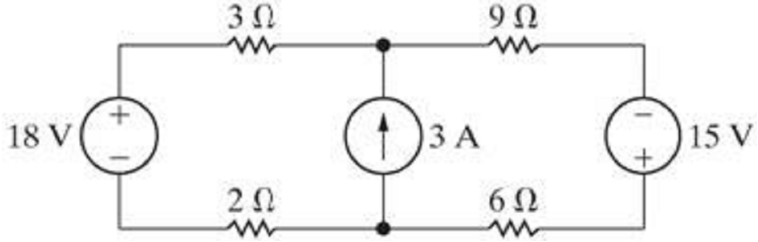
Homework Set #17
DUE Tuesday, April 25, 2017

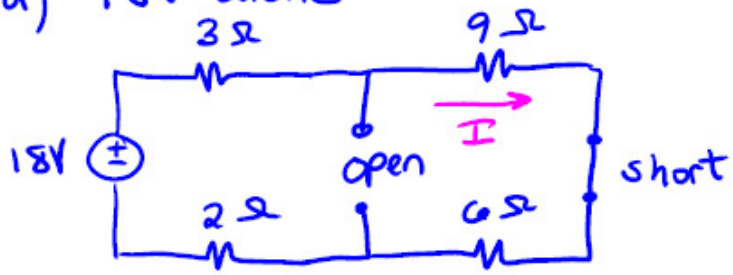
1. For the following circuit:



a. Use the principle of linear superposition to find the current through the 9Ω resistor (positive from left to right) for each source acting alone.
b. Now compute the current in the 9Ω resistor when the three sources are activated together. Demonstrate that this result is equal to the sum of the individual current responses.
c. Compute the power in the 9Ω resistor due to each source acting alone and when the three sources are activated together. Does superposition hold for power calculations?

(Hint: you analyzed this circuit before in Homework 12)

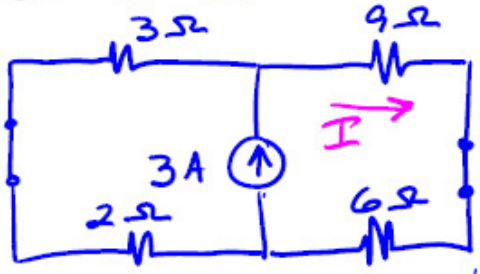
a) 18 V alone



KVL) $18 = I(3+9+6+2)$

$I|_{18V} = 0.9\ A$

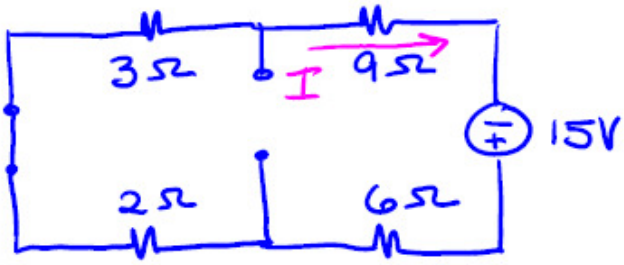
3A alone



curr div) $I = 3\,\dfrac{(9+6)\,//\,(3+2)}{(9+6)}$

$I|_{3A} = 0.75A$

15V alone



$15 = I(6+2+3+9)$

$I\big|_{15} = 0.75\,A$

$I = 0.9 + 0.75 + 0.75$

$\boxed{I = 2.4\,A}$

b) Find I with all sources acting together

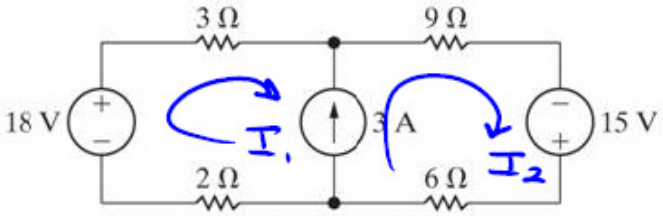


Figure: 04-69-39P4.47

mesh 1+2) $-18 + I_1(3+2) + I_2(9+6) - 15 = 0$

super mesh) $3 = I_2 - I_1$

$$\begin{bmatrix} 5 & 15 \\ -1 & 1 \end{bmatrix}\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 33 \\ 3 \end{bmatrix}$$

$I_1 = -0.6\,A$

$I_2 = 2.4\,A$ same!

c) Power is not linear so $\boxed{P_T = 2.4^2(9) = 15.84\,W}$

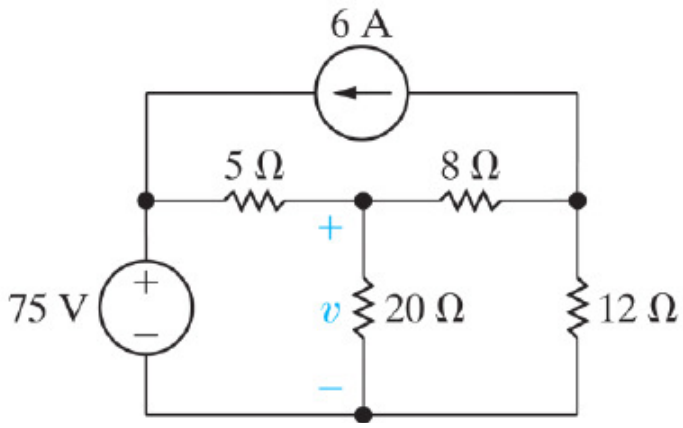
$P_{18} = 0.9^2(9) = 7.29$

$P_3 = 0.75^2(9) = 5.063$

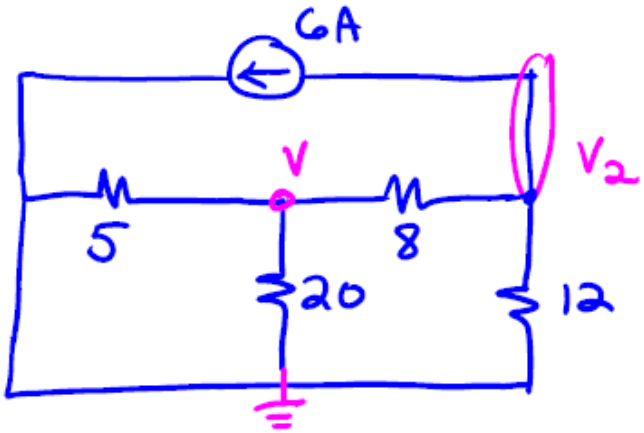
$P_{15} = 0.75^2(9) = 5.063$

$17.42\,W \neq 15.84\,W$

2. For the following circuit:
   a) Use the principle of superposition to find the voltage *v*
   b) Find the power dissipated in the 20 Ω resistor.



6A source only



KCL V: $\frac{V}{5} + \frac{V}{20} + \frac{V - V_2}{8} = 0$

KCL V2: $\frac{V_2 - V}{8} + \frac{V_2}{12} + 6 = 0$

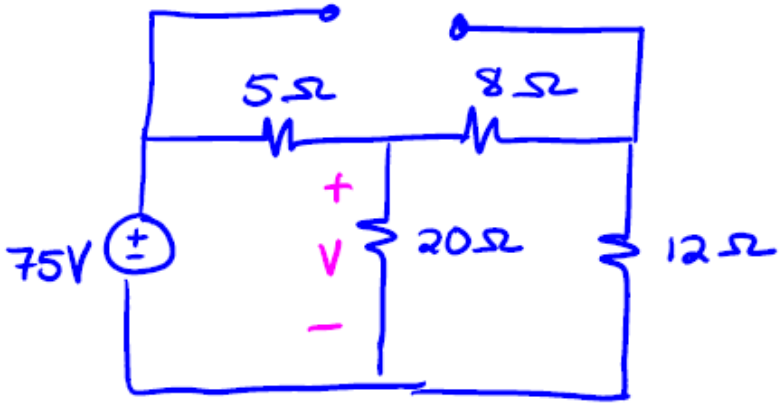
$$\begin{bmatrix} \frac{1}{5} + \frac{1}{20} + \frac{1}{8} & -\frac{1}{8} \\ -\frac{1}{8} & \frac{1}{8} + \frac{1}{12} \end{bmatrix} \begin{bmatrix} V \\ V_2 \end{bmatrix} = \begin{bmatrix} 0 \\ -6 \end{bmatrix}$$

$V = -12V$

$V_2 = -36V$

$V\big|_{6A} = -12V$

For 75V source acting alone



Volt div)

$$V = 75\,\frac{20 \,||\, (8+12)}{5 + 20 \,||\, (8+12)}$$

$V\big|_{75V} = 50V$

$V = -12 + 50$

$\boxed{V = 38V}$

b) $P = \frac{38^2}{20}$

$\boxed{P = 72.2\ W}$