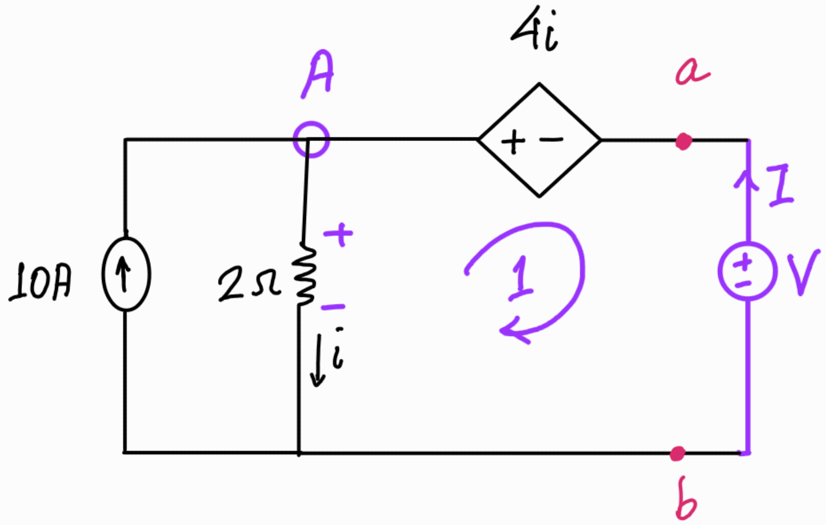
$$\boxed{I = \frac{V}{6} + 3}$$

Solution

Problem 2



Derive the I-V characteristics of the portion left to the terminals a-b.



KCL @ A — $10 + I = i$ —— (i)

KVL @ 1 — $V - 2i + 4i = 0$

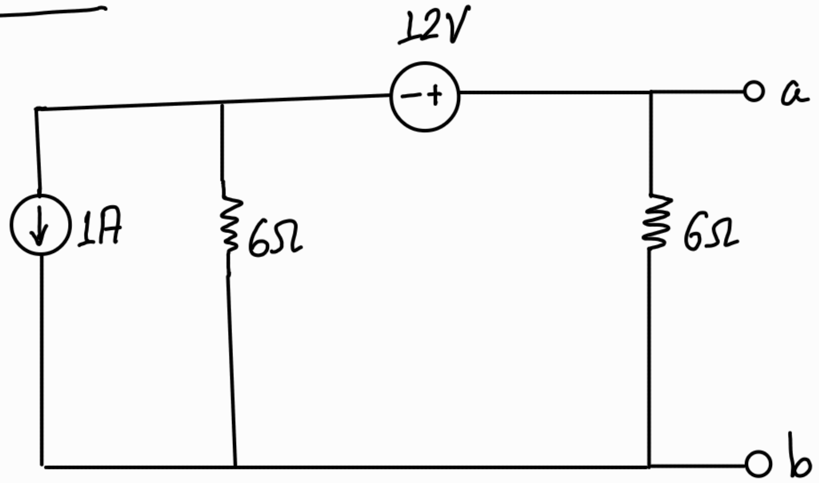
$\Rightarrow V = -2i$

$\Rightarrow i = -\frac{V}{2}$ —— (ii)

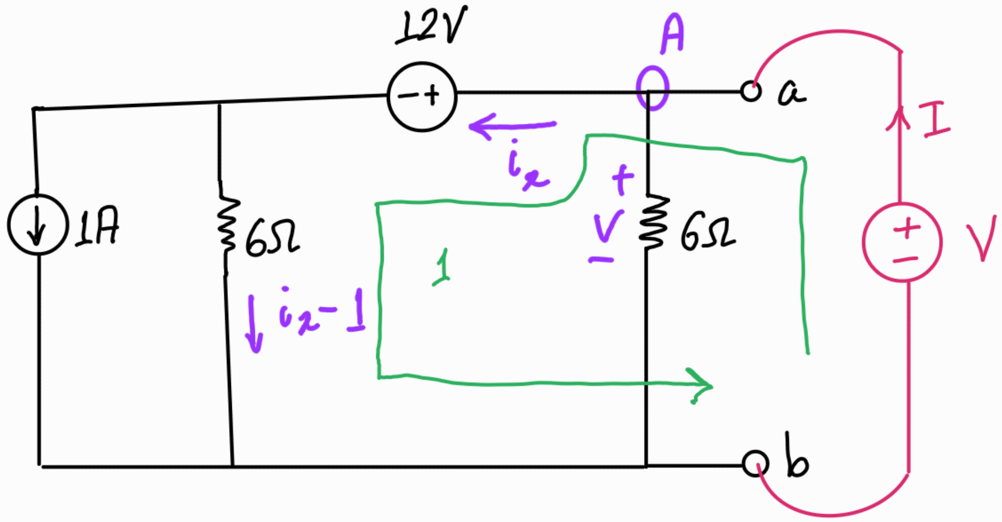
$\therefore$ (i) $\rightarrow$ $\boxed{I = -\frac{V}{2} - 10}$

Solution

Problem 3



From the following circuit derive the I-V characteristics between the terminals a-b



KCL @ A — $I = i_x + \frac{V}{6}$ —— (i)

KVL @ 1 — $12 + 6i_x - 6 - V = 0$

$\Rightarrow 6i_x = V - 6$

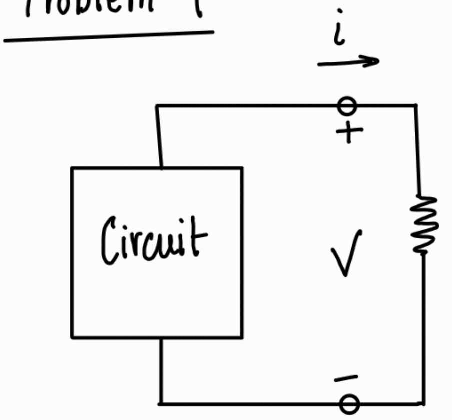
$\Rightarrow i_x = \frac{V}{6} - 1$

$\therefore$ (i) $\rightarrow$ $I = \frac{V}{6} - 1 + \frac{V}{6}$

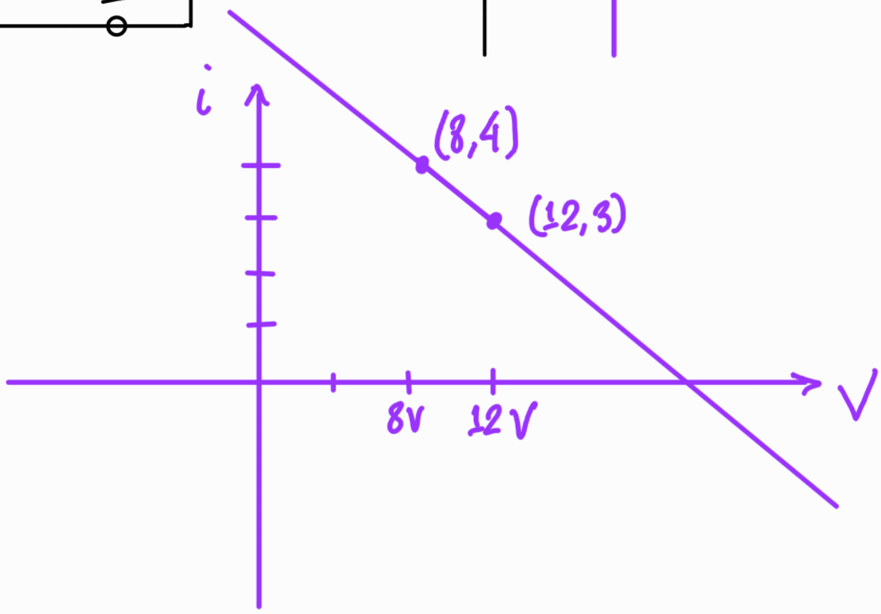
$\Rightarrow \boxed{I = \frac{V}{3} - 1}$

Solution

Problem 4



R	i	V=iR
2KΩ	4mA	8V
4KΩ	3mA	12V



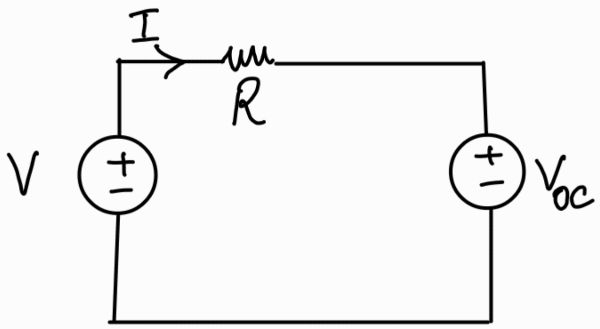
equation from graph —
$$\frac{4-3}{8-12} = \frac{I-3}{V-12}$$

$$\Rightarrow V-12 = -4I+12$$

$$\Rightarrow I = -\frac{V}{4}+6$$

Now how do we find the simplest form of ckt from I-V equations?

The simplest form of ckt —



Simplest IV equation

$$I = \frac{V-V_{oc}}{R}$$

To draw the ckts we need to bring the I-V equation to this form.

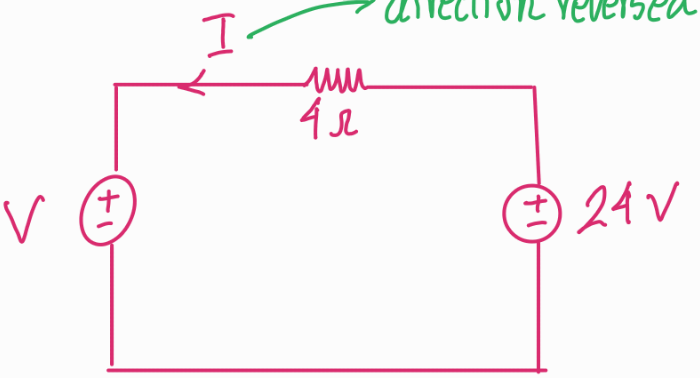
Going back to our problem —

our IV equation $\rightarrow$ $I = -\frac{V}{4} + 6$

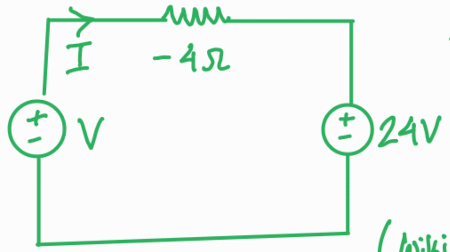
$$= -\frac{V-24}{4}$$

$\therefore$ ckt —

direction reversed because of -ve sign

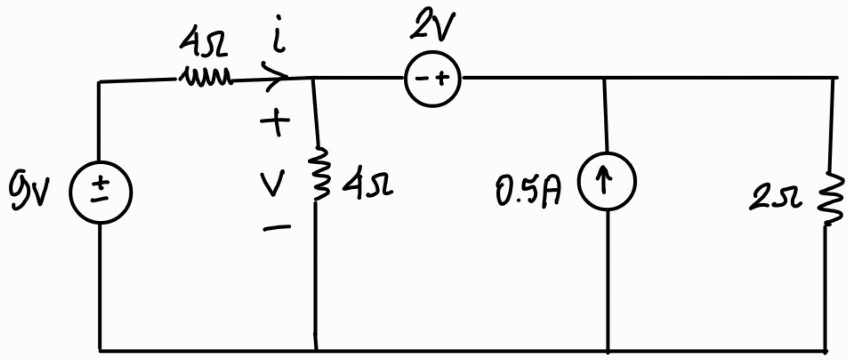


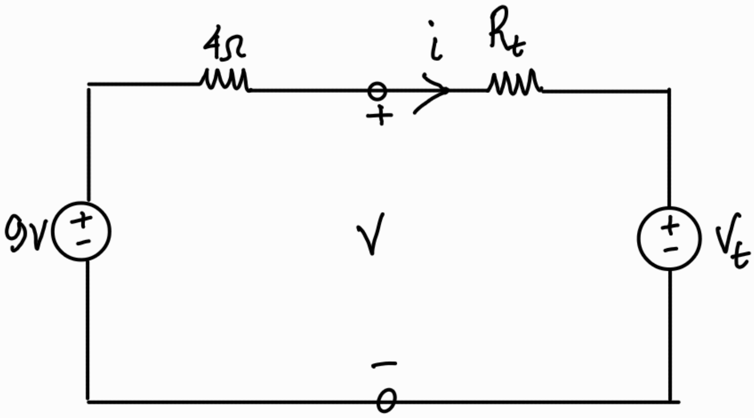
This is also correct —



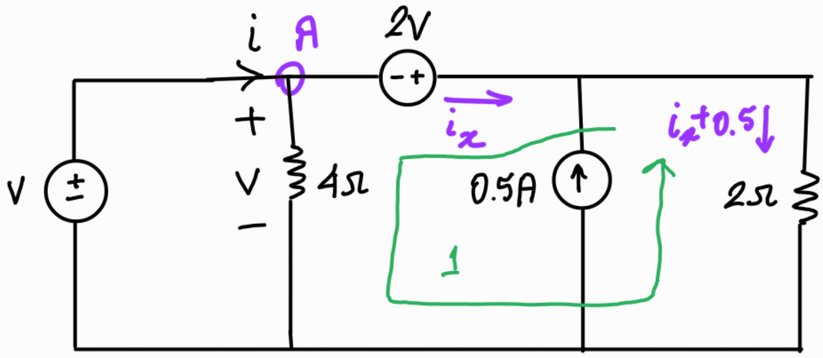
−ve resistance can happen in electronic devices (wiki has a great page on this)

Problem 5





Determine the value of R_t & V_t if the two circuits are equivalent to each other.



We have to at first find the I-V characteristics equation for this circuit.

KCL @ A $\rightarrow$ $i = \frac{v}{4} + i_x$ —— (i)

KVL @ 1 $\rightarrow$ $v - 2i_x - 1 + 2 = 0$

$$\Rightarrow i_x = \frac{v}{2} + \frac{1}{2}$$

$\therefore$ (i) $\rightarrow$ $i = \frac{v}{4} + \frac{v}{2} + \frac{1}{2}$

$$= \frac{3v}{4} + \frac{1}{2}$$

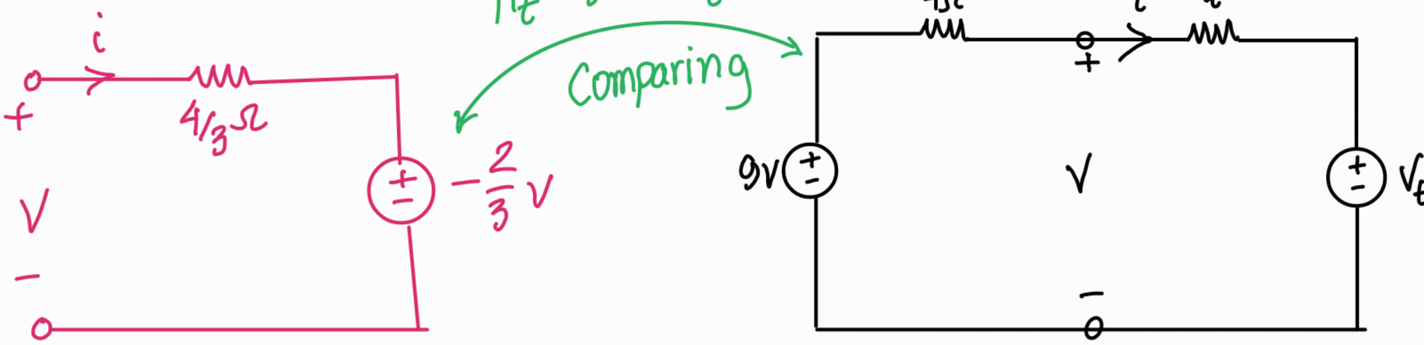
now we have to change it to the simplest form —

$$i = \frac{3v+2}{4}$$

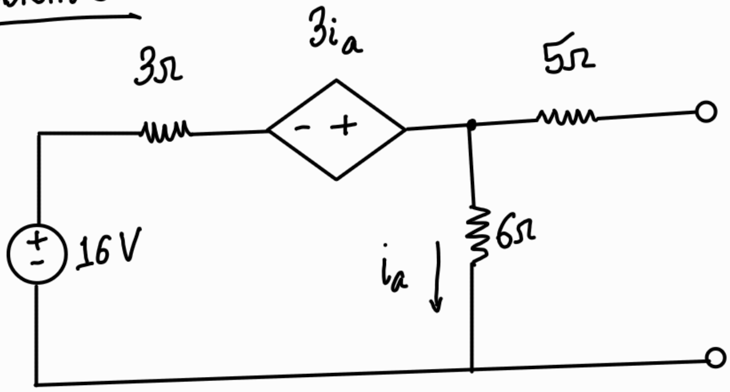
$$= \frac{v - (-\frac{2}{3})}{\frac{4}{3}}$$

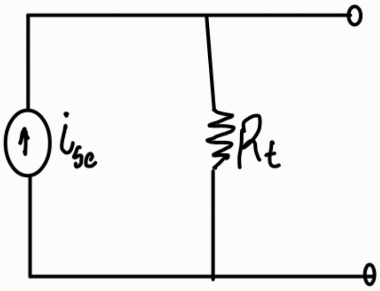
$\therefore$ the simplest ckt —

$R_t = \frac{4}{3}\Omega$; $V_t = -\frac{2}{3}V$



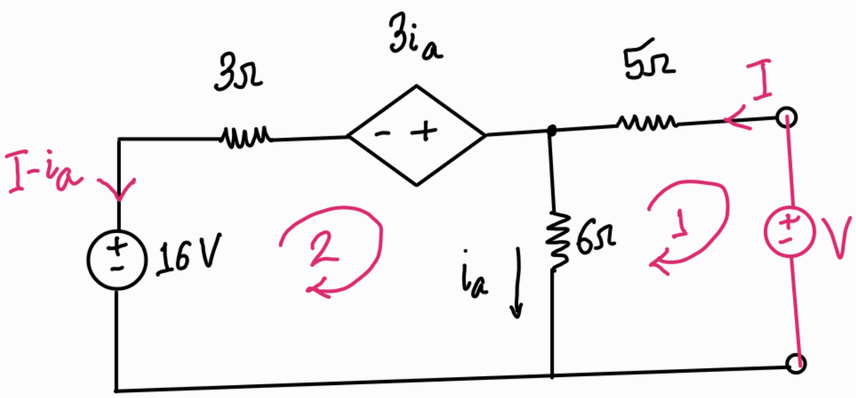
Problem 6





Determine the value of i_{sc} and R_t if two ckts are equivalent.

Find the I-V characteristics equation for the original ckt —



KVL @ 1 —

$$V - 6i_a - 5I = 0 \quad \text{(1)}$$

KVL @ 2 —

$$-16 - 3I + 3i_a - 3i_a + 6i_a = 0$$

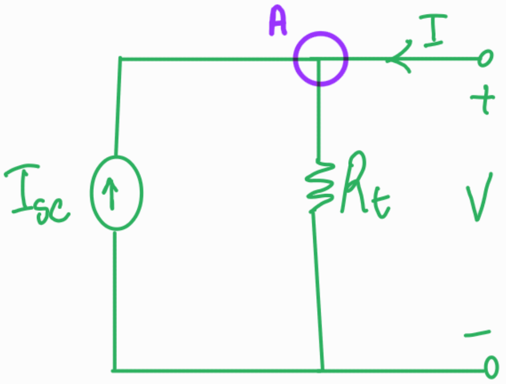
$$\Rightarrow 6i_a = 16 + 3I$$

$$\text{(1)} \Rightarrow V - 16 - 3I - 5I = 0$$

$$\Rightarrow I = \frac{V}{8} - 2$$

We cannot use our previous simplest circuit because it was in the form of voltage source.

Lets derive a simplest equation form for the ckt —



KCL @ A —

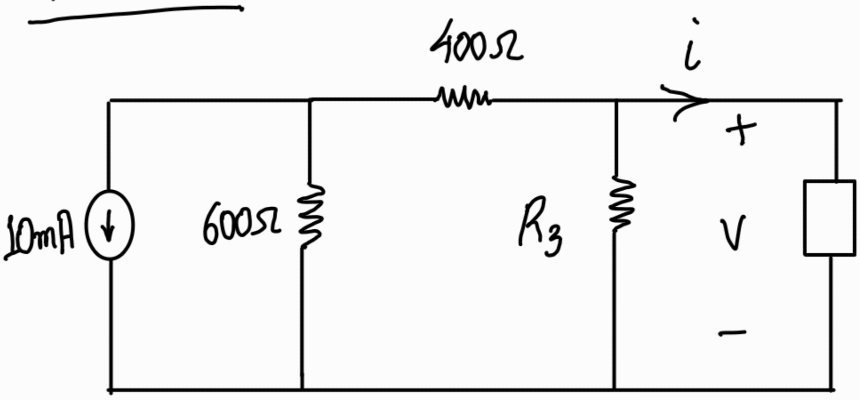
$$I + I_{sc} = \frac{V}{R_t}$$

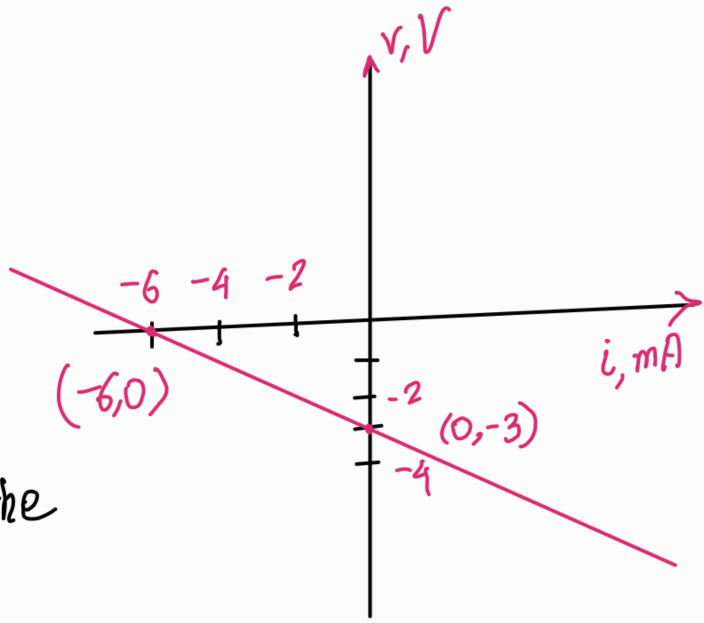
$$\Rightarrow \underline{I} = \frac{V}{R_t} - I_{sc}$$

Now our original I-V equation — $I = \frac{V}{8} - 2$

comparing
$I_{sc} = 2A$
$R_t = 8\Omega$

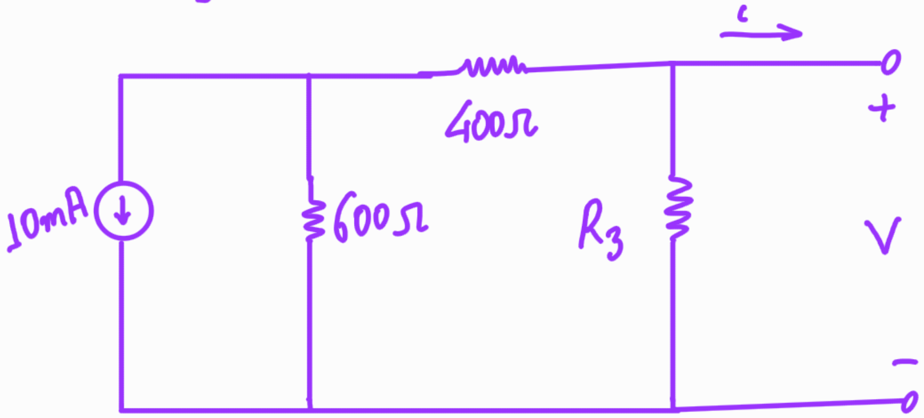
Problem 7





From the v-i characteristics find the value of R_3

Since R_3 is on the left side, we are only concerned with that part

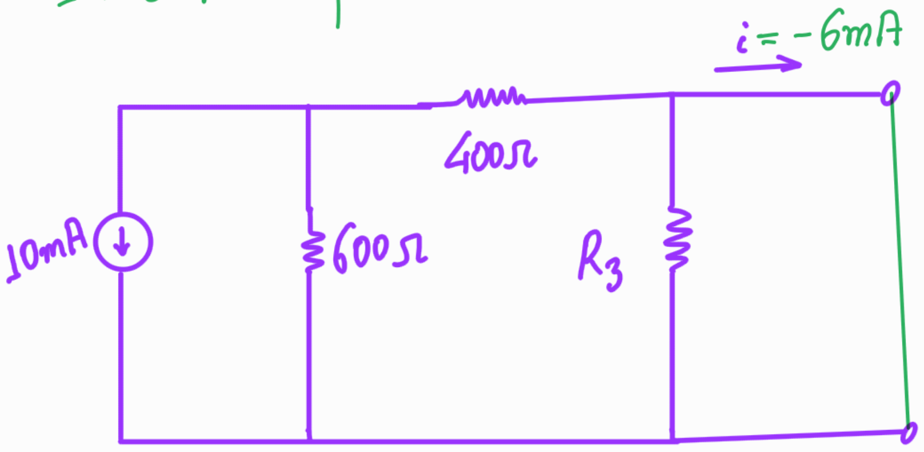


In such problems, we will take advantage of the extreme points in the graph.

1st extreme point → (−6mA, 0V) ⟶ short circuit

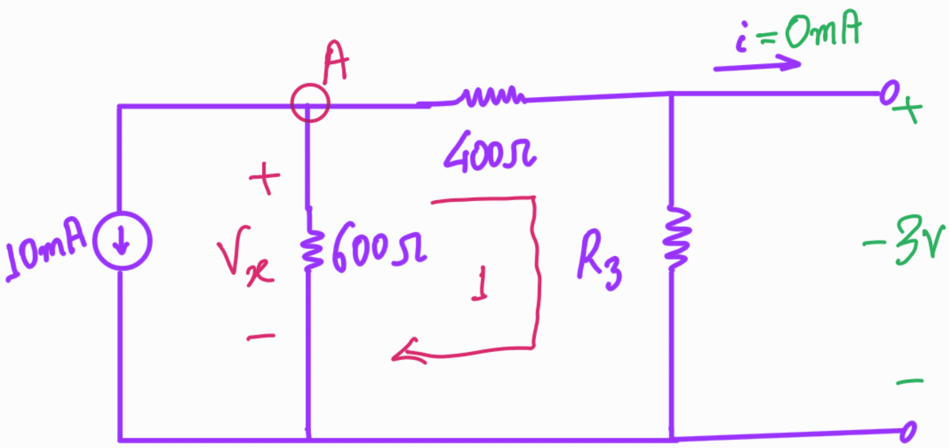
2nd extreme point → (0mA, −3V) ⟶ open circuit

1st extreme point ckt —



Cannot be used because we lose R_3 to a short circuit

2nd extreme point ckt —



We can use this ckt.

KCL @ A — $10^{-2} + \frac{V_x}{600} + \frac{-3}{R_3} = 0$ ——— (i)

Voltage divider in 1 ⟶ $-3 = \frac{R_3 V_x}{400 + R_3}$

$\Rightarrow -1200 - 3R_3 = R_3 V_x$

$\Rightarrow V_x = -\frac{1200}{R_3} - 3$

$$\therefore \text{(i)} \Rightarrow 10^{-2} - \frac{2}{R_3} - \frac{1}{200} - \frac{3}{R_3} = 0$$

$$\Rightarrow \frac{5}{R_3} = \frac{2-1}{200}$$

$$\Rightarrow R_3 = 1000 = 1\,k\Omega$$