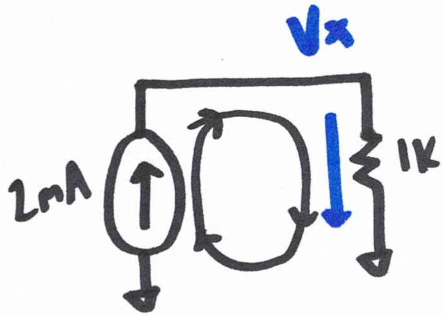
EE 220: Circuits I

- current sources
- series resistors, equivalents
- parallel resistors, equivalents
- examples



$V = I \cdot R$

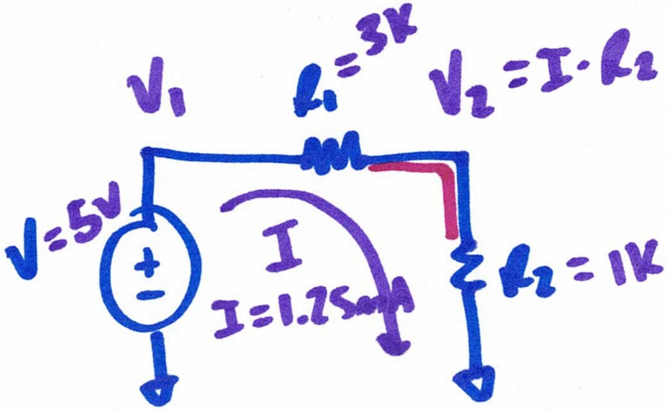
$V = 2mA \cdot 1k\Omega$

$\boxed{V_x = 2V}$

$V_2 = I \cdot R_2 = 1.25\,mA \cdot 1K = 1.25V$ ✓

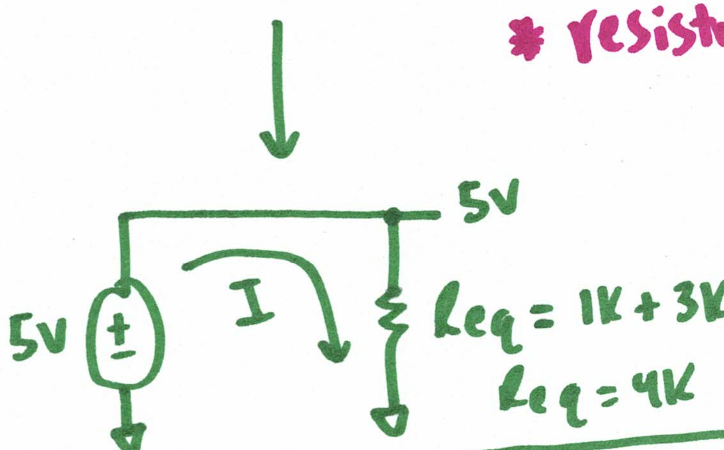
Find: V_1, V_2, I

$V_1 = 5V$ | $V_2 = 1.25V$ | $I = 1.25\,mA$



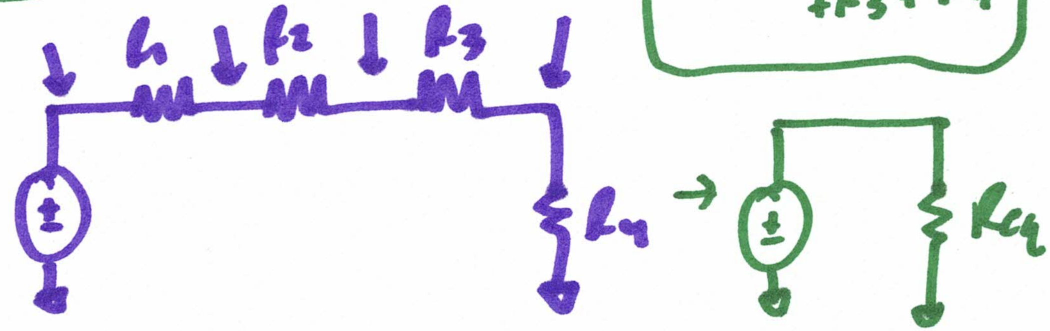
* resistors connected in **Series**:

- share one node
- same current through them
- To find Req, add their values

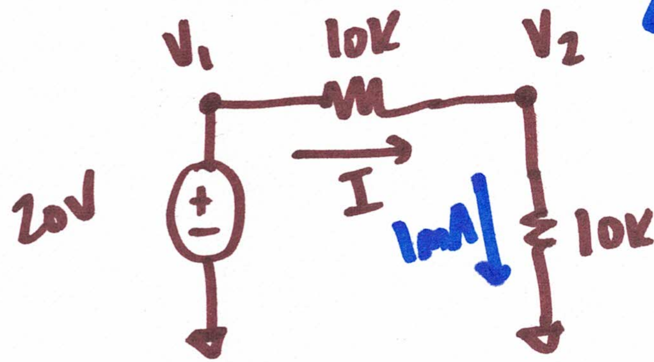


$$I = V/R = \frac{5V}{4K} = 1.25\,mA$$

$$R_{eq} = R_1 + R_2 + R_3 + R_4$$



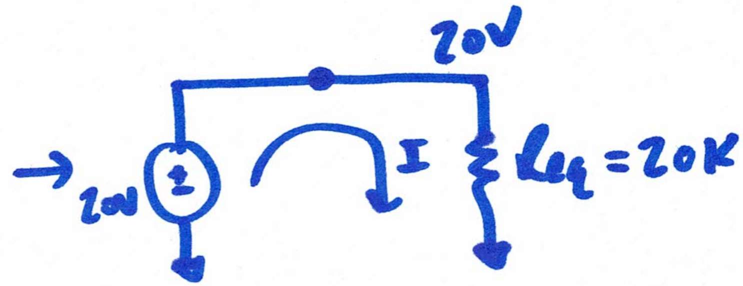
Voltage divider



$$V_1 = 20V$$

$$V_2 = 1mA \cdot 10K$$

$$V_2 = 10V$$



$$I = \frac{20V}{20K} = 1mA$$

Series: same current, share **one** node

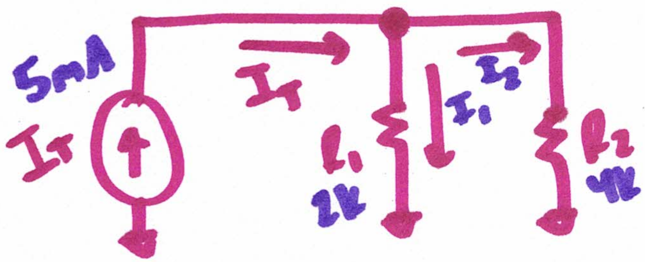
parallel: same voltage, share **two** nodes

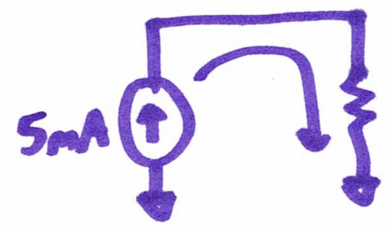
$$\frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{R_{eq}}$$

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

"product over sum"

$V_x = 6.65V$





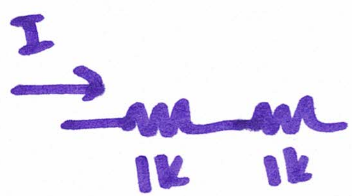
KCL: Kirchhoff's Current Law

$I_T = I_1 + I_2$

$V_x = 5mA \cdot 1.333K$

$$V_x = 6.65V$$

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



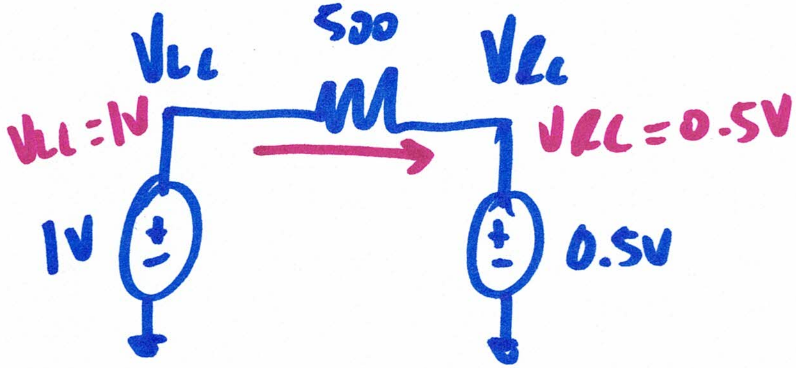
$R_{eq} = 2K$

$$I_1 = \frac{6.65V}{2k} = 3.33mA$$

$$I_2 = \frac{6.665V}{4k} = 1.66mA$$

EE 220: Circuits I

HW1: 3c



$$\frac{1V - 0.5V}{500} = \frac{0.5}{500} = 1mA$$

0.001

HW1: 3a

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

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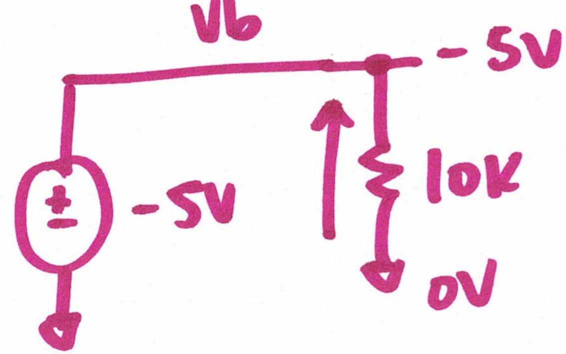
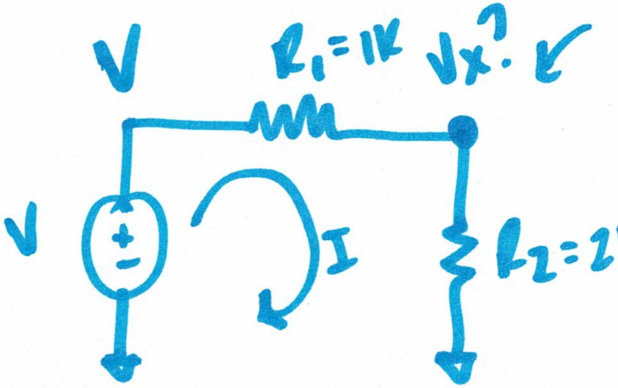
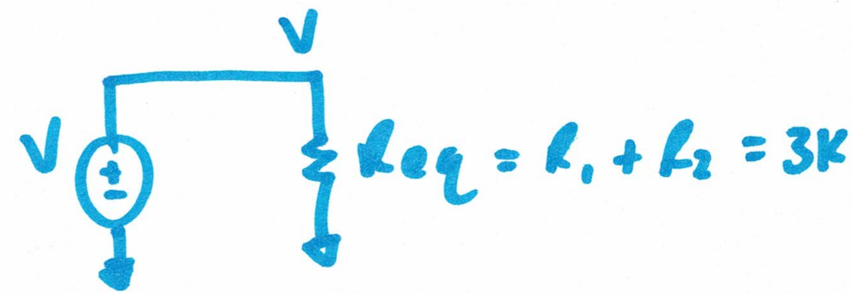
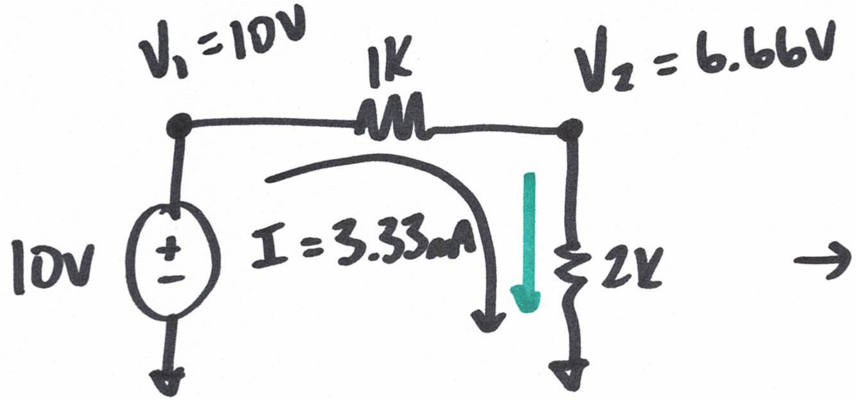
HW1: 1B



series : same current







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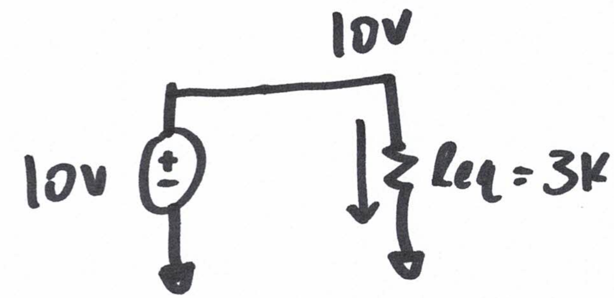
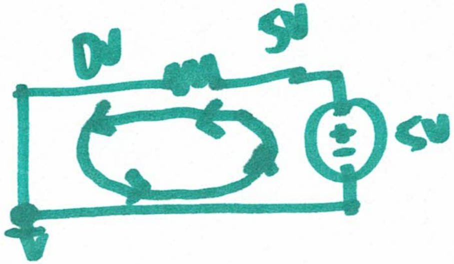


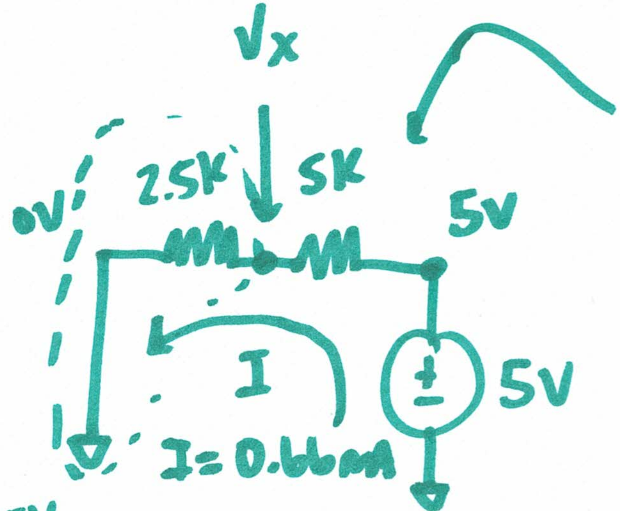
$$V = IR$$

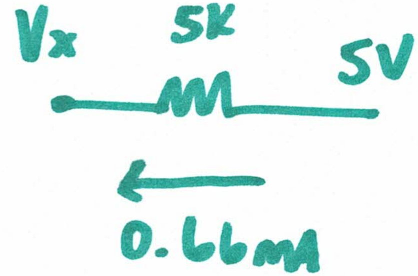
$$V = 3.33\,\text{mA} \cdot 2\,\text{k}\Omega$$

$$\boxed{V_2 = 6.66\,\text{V}}$$

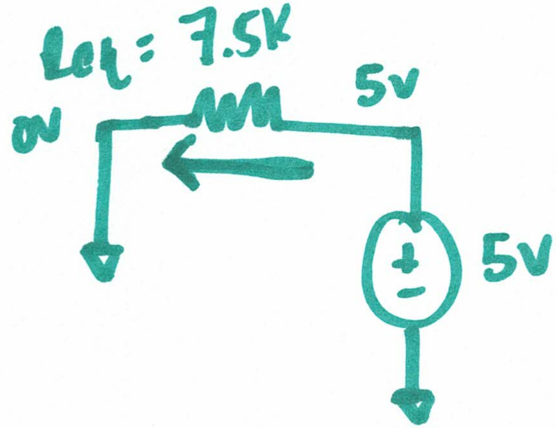
$$\frac{10\text{V} - 0\text{V}}{3\text{K}} = \boxed{3.33\,\text{mA}}$$







$V = IR$



10^{-6}

$I = V/R$

$I = \frac{5V}{7.5K} = 666.66\mu A$

$= 0.666\,mA$

$V_x =$

$V_x = 0.66mA \cdot 2.5K$

$V = 5V - V_x = 0.66mA \cdot 5K$

$5V - V_x = 3.3V$

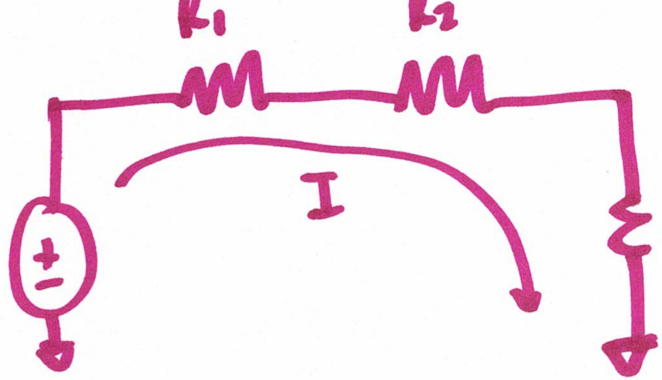
$+V_x \quad +V_x$

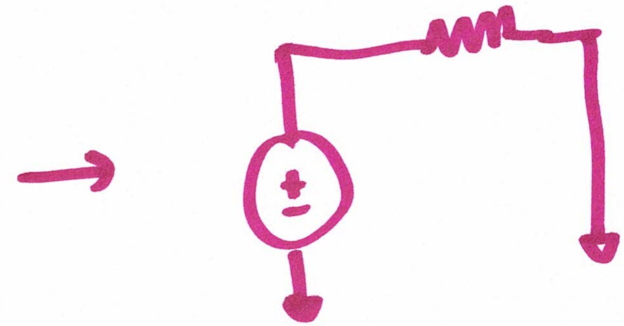
$5V - 3.3V = V_x$

$V_x = 1.7V$

Series resistors: same current, not necessarily same voltage

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





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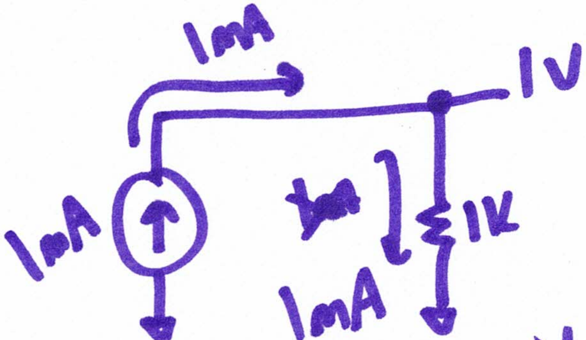
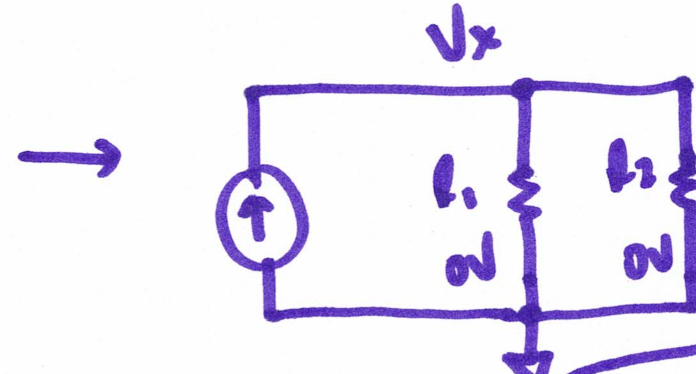
parallel resistors: same voltage, not necessarily same current.





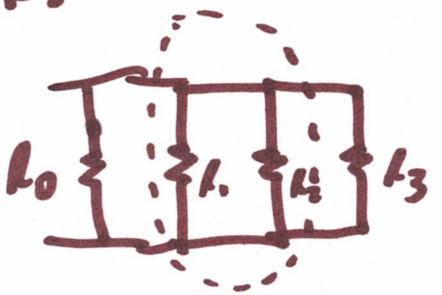
$V = I \cdot R$

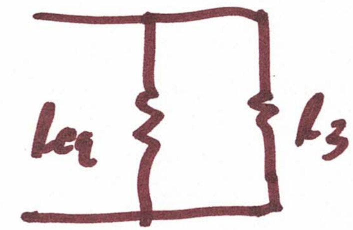
$V = 1mA \cdot 1K$

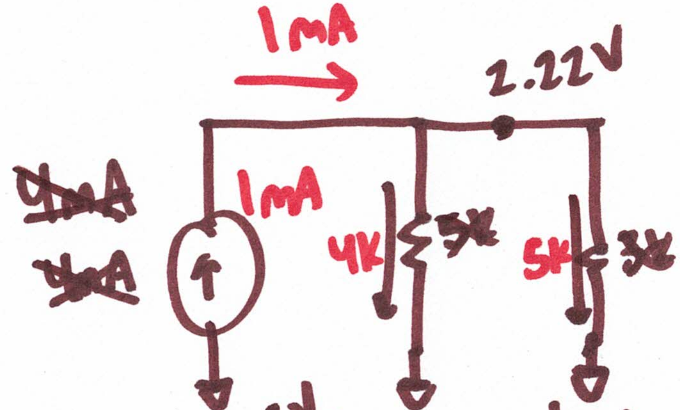
$V = 1V$

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

parallel resistors: $R_{eq} = \frac{R_1 \cdot R_2}{R_1 + R_2}$







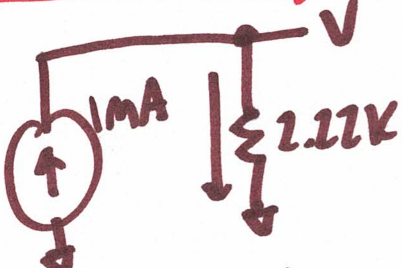
$\frac{2.22V}{4K}$ $\quad$ $2.22V / 5K$

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

$\left(\frac{1}{4K} + \frac{1}{5K}\right) = \frac{1}{R_{eq}}$

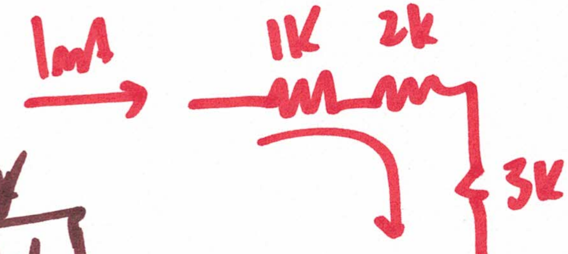
$R_{eq} = \frac{4K \cdot 5K}{4K + 5K}$

$R_{eq} = 2.22K$



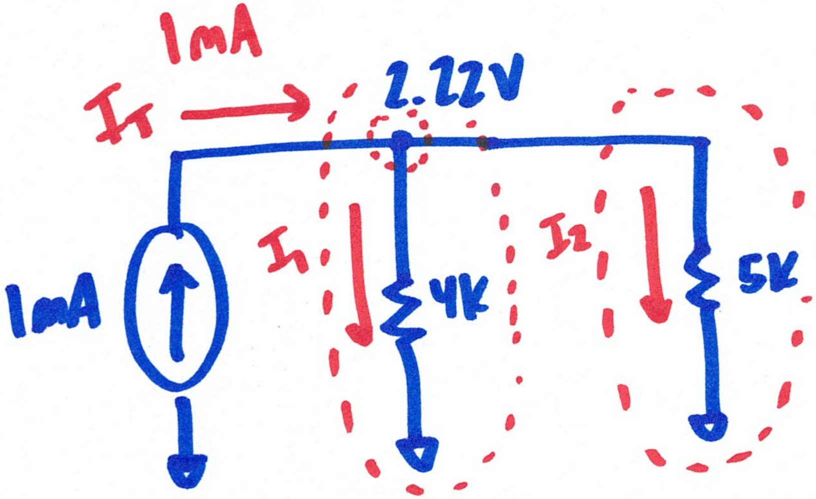
$V = 1mA \cdot 2.22K$

$V = 2.22V$



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

KCL:



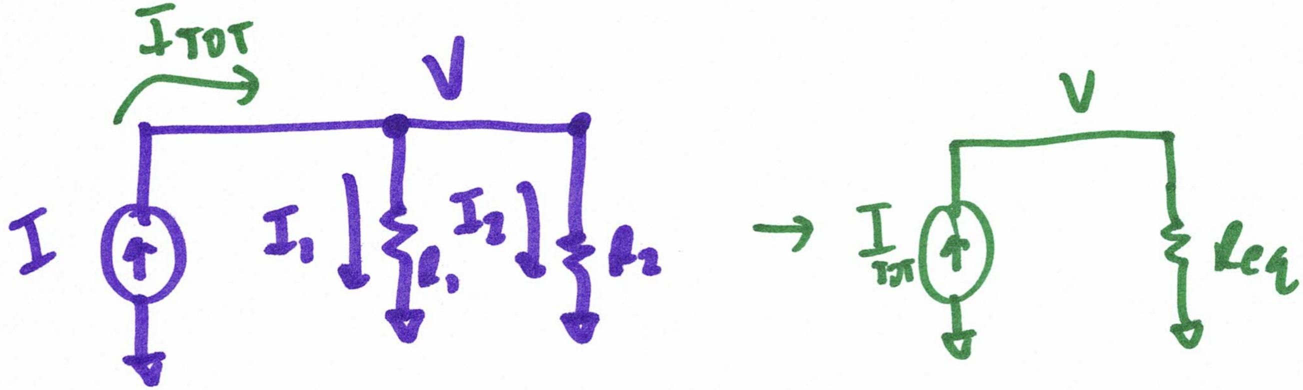
4K: 2.22V —/\/\/\— 0V

$$I_1 = V/R = \frac{2.22V}{4K} = 0.555\text{ mA}$$

5K: 2.22V —/\/\/\— 0V

$$I_2 = V/R = \frac{2.22V}{5K} = 0.444\text{ mA}$$

$I_1 + I_2$: 0.999 mA $\approx$ 1mA



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

$$R_{eq} = \frac{1}{\left(\frac{1}{R_1} + \frac{1}{R_2}\right)} \frac{(R_1 \cdot R_2)}{(R_1 \cdot R_2)}$$

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

"product over sum"

$$I_1 = \frac{V}{R_1}$$

$$I_2 = \frac{V}{R_2}$$

$$I_{TOT} = \frac{V}{R_{eq}}$$

$$I_{TOT} = I_1 + I_2$$

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

$$\cancel{V}\left(\frac{1}{R_{eq}}\right) = \cancel{V}\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

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

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