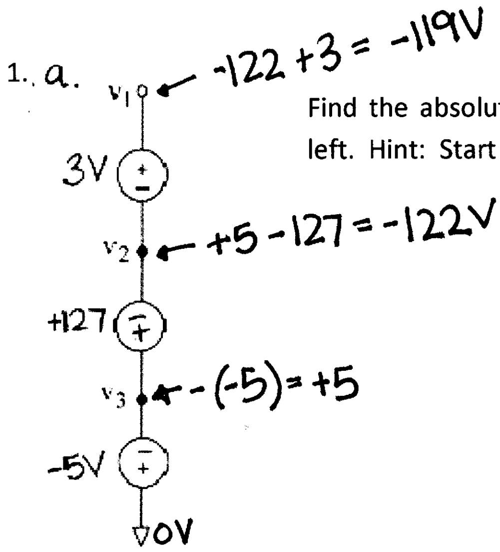
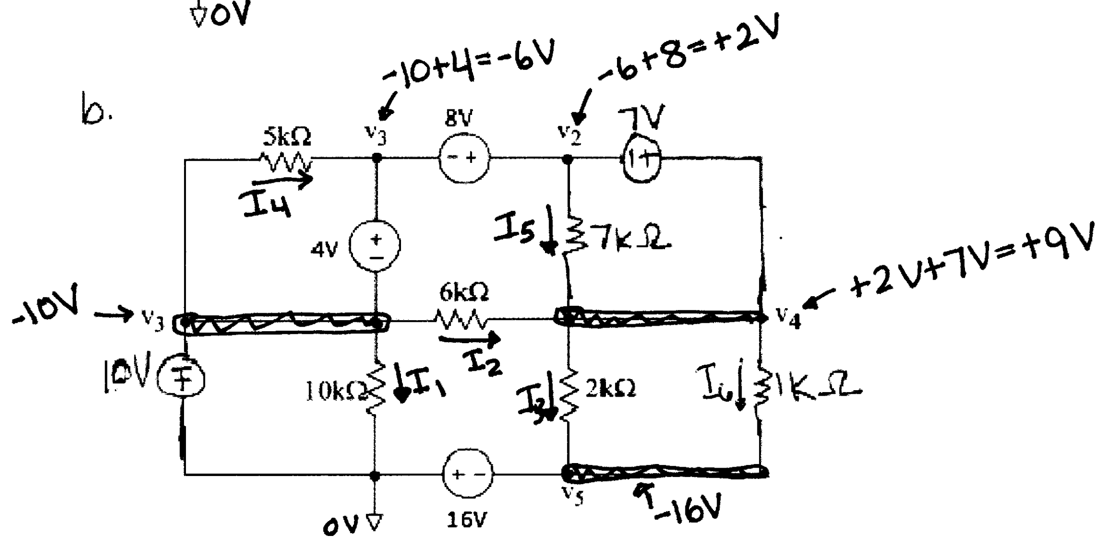
1. a.



Find the absolute voltages at all the labeled nodes in the circuit at the left. Hint: Start at the bottom(which is 0V) and work upwards.

b.



Find the absolute voltages at all the labeled nodes in the above circuit. Hint: This may be done by inspection.

c. Using Ohm's law and the node voltages found in part b, find the currents for all the resistors in part b.

$$I_1 = \frac{-10}{10K} = -1mA$$

$$I_2 = \frac{-10-(9)}{6K} = -\frac{19}{6}mA$$

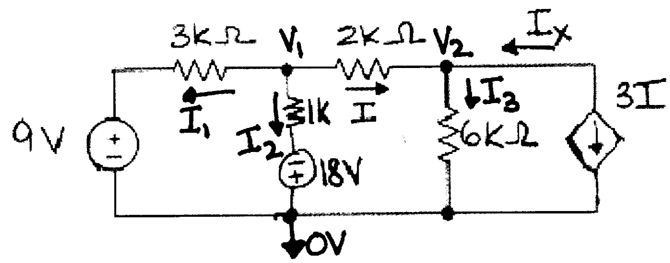
$$I_3 = \frac{+9-(-16)}{2K} = \frac{+25}{2}mA$$

$$I_4 = \frac{-10-(-6)}{5K} = -\frac{4}{5}mA$$

$$I_5 = \frac{2-9}{7K} = -1mA$$

$$I_6 = \frac{+9-16}{1K} = -7mA$$

4.



a. Use the node-voltage method to determine I_X.

b. Determine the amount of power in the dependent source.

$$I_1 = \frac{V_1 - 9}{3K}, \quad I_2 = \frac{V_1 - (-18)}{1K}, \quad I_3 = \frac{V_2}{6K}, \quad I = \frac{(V_1 - V_2)}{2K}$$

① at V_1: $$\frac{(V_1 - 9)}{3k} + \frac{V_1 - (-18)}{1k} + \frac{(V_1 - V_2)}{2k} = 0$$

② at V_2: $$-\frac{(V_1 - V_2)}{2K} + \frac{V_2}{6K} + 3 \cdot I = 0$$

① $$V_1 \underbrace{\left(\frac{1}{3K} + \frac{1}{1K} + \frac{1}{2K}\right)}_{1.83m} - \frac{V_2}{2K} = -18m + 3m$$

#4. ① $V_1(1.83m) - \frac{V_2}{2k} = -15m$

$$V_1 = \frac{V_2}{2k \cdot 1.83m} - \frac{15m}{1.83m} = 273m \cdot V_2 - 8.2$$

plug into ②

$$-\frac{1}{2k} \cdot (273m \cdot V_2 - 8.2) + \frac{V_2}{2k} + \frac{V_2}{6k} + \frac{3 \cdot (273m \cdot V_2 - 8.2)}{2k} - \frac{3V_2}{2k} = 0$$

$$V_2(136.5\mu + 500\mu + 166.7\mu + 409.5\mu - 1.5m) = -4.1m + 12.3m$$

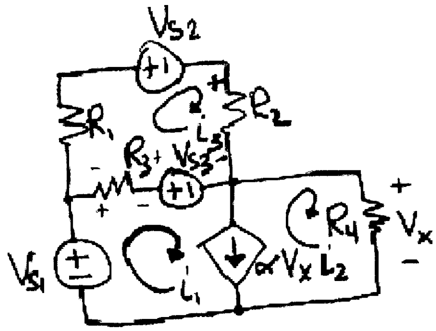
$$V_2 = \frac{8.2m}{-287.3\mu} = -28.5V$$

$$V_1 \simeq -16$$

$$I_x = -3I = -3\frac{(V_1 - V_2)}{2k} = \frac{-3(-16 + 28.5)}{2k} = \boxed{-18.75mA}$$

$$\text{power} = 3 \cdot I \cdot V_2 = -I_x \cdot V_2 = 18.75m \cdot (-28.5) = \boxed{-534mW}$$

5.



Use the mesh-current method to find i_1 and i_2, and i_3.

① $\alpha V_x = i_1 - i_2$

$V_x = +i_2 R_4$

② $+ V_{S1} + (i_3 - i_1)R_3 - V_{S3} - i_2 R_4 = 0$

③ $+V_{S3} + (i_1 - i_3)R_3 - i_3 R_1 - V_{S2} - i_3 R_2 = 0$

① $i_1 = i_2(\alpha R_4 + 1)$

plug into ②

$V_{S1} + i_3 R_3 - i_2 R_3(\alpha R_4 + 1) - V_{S3} - i_2 R_4 = 0$

② $i_3 = \dfrac{V_{S3} - V_{S1} + i_2[R_4(\alpha R_3 + 1) + R_3]}{R_3}$

plug ①② into ③

$V_{S3} + i_2 R_3(\alpha R_4 + 1) - V_{S2} + (-R_3 - R_1 - R_2)\left[\dfrac{V_{S3} - V_{S1} + i_2[R_4(\alpha R_3 + 1) + R_3]}{R_3}\right] = 0$

#5. (cont.)

$$i_2'\left(R_3(\alpha R_4+1)-\frac{(R_1+R_2+R_3)}{R_3}\left[R_4(\alpha R_3+1)+R_3\right]\right)=-V_{S3}+V_{S2}+(R_1+R_2+R_3)\cdots$$

$$\cdots\left[\frac{V_{S3}}{R_3}-\frac{V_{S1}}{R_3}\right]$$

$$\boxed{i_2'=\frac{\left[-V_{S3}+V_{S2}+(R_1+R_2+R_3)\left[\frac{V_{S3}-V_{S1}}{R_3}\right]\right]\cdot R_3}{R_3(\alpha R_4+1)R_3-(R_1+R_2+R_3)\left[R_4(\alpha R_3+1)+R_3\right]}}$$

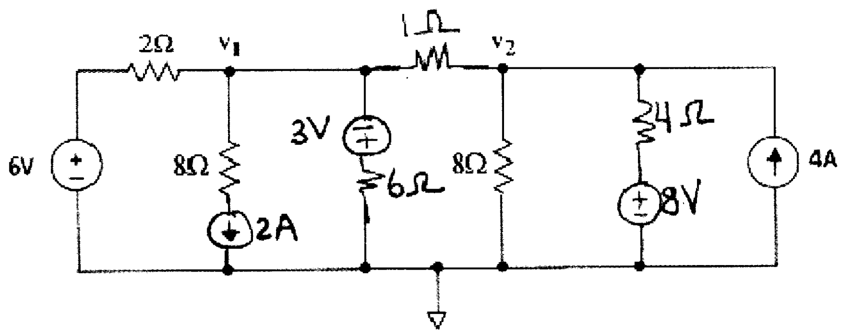
$\downarrow$ reduced

$$\boxed{i_2'=\frac{(-V_{S1}+V_{S2})R_3+(R_1+R_2\quad)(V_{S3}-V_{S1})}{-R_4(R_1+R_2+R_3)}}$$

$$\boxed{i_1'=\frac{\left[(V_{S2}-V_{S1})R_3+(V_{S3}-V_{S1})(R_1+R_2)\right](\alpha R_4+1)}{-R_4(R_1+R_2+R_3)}}$$

$$\boxed{i_3'=\frac{V_{S3}-V_{S1}}{R_3}+\left[\frac{(+V_{S2}-V_{S1})R_3+(R_1+R_2)(V_{S3}-V_{S1})}{-R_4(R_1+R_2+R_3)}\right]\cdot\frac{\left[R_4(\alpha R_3+1)+R_3\right]}{R_3}}$$

6.



a. Use the node-voltage method to find v_1 and v_2.

b. Determine the amount of power supplied by the 6V voltage source.

7. Use the mesh current method to solve Problem 6 to find v_1 and v_2.

① $$\frac{V_1-6}{2} + 2 + \frac{V_1+3}{6} + \frac{(V_1-V_2)}{1} = 0$$

② $$\frac{V_2-V_1}{1} + \frac{V_2}{8} + \frac{(V_2-8)}{4\Omega} - 4 = 0$$

From ①: $$V_1\left(\frac{1}{2}+\frac{1}{6}+1\right) = +3-2+\frac{1}{2}+V_2$$

$$V_1\underbrace{\left(\frac{3}{6}+\frac{1}{6}+\frac{6}{6}\right)}_{\frac{10}{6}} = \frac{6}{2}-\frac{4}{2}+\frac{1}{2}+V_2 = \frac{3}{2}+V_2$$

$$V_1 = \frac{3}{2}\cdot\frac{6}{10} + V_2\cdot\frac{6}{10} = \frac{9}{10}+\frac{3}{5}\cdot V_2$$

plugging into ②:

$$V_2\left(1+\frac{1}{8}+\frac{1}{4}\right) - \frac{9}{10} - \frac{3}{5}\cdot V_2 = +2+4$$

$$V_2\left[\frac{40}{40}+\frac{5}{40}+\frac{10}{40}-\frac{24}{40}\right] = \frac{9}{10}+\frac{20}{10}+\frac{40}{10}$$

$$V_2\left(\frac{31}{\cancel{40}}\right) = \frac{69}{10}\cdot\frac{40}{31} = 8.9V$$

#6. (cont.)

$V_2 = \boxed{8.9V}$

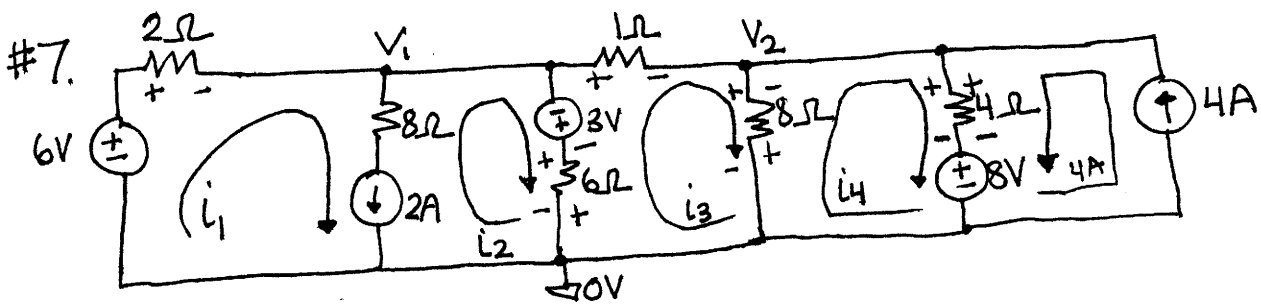
$V_1 = \frac{9}{10} + \frac{3}{5}(8.9) = \boxed{6.24V}$

power in 6V supply:

current $= \frac{V_1 - 6}{2} = \frac{6.24-6}{2} = -.120A$

$p = (+6)(-.120) = \boxed{-0.720W}$

#7.



① $2 = (i_1 - i_2)$

② $+6 - i_1(2) + 3 - i_2(6) + i_3(6) = 0$

③ $(+i_3 - i_4)8 - (i_4 + 4)4 - 8 = 0$

④ $+6 - i_1(2) - i_3 - (i_4 + 4)4 - 8 = 0$

From ① $i_1 = (2 + i_2)$, plug into ②: $6 - 2(2+i_2) + 3 - 6i_2 + i_3 6 = 0$

$+5 - 2i_2 - 6i_2 + 6i_3 = 0$

$+5 - 8i_2 + 6i_3 = 0 \rightarrow 6i_3 = \frac{8i_2 - 5}{6}$

plug into ③

$\left(\frac{8i_2}{6} - \frac{5}{6}\right)8 - i_4 \cdot 8 - 4i_4 - 16 - 8 = 0$

$i_4 = \frac{\left[+24 + \frac{40}{6} - \frac{64i_2}{6}\right]}{-12} = -2 - \frac{10}{6 \cdot 3} + \frac{64i_2}{6 \cdot 12}$

plug all into ④:

#6. (cont.)

$$+6-2(2+i_2)-\frac{8}{6}i_2-\frac{5}{6}-4\left(-2-\frac{10}{18}+\frac{64i_2}{6\cdot 12}\right)-16-8=0$$

$$i_2\left(-2-\frac{8}{6}-\frac{4(64)}{6\cdot 12}\right)=-6+4+\frac{5}{6}-8-\frac{40}{18}+16+8$$

$$-i_2(3.3+3.556)=+14+0.833-2.22$$

$$i_2=\frac{+12.61}{-6.856}=-1.84$$

$$i_1=2+i_2=+0.160$$

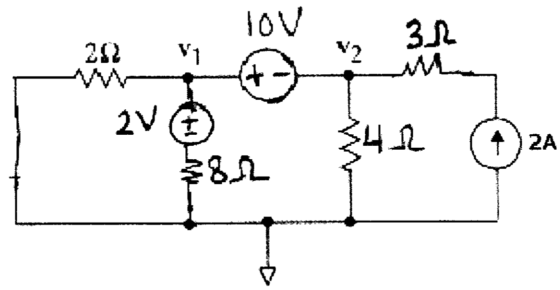
$$i_3=\frac{8(-1.84)-5}{6}=-3.3$$

$$i_4=-2-\frac{10}{18}+\frac{64(-1.84)}{6\cdot 12}=-2-0.556-1.64=-4.2$$

$$V_1=+6-2(i_1)=\boxed{+5.68V}$$

$$V_2=(+i_3-i_4)8=(-3.3+4.2)8=\boxed{+7.2V}$$

8.



Use either the node-voltage method or current mesh method to find v_1 and v_2.

$$\frac{V_1}{2} + \frac{(V_1-2)}{8} + \frac{V_2}{4} - 2 = 0$$

$$(+V_1 - V_2) = +10$$

$$V_1 = 10 + V_2$$

$$\frac{10}{2} + \frac{V_2}{2} + \frac{10}{8} + \frac{V_2}{8} - \frac{1}{4} + \frac{V_2}{4} - 2 = 0$$

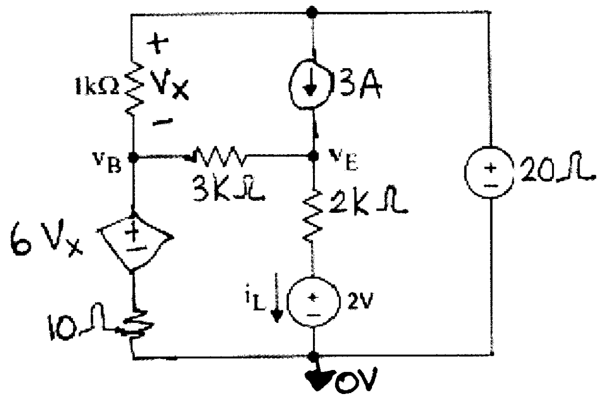
$$V_2\left(\frac{1}{2} + \frac{1}{8} + \frac{1}{4}\right) = -5 - \frac{10}{8} + \frac{1}{4} + 2$$

$$V_2\underbrace{\left(\frac{4}{8} + \frac{1}{8} + \frac{2}{8}\right)}_{\frac{7}{8}} = \frac{-40 - 10 + 2 + 16}{8} = -\frac{4(8)}{7}$$

$$\boxed{V_2 = -4.57V}$$

$$\boxed{V_1 = +5.43V}$$

9.



Use the node-voltage method to find v_1 and v_2.

10. Solve Problem 9 using the mesh current method to find v_1 and v_2.

#9. $$\frac{(V_B-6V_x)}{10}+\frac{(V_B-V_E)}{3K}+\frac{(V_B-20)}{1K}=0$$

$$(20-V_B)=V_x$$

① $$\frac{(V_B-6(20-V_B))}{10}+\frac{(V_B-V_E)}{3K}+\frac{(V_B-20)}{1K}=0$$

② $$\frac{(V_E-V_B)}{3K}-3+\frac{(V_E-2)}{2K}=0$$

$$V_E\left(\frac{1}{3k}+\frac{1}{2K}\right)=\frac{V_B}{3K}+3+\frac{1}{1K}$$

$$V_E(333\mu+500\mu)=333\mu V_B+3.001$$

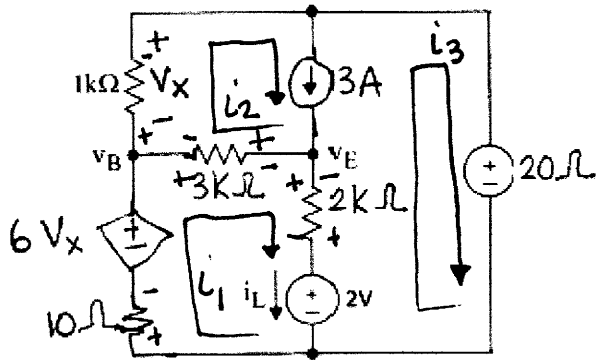
$$V_E=0.4V_B+3.6K$$

plug into ①: $$\frac{V_B}{10}-\frac{120}{10}+\frac{6V_B}{10}+\frac{V_B}{3K}-\frac{0.4V_B}{3K}-\frac{3.6K}{3K}+\frac{V_B}{1K}-\frac{20}{1K}=0$$

$$V_B\left(\frac{1}{10}+\frac{6}{10}+\frac{1}{3K}-\frac{0.4}{3K}+\frac{1}{1K}\right)=+12+\frac{3.6K}{3K}+\frac{20}{1K}$$

$$V_B(0.7)=13.22\rightarrow \boxed{\begin{matrix}V_B=18.9V\\ V_E\doteq 3.6K\end{matrix}}$$

9.



Use the node-voltage method to find v_1 and v_2.

10. Solve Problem 9 using the mesh current method to find v_1 and v_2.

#10. ① $3 = i_2 - i_3 \longrightarrow i_3 = (i_2 - 3)$

$V_x = -i_2(1k)$

② $-i_1(10) + 6(-i_2(1k)) - i_2(1k) - 20 = 0$

③ $-i_1(10) + 6(-i_2(1k)) + 3k(i_2 - i_1) + 2k(+i_3 - i_1) - 2 = 0$

plug ① into ③:

$-i_1(10) - i_2(6k) + i_2(3k) - i_1(3k) + 2k(i_2 - 3) - i_1(2k) - 2 = 0$

$i_1(-10 - 3k - 2k) = +2 + i_2(-6k + 3k + 2k) + 6k$

$i_1 = \dfrac{6{,}002 + i_2(-1k)}{-5{,}010}$

plug into ②:

$\left[-\dfrac{6{,}002 + i_2(-1k)}{-5{,}010}\right] \cdot 10 - 6k\,i_2 - 1k\,i_2 - 20 = 0$

$i_2\left(+\dfrac{1k \cdot 10}{5{,}010} - 6k - 1k\right) = +20 + \dfrac{6{,}002 \cdot 10}{-5{,}010}$

$i_2(-7k) = 8.02 \Rightarrow i_2 = -1.1m, \quad i_1 = 1.2mA, \quad i_3 \cong -3$

$V_B = +20 + i_2(1k) = \boxed{+18.9V}$