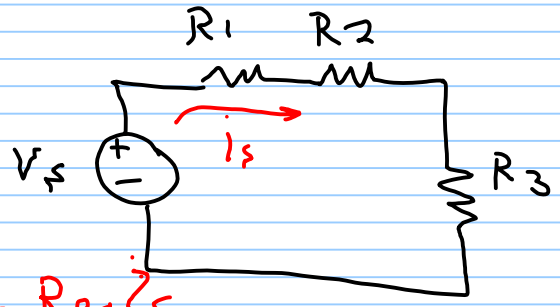
chapter 3 simple Resistive circuits

Note Title 9/21/2020

Resistors in series:-



KVL

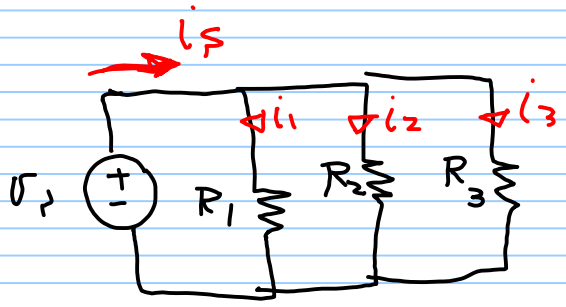
$$-V_s + R_1 i_s + R_2 i_s + R_3 i_s = 0$$

$$V_s = (R_1 + R_2 + R_3) i_s \quad \Big\} \quad V_s = R_{eq} i_s$$

$\hookrightarrow R_{eq} = R_1 + R_2 + R_3$

$\hookrightarrow$ series elements have the same current.

Resistors in Parallel:-



$\hookrightarrow$ parallel elements have the same voltage

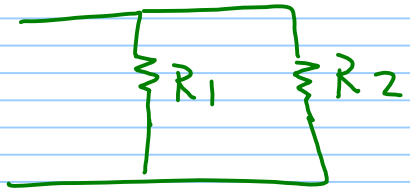
$$i_1 = \frac{V_s}{R_1}, \quad i_2 = \frac{V_s}{R_2}, \quad i_3 = \frac{V_s}{R_3}$$

$$i_s = i_1 + i_2 + i_3$$

$$i_s = V_s\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$$

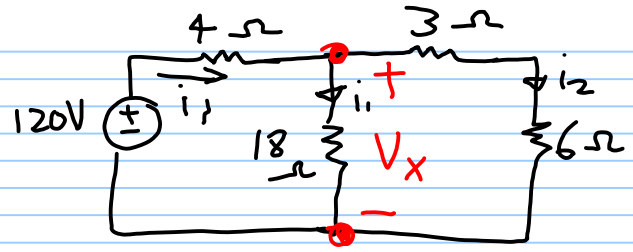
$$\therefore \frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_{eq}} = \sum_{i=1}^{N} \frac{1}{R_i}$$



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

Ex)



find i_s, i_1, i_2

$$Req = [[(3+6)] // 18] + 4$$

$$= 10\,\Omega$$

$$\therefore i_s = \frac{V_s}{Req} = \frac{120}{10} = 12\,A \quad \text{(1)}$$

$$\begin{cases} i_1 = \dfrac{9}{9+18} * 12 \\ i_2 = \dfrac{18}{18+9} * 12 \end{cases}$$

CDR

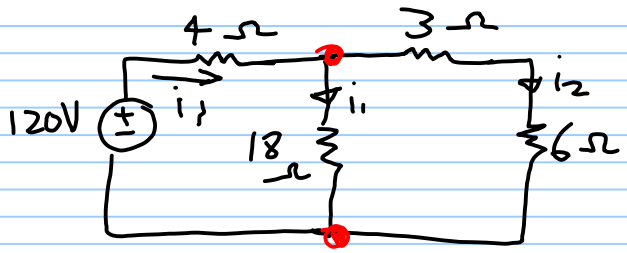
$$-120 + 4 \times 12 + V_x = 0 \quad \text{(KVL)}$$

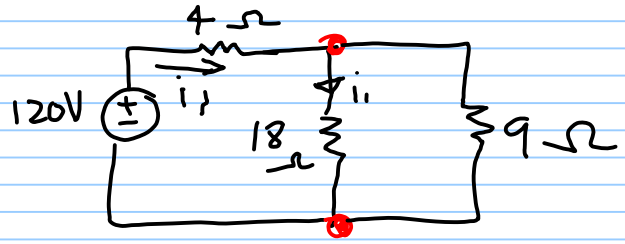
$$V_x = 72\,V$$

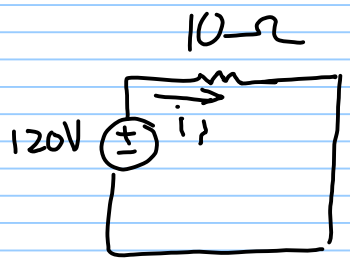
$$\therefore i_1 = \frac{V_x}{18} = \frac{72}{18} = 4\,A$$

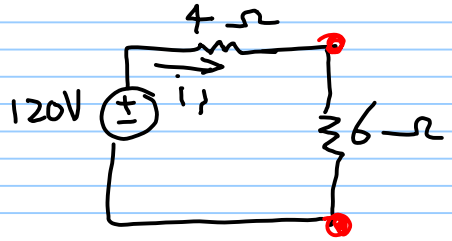
$$\therefore i_2 = i_s - i_1 = 12 - 4 = 8\,A$$

OR $$i_2 = \frac{V_x}{3+6} = \frac{72}{9} = 8\,A$$

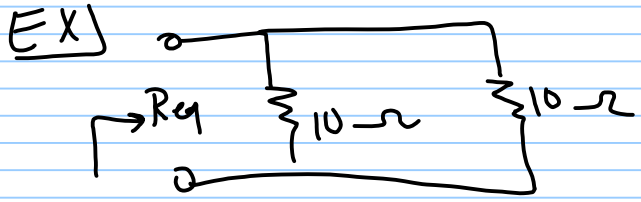






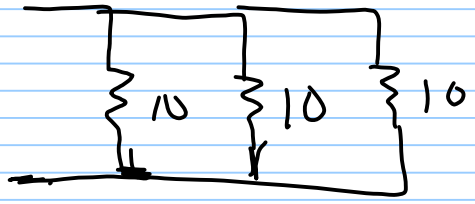


EX



$$R_{eq} = \frac{10 \times 10}{10+10} = 5$$

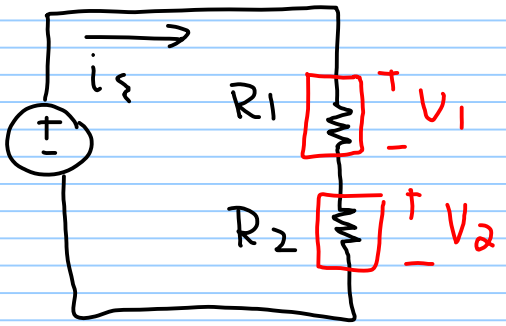
$$= 10/2$$



$$R_{eq} = \frac{10}{3}$$

The Voltage Divider Rule VDR

↳ applied when the voltage is divided between series elements.



↳ $i_s = \frac{V_s}{R_1+R_2}$

$\therefore V_1 = i_s R_1$

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

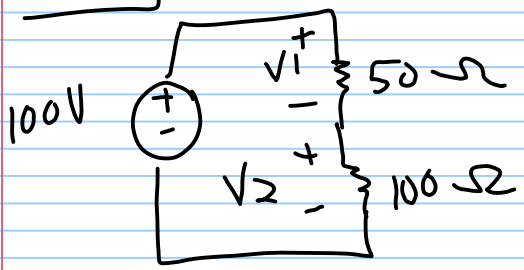
$$V_1 = \frac{R_1}{R_{eq}} V_s$$

$\therefore V_2 = i_s R_2$

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

$$V_2 = \frac{R_2}{R_{eq}} V_s$$

EX

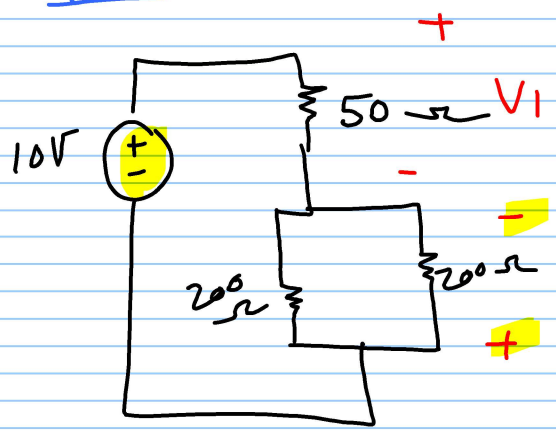


$$V_1 = \frac{50}{50+100} \times 100 = 33.33\,V$$

$$V_2 = \frac{100}{100+50} \times 100 = 66.66\,V$$

$$= 2 \times V_1$$

EX1

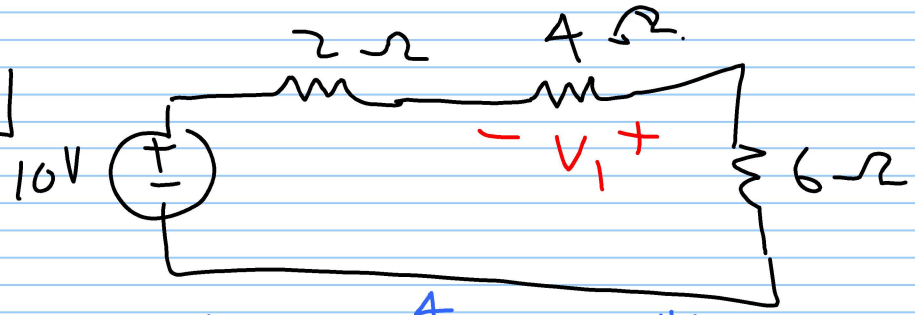


find V_1

$$V_1 = \frac{50}{50 + \frac{200}{2}} * 10$$

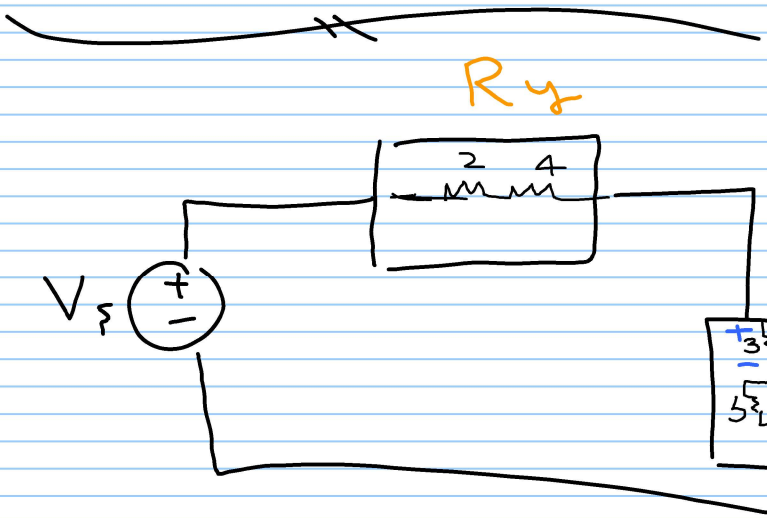
$$V_2 = \frac{-(200/2)}{(200/2) + 50} * 10$$

EX



find V_1

$$V_1 = -\frac{4}{4 + (2+6)} * 10$$



① $$V_x = \frac{R_x}{R_x + R_y} V_s$$

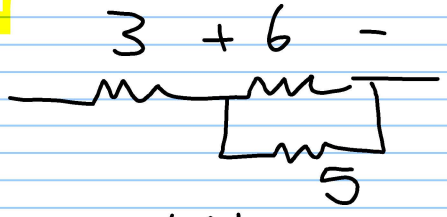
$$R_x = [3 + (6 // 5)]$$

$$R_y = (2 + 4)$$

② find $V_{3\Omega}$ $$V_{3\Omega} = \frac{3}{3 + [2 + 4 + \frac{30}{11}]} V_s$$

OR

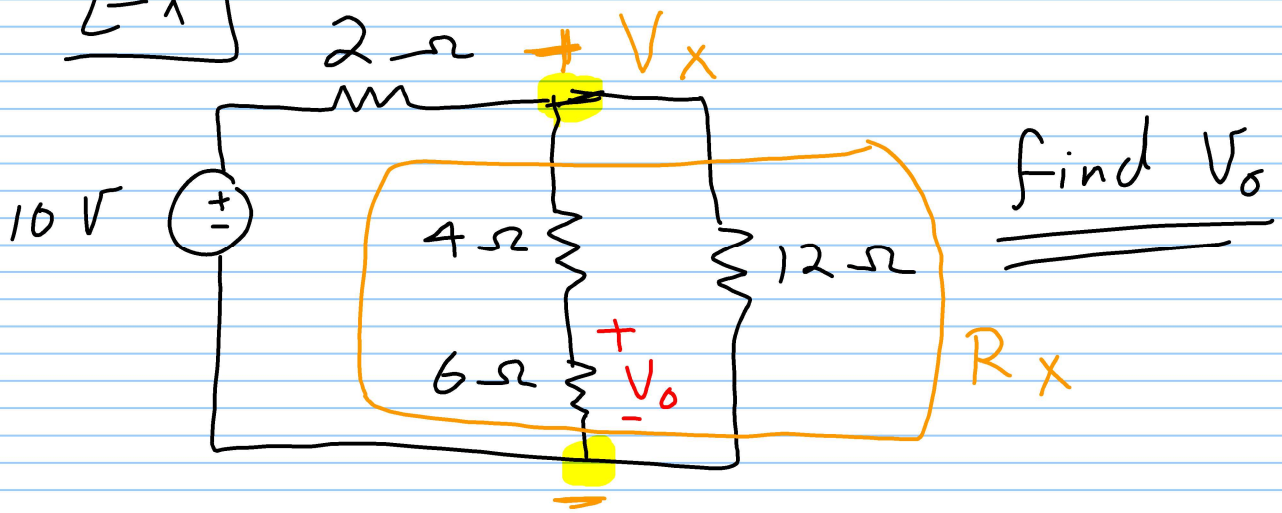
$$V_{3\Omega} = \frac{3}{3+[6//5]} \boxed{V_x}$$



& find $V_{6\Omega}$

$$V_{6\Omega} = \frac{[6//5]}{[6//5]+3} * V_x$$

Ex



find V_o

$$V_x = \frac{R_x}{R_x+2} \times 10$$, then

$$R_x = 10//12 = 5.45\ \Omega$$

$$V_o = \frac{6}{6+4} * V_x$$

$$\Rightarrow V_o = \frac{6}{6+4}\left(\frac{R_x}{R_x+2}\right)\times 10$$

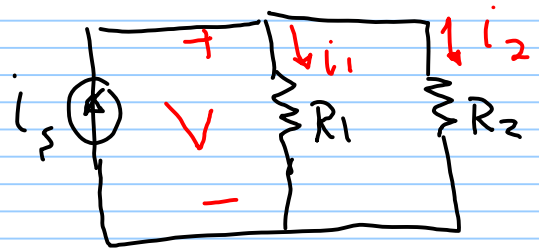
$$= \left(\frac{6}{10}\right)\left(\frac{5.45}{7.45}\right)*10 = 4.389\ V$$

The current Divider Rule

CDR

$$V = i_1 R_1 = i_2 R_2$$

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



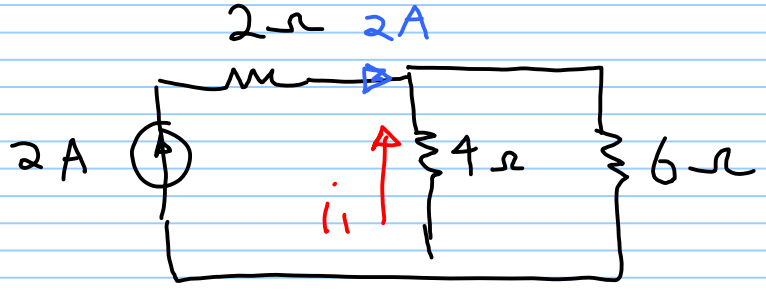
$$\therefore i_1 = \frac{R_{eq}}{R_1} i_s \quad OR$$

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

$$i_2 = \frac{R_{eq}}{R_2} i_s \quad OR$$

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

EX find i_1

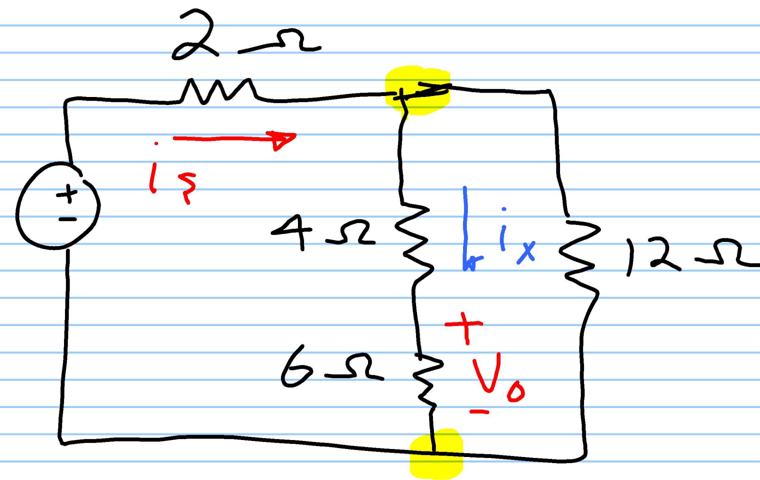


$$i_1 = -\frac{6}{6+4} * 2$$

$$= -1.2\,A$$

EX]

find v_o



① find I_s

$R_{eq} = 2 + [10 // 12]$

$= 2 + 5.45$

$= 7.45\ \Omega$

$\therefore\ i_s = \frac{10}{R_{eq}} = \frac{10}{7.45} = 1.34\ A$

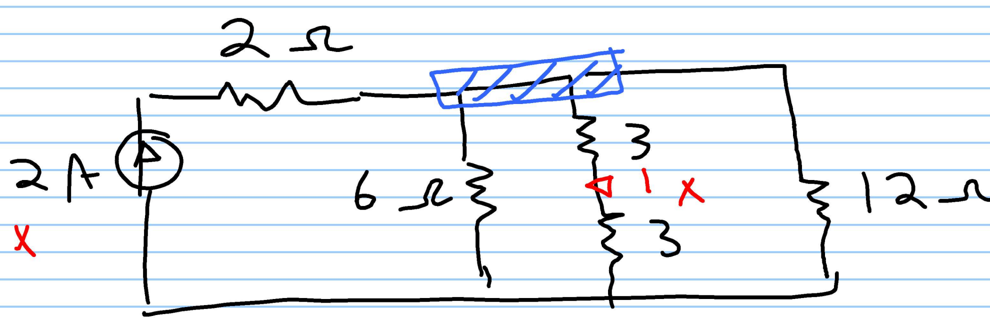
② find i_x

$i_x = \frac{12}{12 + (4+6)} * (1.34) = 0.73\ A$

$\therefore\ V_o = (6\Omega)(0.73A)$

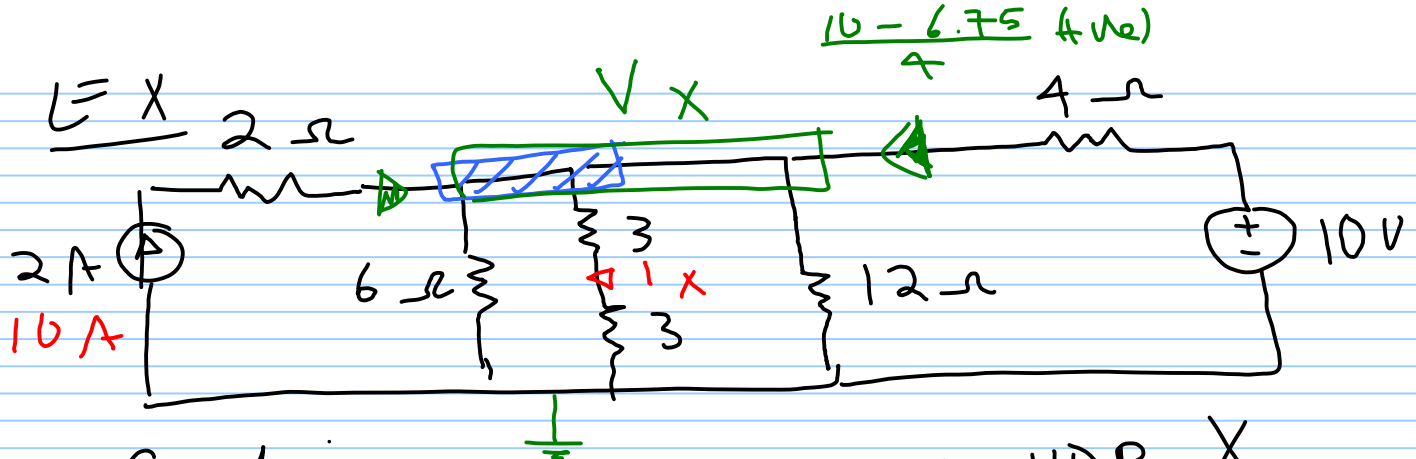
$= 4.38$ Volt.

EX]



find i_x

$i_x = \frac{[6 // 12]}{[6 // 12] + [3+3]} * 2\ A$



find i_x CDR or VDR X

use KVL & KCL

Ch 4

$$-2+\frac{V_x}{6}+\frac{V_x}{3+3}+\frac{V_x}{12}+\frac{V_x-10}{4}=0$$

$V_x =$ ___ Volt

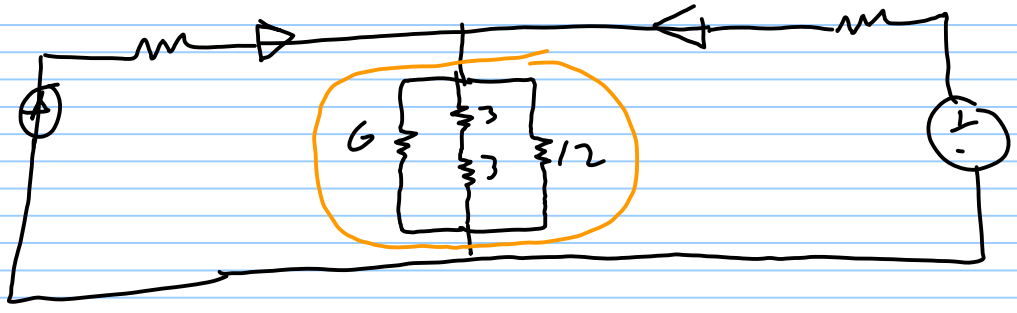
$$\therefore\ i_x=\frac{V_x}{3+3}\ A$$

$$V_x\left(\frac{1}{6}+\frac{1}{6}+\frac{1}{12}+\frac{1}{4}\right)=2+\frac{10}{4}$$

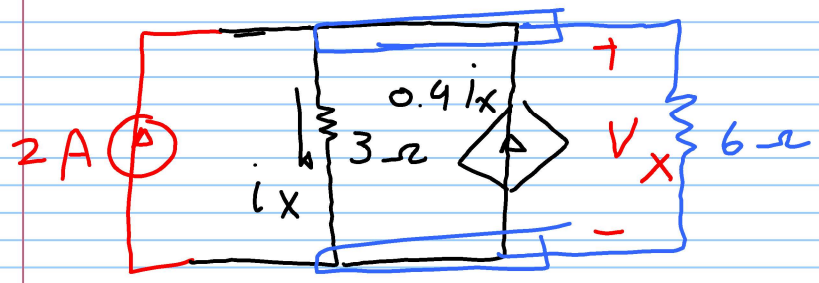
$$V_x\left(\frac{2}{3}\right)=4.5$$

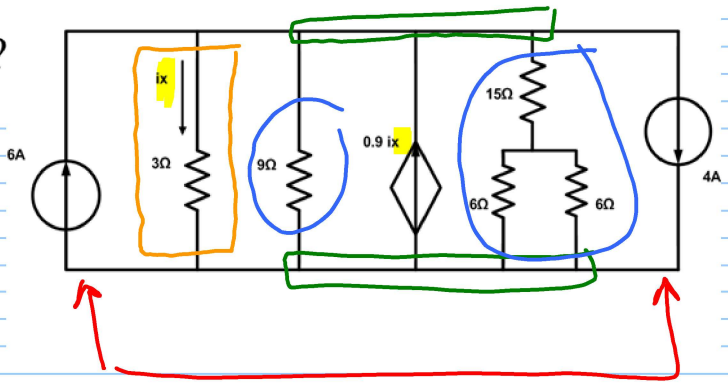
$$V_x = 6.75 \text{ Volt}$$

when using (10A) $V_x = 18.75$



Find the power supplied by the 0.9 ix source?





$R_{eq}^{*} = 9 \,//\, [15+3]$

$= 9 \,//\, 18$

$= 6\,\Omega$

CDR

$i_x = \frac{6}{6+3}\left[2 + 0.9\, i_x\right]$

$i_x = \frac{12 + 5.4\, i_x}{9}$

$\{ 9 i_x = 12 + 5.4 i_x \}$

$\therefore i_x = \frac{12}{9 - 5.4} = 3.33\,A$

$\therefore V_x = (3\,\Omega)(3.33)$

$\simeq 10$ Volt

$P_{6.9 i_x} = -(0.9 i_x)(V_x)$

$= -30\,W$

Bridge Circuits

One type of resistive circuit that cannot be simplified through series and/or parallel combinations is the "bridge circuit." A bridge circuit is shown below (drawn twice). Study the circuit to verify that there are no series resistors and no parallel resistors.