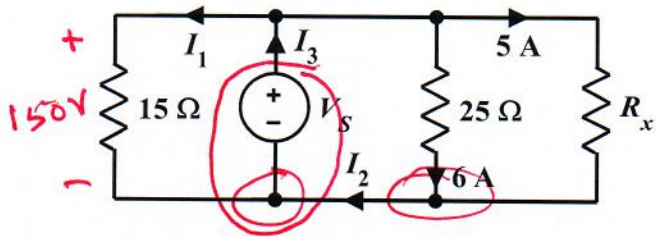
EE/EET 2240

Homework Problem #006

For the circuit shown below:



a. Determine the value of V_S.

150 V

b. Determine the value of I_1.

10 A

c. Determine the value of I_2.

11 A

d. Determine the value of I_3.

21A

e. Determine the value of R_x.

30 Ω

f. How much power does the 15Ω resistor absorb?

1500 W

g. How much power does the 25Ω resistor absorb?

900 W

h. How much power does R_x absorb?

750 W

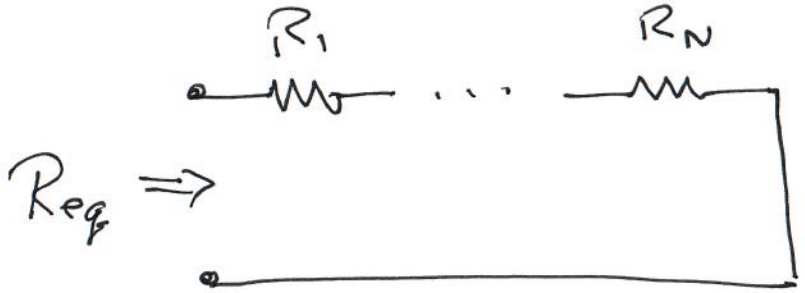
i. How much power does the independent voltage source deliver?

3150 W

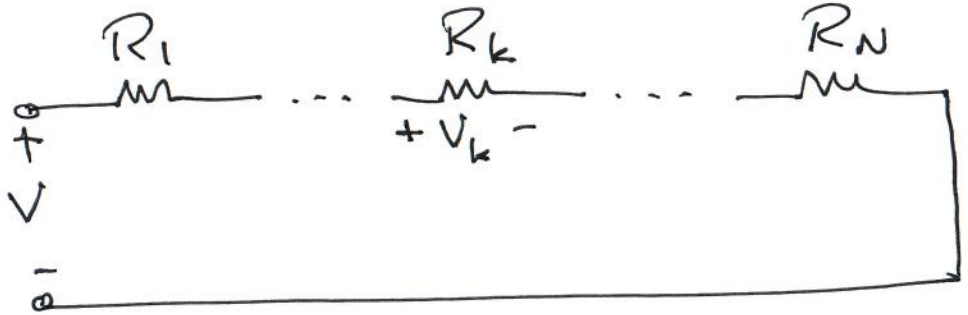
j. Verify that power is conserved.

✓

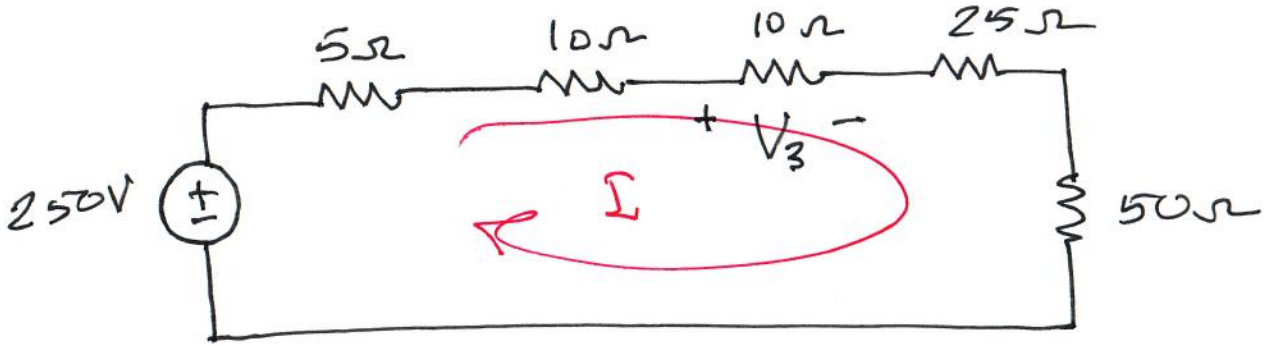
1500 + 900 + 750 = 3150



$$R_{eq} = R_1 + \cdots + R_N$$



$$\frac{V_k}{V} = \frac{R_k}{R_1 + \cdots + R_N} \leftarrow R_{eq}$$

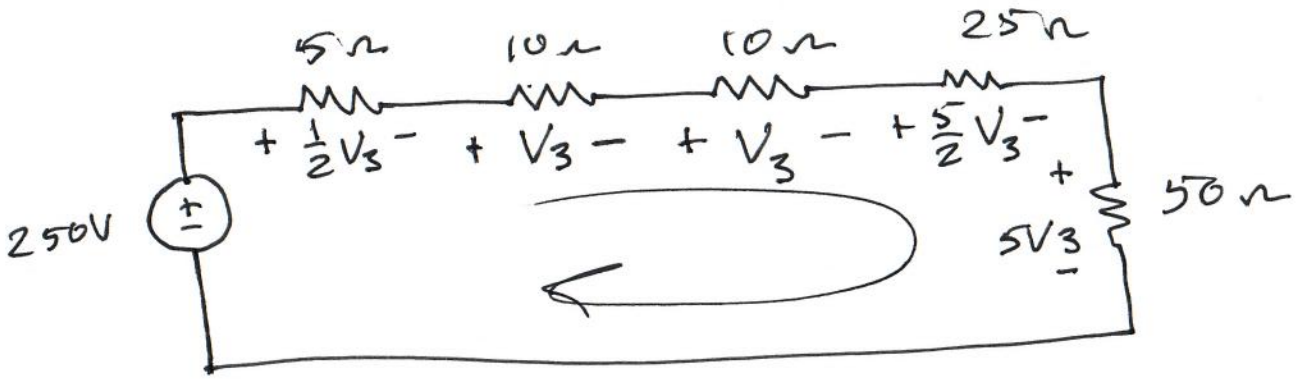


$$\frac{V_3}{250V} = \frac{10\Omega}{5\Omega + 10\Omega + 10\Omega + 25\Omega + 50\Omega} = \frac{10}{100} = \frac{1}{10}$$

$$V_3 = \frac{1}{10}\,250 = 25V$$

$$I = \frac{250V}{100\Omega} = 2.5A$$

$$V_3 = (10\Omega)\,I = 25V$$

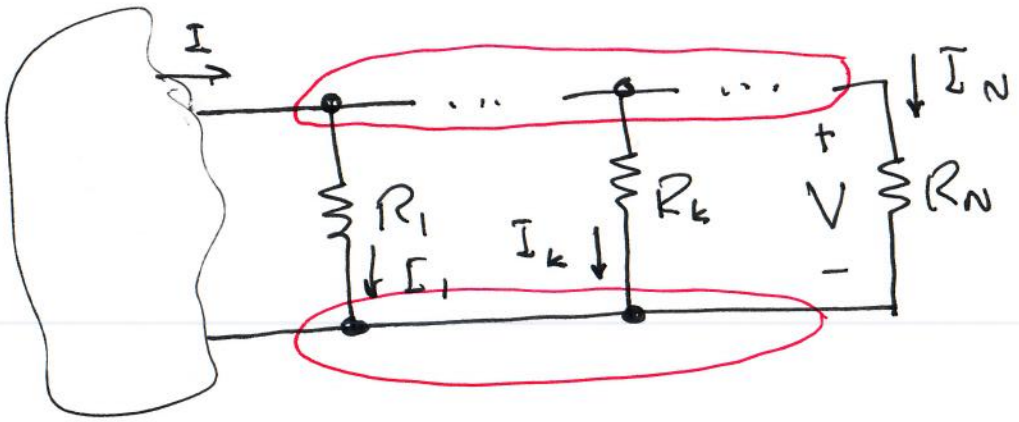


KVL: $\frac{1}{2}V_3 + V_3 + V_3 + \frac{5}{2}V_3 + 5V_3 = 250$

$10V_3 = 250$

$V_3 = 25V$

Parallel Resistors



$$I_N = \frac{V}{R_N}$$
$$\vdots$$
$$I_k = \frac{V}{R_k}$$
$$\vdots$$
$$I_1 = \frac{V}{R_1}$$

$$I_1 + \cdots + I_k + \cdots + I_N = I$$

$$\frac{V}{R_1} + \cdots + \frac{V}{R_k} + \cdots + \frac{V}{R_N} = I$$

$$\left(\frac{1}{R_1} + \cdots + \frac{1}{R_k} + \cdots + \frac{1}{R_N}\right) V = I$$

$$V = \frac{I}{\left(\frac{1}{R_1} + \cdots + \frac{1}{R_k} + \cdots + \frac{1}{R_N}\right)}$$

$$\frac{1}{(1/R_{eq})}$$

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

equivalent conductance

$$\frac{I_k}{I} = \frac{\frac{1}{R_k} V}{\left(\frac{1}{R_1} + \cdots + \frac{1}{R_k} + \cdots + \frac{1}{R_N}\right) V}$$

current divider

For resistors connected in series:

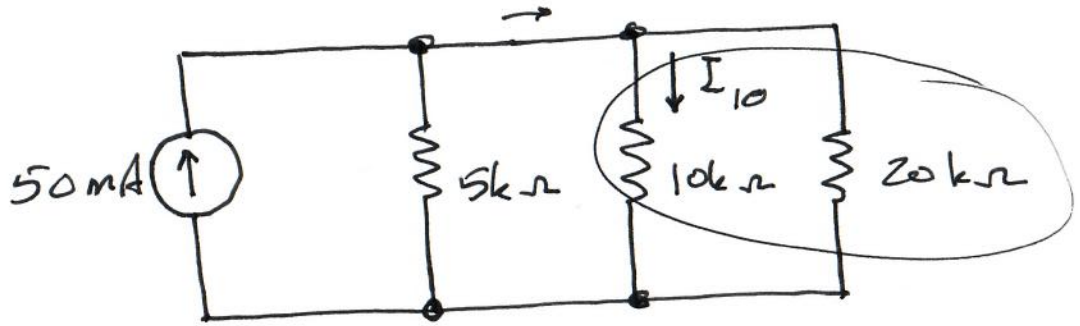
values add

$$R_{eq} = R_1 + \cdots + R_N$$

For resistors connected in parallel:

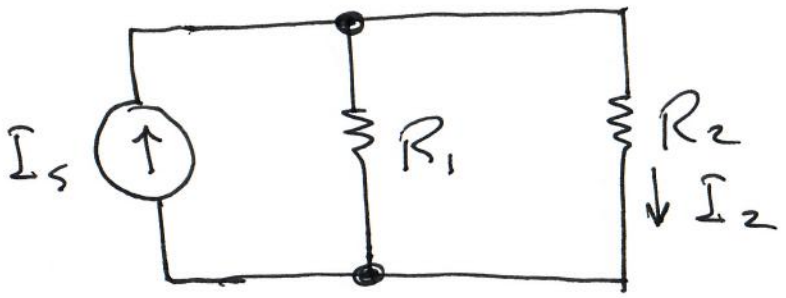
inverse values add to give inverse resistance

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



$$\frac{I_{10}}{50\,mA} = \frac{\frac{1}{10k\Omega}}{\frac{1}{5k\Omega} + \frac{1}{10k\Omega} + \frac{1}{20k\Omega}} = \frac{2}{7}$$

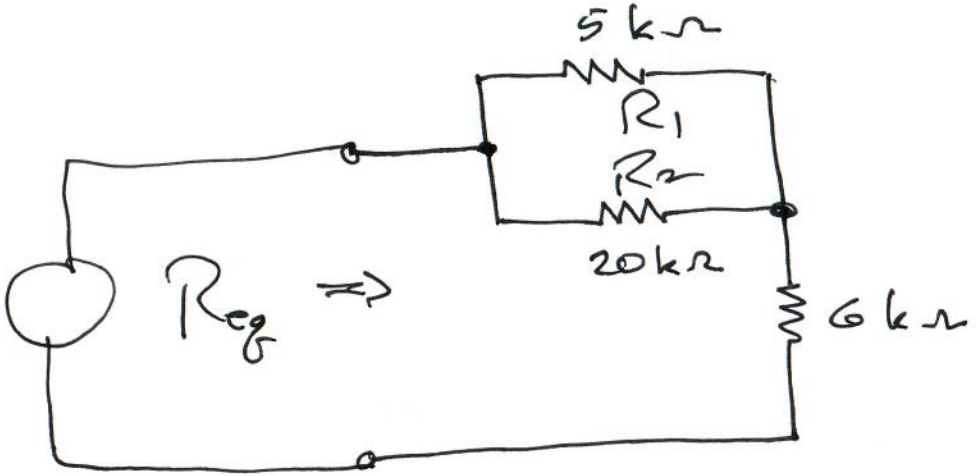
$$I_{10} = \frac{100}{7}\,mA$$



$$\frac{I_2}{I_s} = \frac{\frac{1}{R_2}}{\frac{1}{R_1}+\frac{1}{R_2}} \cdot \frac{R_2}{R_2} = \frac{1}{\frac{R_2}{R_1}+1}$$

$$\boxed{\frac{I_2}{I_s} = \frac{R_1}{R_1+R_2}}$$

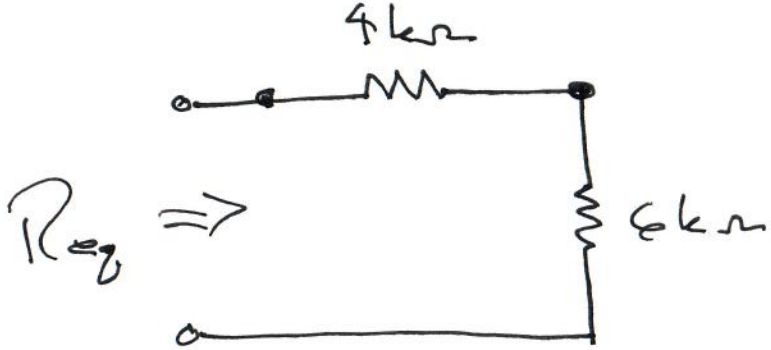
$$I_2 = \frac{R_1}{R_1+R_2}\, I_s$$



$$\frac{1}{R_{eq}} = \frac{1}{5k\Omega} + \frac{1}{20k\Omega}$$

$$\frac{1}{R_{eq}} = \frac{5}{20k\Omega} = \frac{1}{4k\Omega}$$

$$R_{eq} = 4k\Omega$$



$$R_{eq} = 10k\Omega$$

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

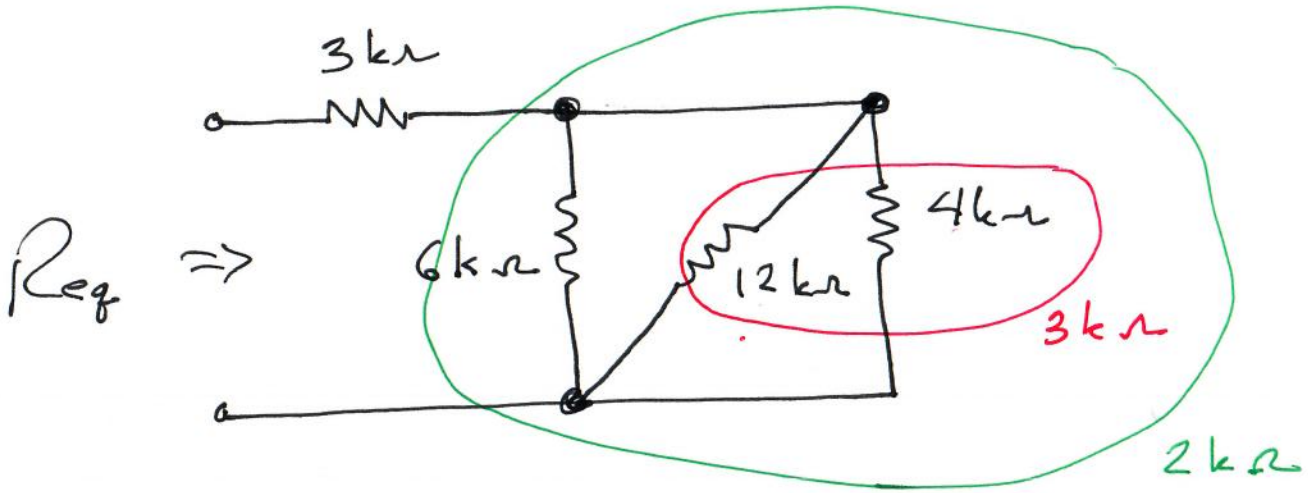
$$R_{eq} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}} \frac{R_1 R_2}{R_1 R_2}$$

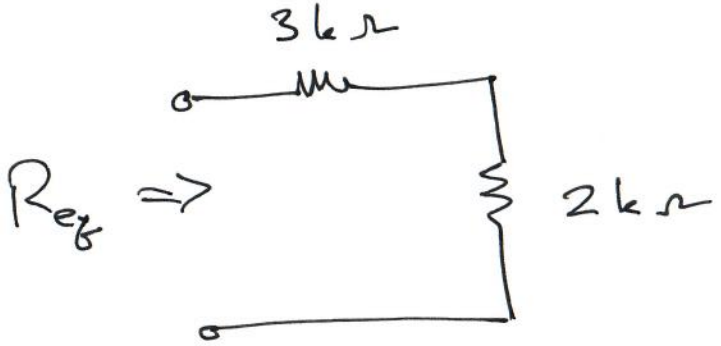
$$R_{eq} = \frac{R_1 R_2}{R_2 + R_1}$$

$$R_{eq} = \frac{(5k\Omega)(20k\Omega)}{5k\Omega + 20k\Omega}$$

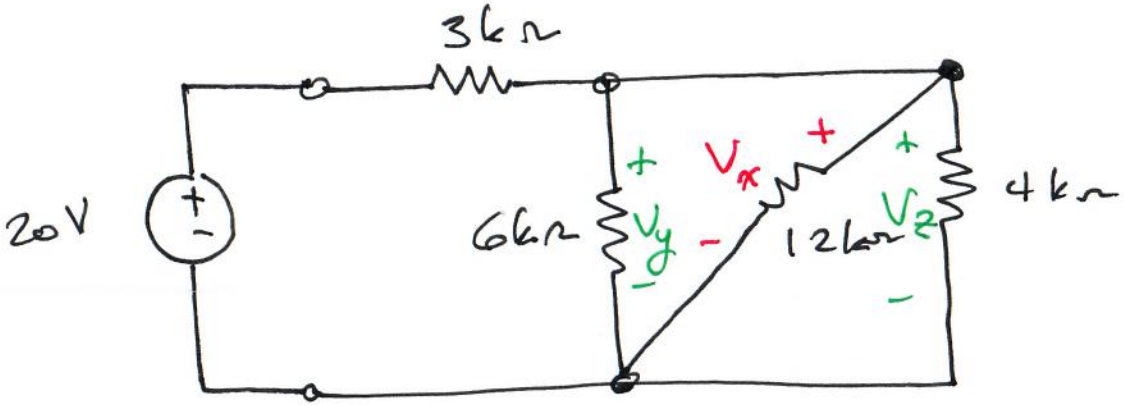
$$= \frac{100k^2\Omega^2}{25k\Omega}$$

$$= 4k\Omega$$





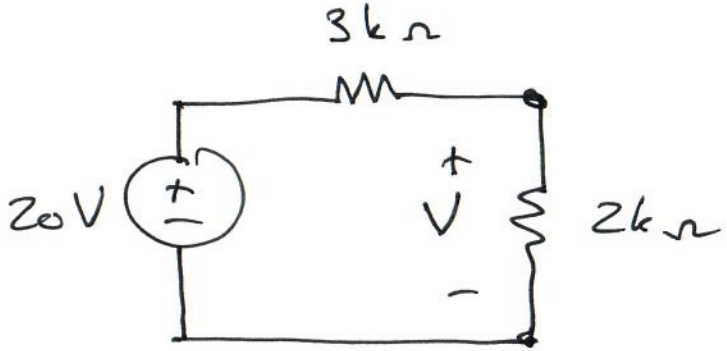
$R_{eq} = 5\,k\Omega$



$V_x = V$

$V_y = V$

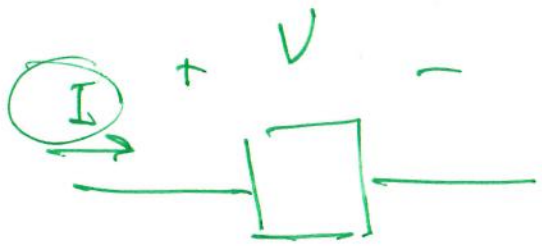
$V_z = V$



$$V = \frac{2k\Omega}{3k\Omega + 2k\Omega} \cdot 20V$$

$$= 8V$$

$$P_{4k\Omega} = \frac{V_z^2}{4k\Omega} = \frac{(8V)^2}{4k\Omega} = 16mW$$



absorbs