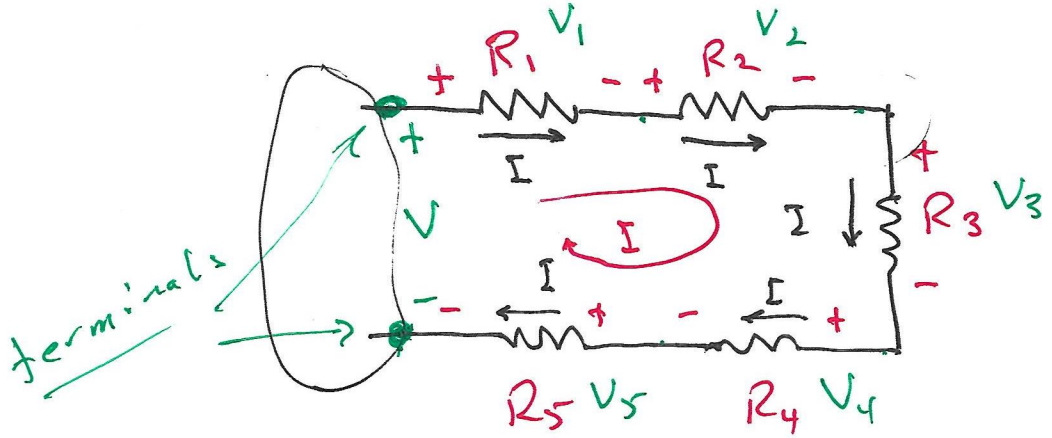
Equivalent

Series Resistors



All ~~resistors~~ components have the same current.

$$-V + V_1 + V_2 + V_3 + V_4 + V_5 = 0 \qquad \text{(KVL)}$$

$$V_2 = R_2 I$$

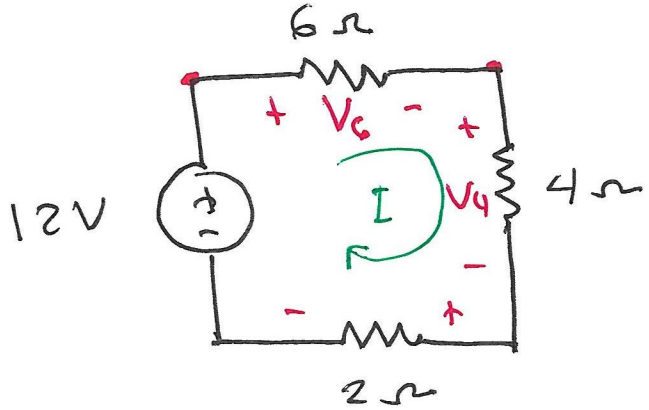
$$V = R_1 I + R_2 I + R_3 I + R_4 I + R_5 I$$

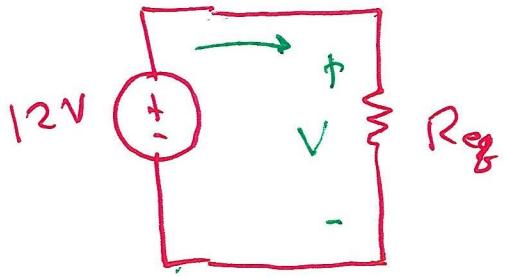
$$= \underbrace{(R_1 + R_2 + R_3 + R_4 + R_5)}_{R_{eq}} I$$

$$\frac{V_2}{V} = \frac{R_2 I}{R_{eq} I} = \frac{R_2}{R_{eq}}$$

$$\boxed{V_2 = \frac{R_2}{R_{eq}} V}$$ Voltage Divider

Example

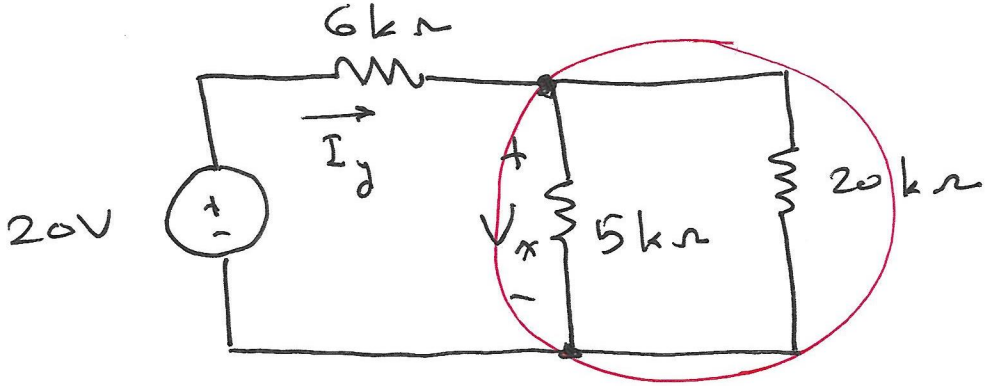




$$V_6 = \frac{6\Omega}{6\Omega + 4\Omega + 2\Omega} \cdot 12V = 6V$$

$$I = \frac{6V}{6\Omega} = 1A$$

$$V_4 = \frac{4\,\Omega}{12\,\Omega} \cdot 12\,V = 4\,V$$



Determine:

a. V_x

b. I_y

c. Power delivered to the 20kΩ resistor.

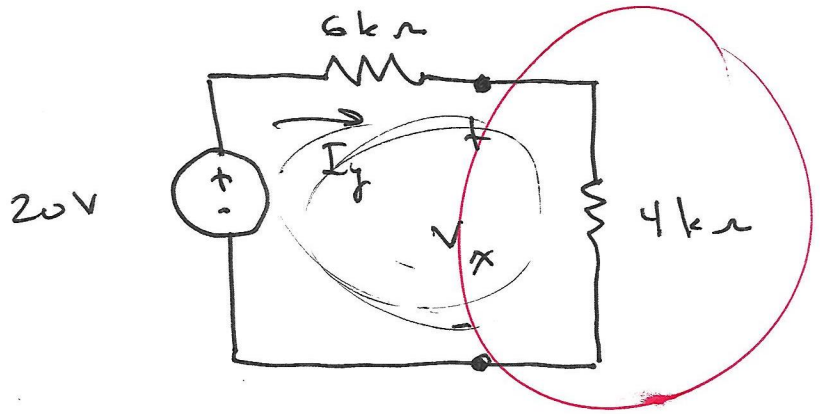
$$\frac{1}{R_{eq}} = \frac{1}{5k\Omega} + \frac{1}{20k\Omega}$$

(parallel resistor equivalent)

$$= \frac{4 + 1}{20k\Omega}$$

$$= \frac{1}{4k\Omega}$$

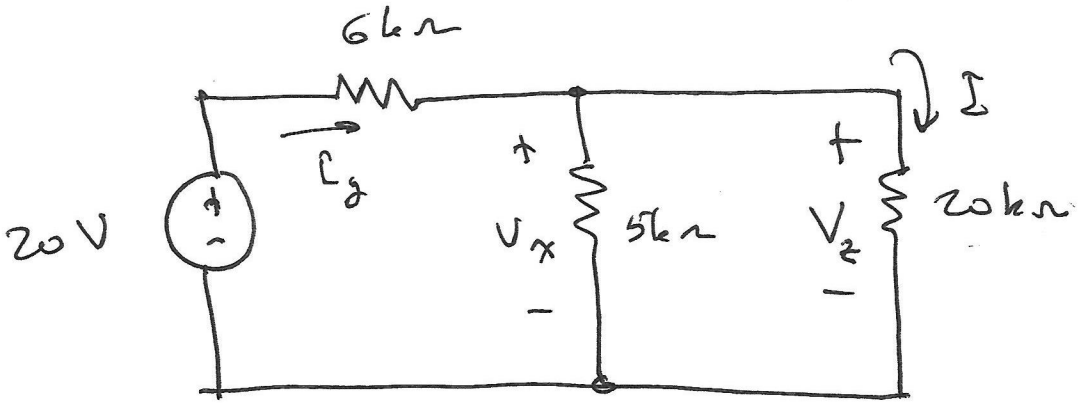
$$R_{eq} = 4k\Omega$$



$$V_x = \frac{4k\Omega}{6k\Omega + 4k\Omega} \cdot 20V$$

$$= 8V$$

$$I_y = \frac{V_x}{4k\Omega} = \frac{8V}{4k\Omega} = 2mA$$



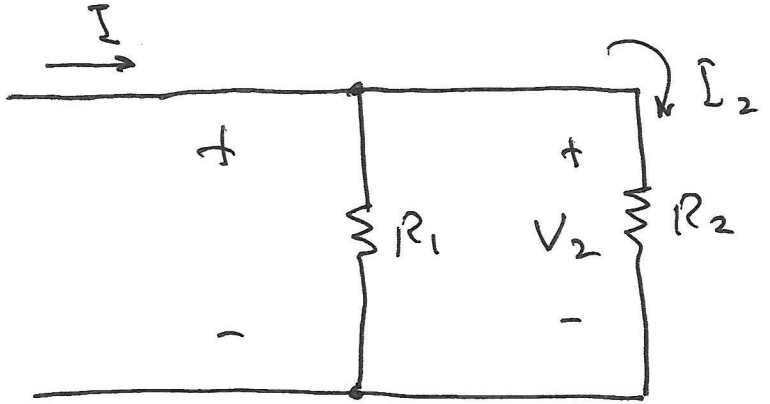
$$V_x = 8V, \quad I_g = 2mA$$

$$P_{20k\Omega} = V \cdot I = 8V \cdot \frac{V_z}{20k\Omega}$$

$$= 8V \cdot \frac{8V}{20k\Omega}$$

$$= \frac{64}{20} mW$$

$$= 3.2\ mW$$



Given I, determine I_2.

$$V_2 = R_2 I_2$$

also $$V_2 = R_{eq} I$$

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

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

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

This page was corrected after class.

$$R_2 I_2 = R_{eq} I$$

$$= \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}} I$$

$$\Rightarrow \frac{I_2}{I} = \frac{1}{R_2\left(\frac{1}{R_1} + \frac{1}{R_2}\right)} = \frac{1}{\frac{R_2}{R_1} + 1}$$

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

For 2 resistors: $R_{eq} = \frac{R_1 R_2}{R_1 + R_2}$

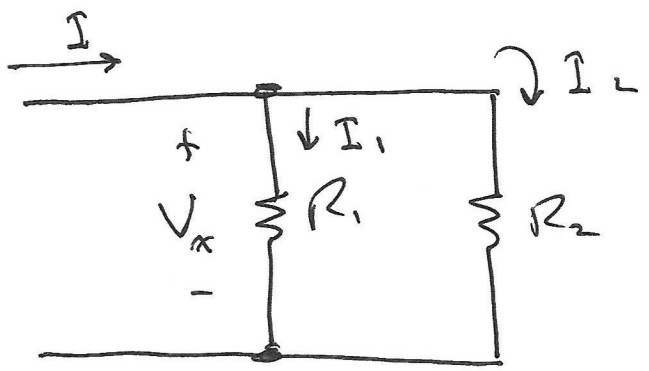
$$\Rightarrow G_{eq} = \frac{R_1 + R_2}{R_1 R_2}$$

$$\frac{I_2}{I} = \frac{R_1}{R_1 + R_2}$$

$$I_2 = \frac{R_1}{R_1 + R_2} I$$

Current Divider

Mind Reset



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

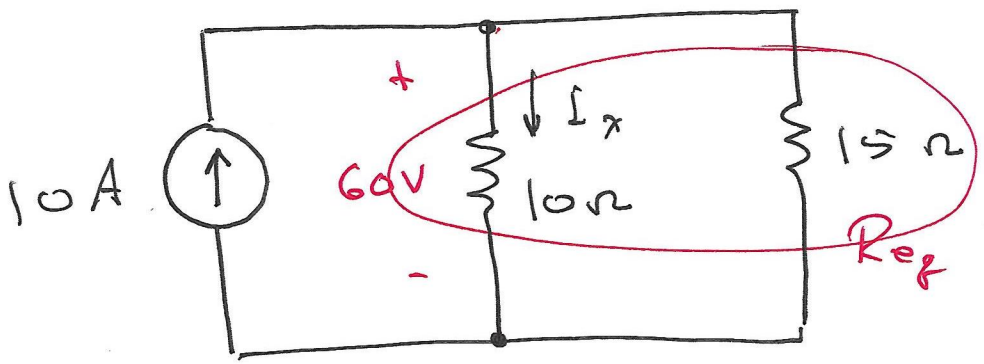
$$I = \frac{V_x}{R_{eq}} = \frac{V_x}{\left(\frac{R_1 R_2}{R_1 + R_2}\right)} = \frac{R_1 + R_2}{R_1 R_2} V_x$$

$$\frac{I_2}{I} = \frac{\frac{1}{R_2} V_x}{\left(\frac{R_1 + R_2}{R_1 R_2}\right) V_x} = \frac{R_1 \cancel{R_2} \frac{1}{\cancel{R_2}}}{R_1 + R_2}$$

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

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

Current Divider

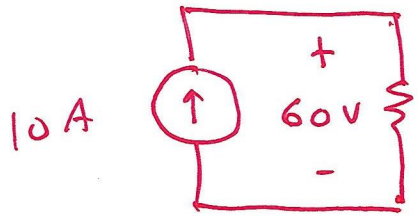


Determine the value of I_x.

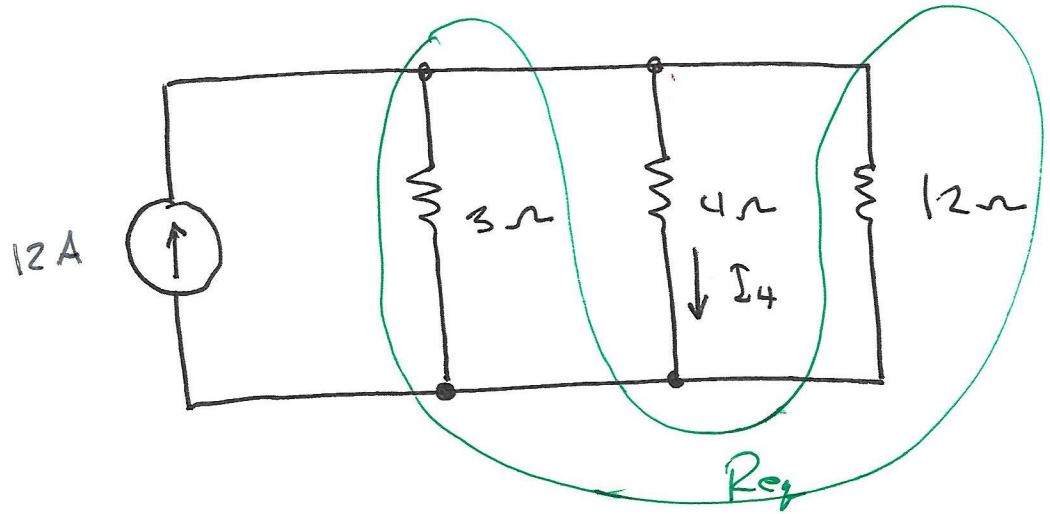
$$\frac{I_x}{10A} = \frac{15\Omega}{10\Omega + 15\Omega}$$

$$I_x = \frac{3}{5}\,10A = 6A$$

$$R_{eq} = \frac{10 \cdot 15}{10 + 15} = \frac{150}{25} = 6\Omega$$

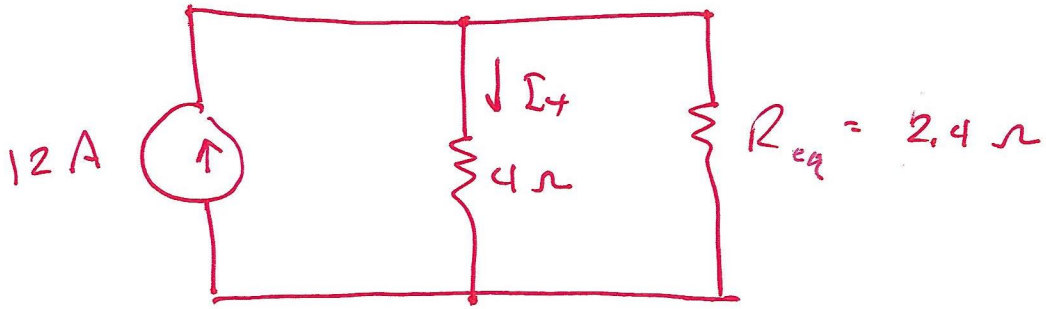


$$\Rightarrow I_x = \frac{60V}{10\Omega} = 6A$$



Determine the value of I_4.

$$R_{eq} = \frac{3 \cdot 12}{3 + 12} = \frac{36}{15} = \frac{12}{5} = 2.4\ \Omega$$



$$I_4 = \frac{2.4}{4 + 2.4} \cdot 12\,A$$

$$= \frac{2.4}{6.4} \cdot 12$$

$$= \frac{3}{8} \cdot 12 = \frac{36}{8} = 4.5\,A$$