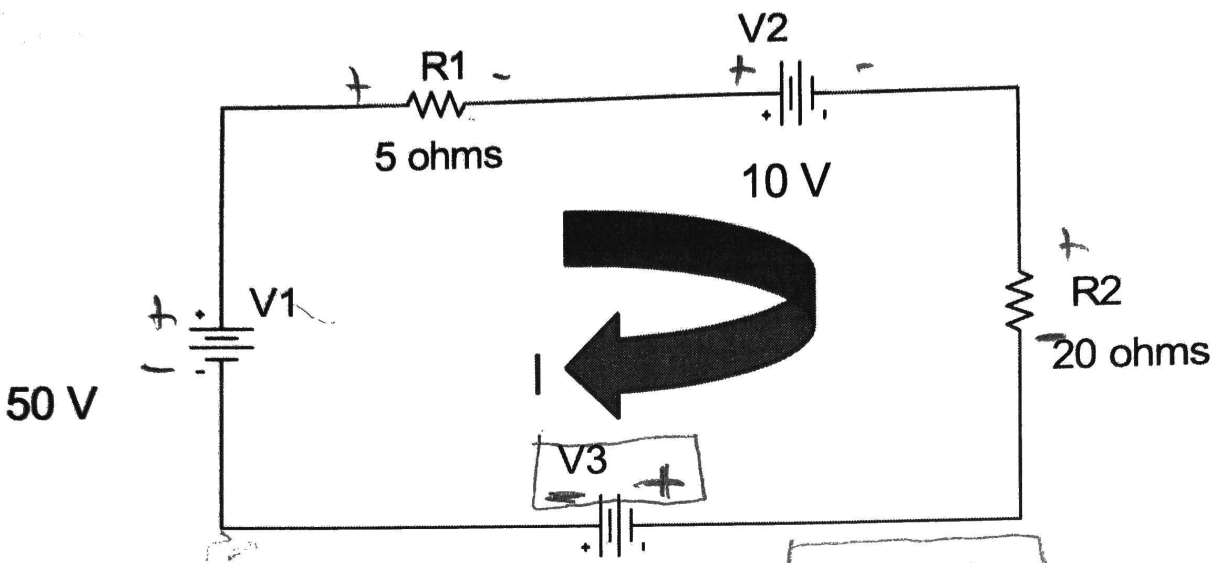
Saaif Ahmed

1) Polarity and KVL

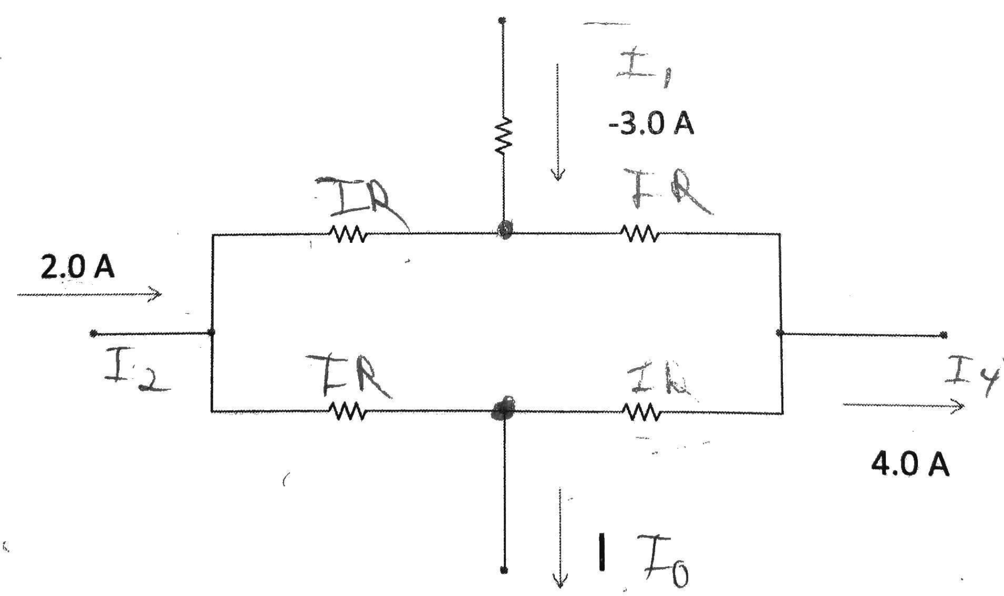
a. Find V3 and its polarity if the current I in the circuit of the figure below is 0.40 A.



$50 = (.4)5 - 10 - 20(.4) + V3 = 0$

$\boxed{V3 = -30}$

b. Find the current I for the circuit shown below. ***Note:* *There are no given values for the resistors, this is not a typo. Yes, you can still find I.***



make the entire circuit one node if equal resistance

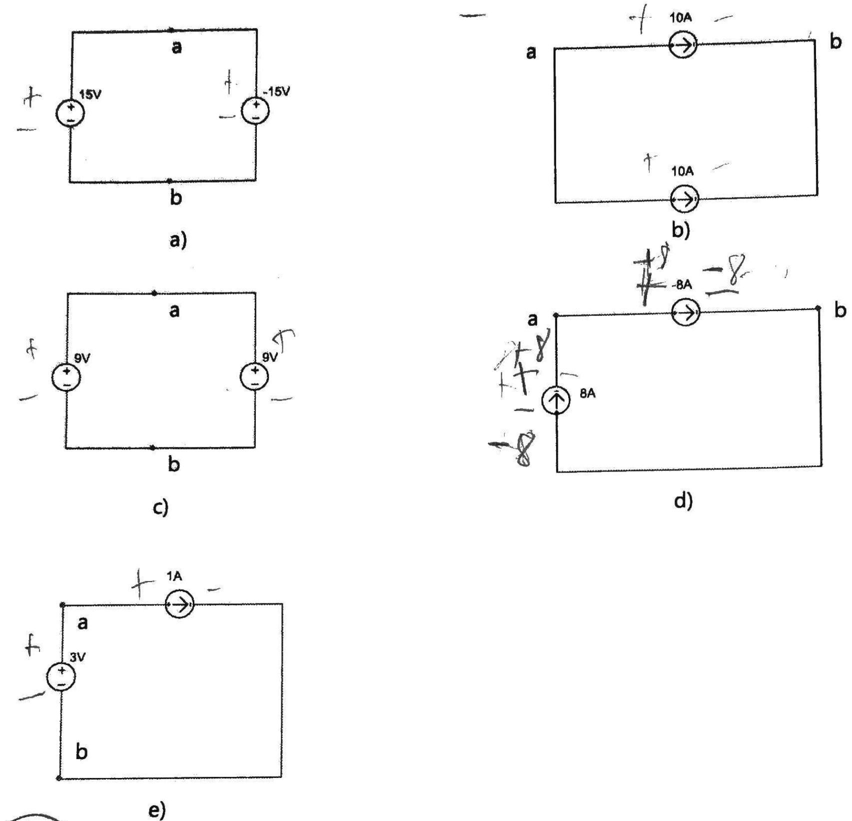
$-3 + 2 = I_0 + 4$

$-1 = I_0 + 4$

$\boxed{-5A = I_0}$

2) Source devices and Total Power

a) Using the definitions of the ideal indpendent voltage and current sources, state which interconnections in the figure below are permissible and which violate the contraints imposed by ideal sources (circle answer). Also state brief reasons why for all figures.



a. Valid / Violation

If you take KVL you end up with -30 instead of 0 which is impossible

b. Valid / Violation

KCL states current at a node must be 0. At point B it is 20A.

c. Valid / Violation

ab

if you take KVL you will end up with 0 so both locations are valid.

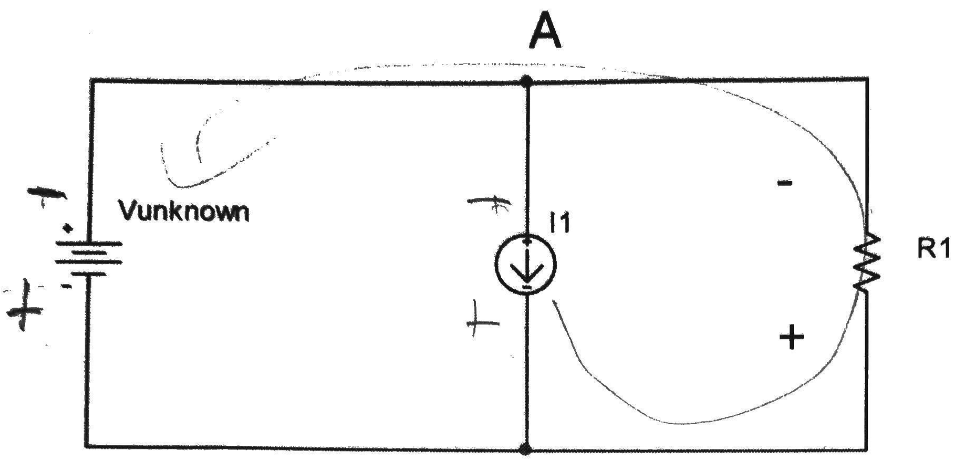
d. Valid / Violation

KCL states current at node must be 0. At point A due to the negative sign the current is 16A not 0A.

e. Valid / Violation

ab

because there are ideal sources each individual component is balanced within itself. The current source doesn't interfere with the voltage source and vice versa.



$I_1 := 6\text{mA}$

$R_1 := 5\text{k}\Omega$

$5000 * 6\text{mA} = 30\text{V}$

b) Determine a value of Vunknown such that the current through the voltage source is zero.

30 V

c) Considering your answer to part b), how much power is supplied by the current source?

$P = VI = RI^2 = 5000\,(6 \times 10^{-3})^2\ W = .18W$

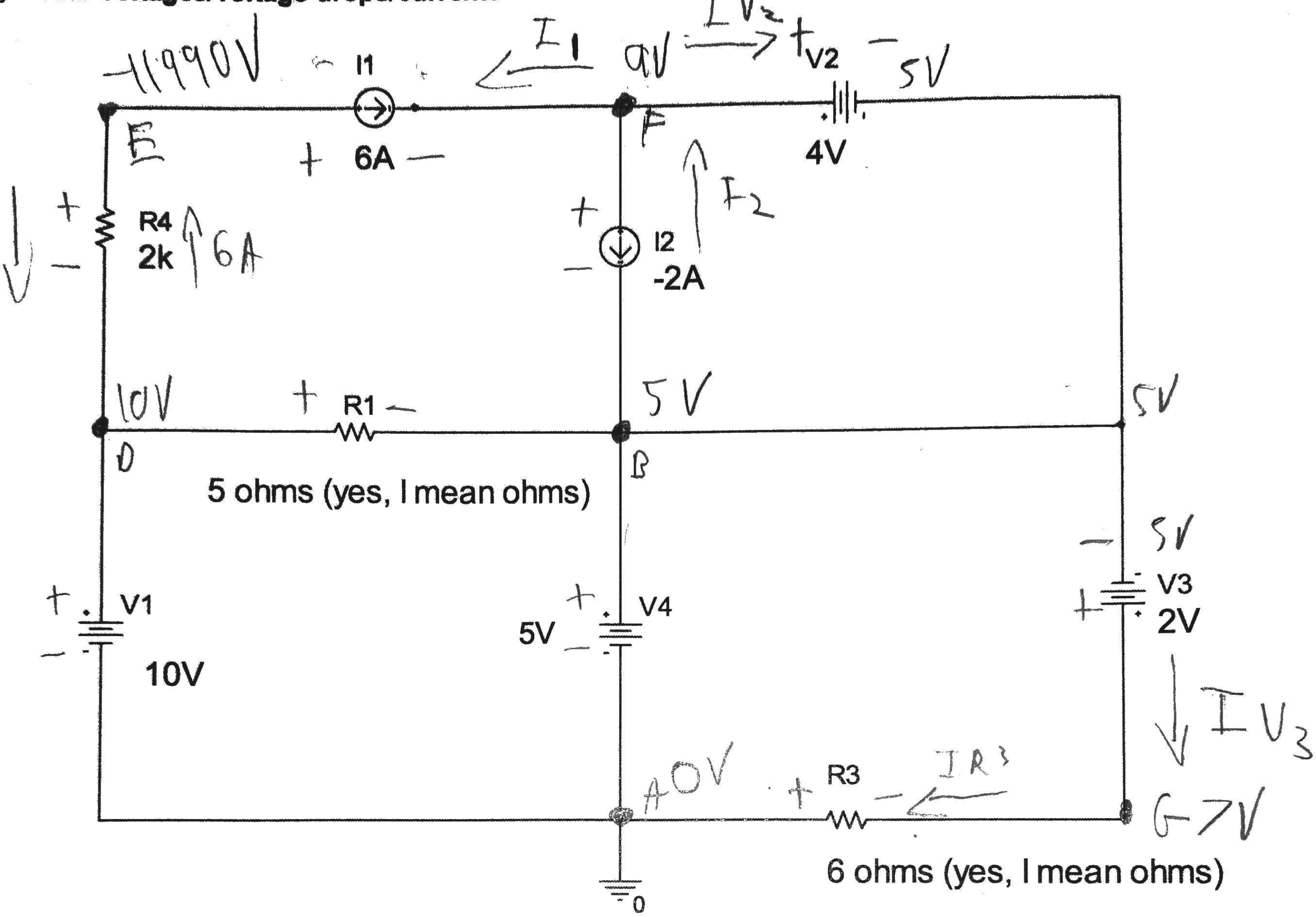
d) How much power is supplied by the voltage source (consider the constraints found in part b) ?

$P = VI = 30 \cdot 0 = 0\ W$

e) How much power is dissapated by the resisitor? ***Answer check 0.18W***

$P = VI = RI^2 = 5000(6 \times 10^{-3})^2 = \boxed{.18W}$

3) Nodal voltages/voltage drops/currents



a) How many nodes are in the above circuit?

6 nodes

b) Determine the voltage at every node. Label every node for full credit!

Work on back

c) Determine the current through R3, V2, and V3 (label or indicate current direction for full credit)

$I_{R_3} = \frac{\Delta V}{R} = \frac{7-0}{6} = \frac{7}{6} = \boxed{1.1\overline{66}\,A = I_{R_3}}$

$I_1 + I_{V_2} = I_2$

$-6A + I_{V_2} = 2A$

$I_{V_2} = \boxed{8A}$

I_{V_3}: KCL

$I_{V_3} = I_{R_3}$

$\boxed{I_{V_3} = 1.1\overline{6}0\,A}$

3B: $V_D = 10V$

$V_E - V_D = -(I_{R4})R4$

$V_E = V_D - (I_{R4})(R4)$

$V_E = 10 - 12000V$

$V_E = -11990V$

Node A: 0V

Node B: 5V

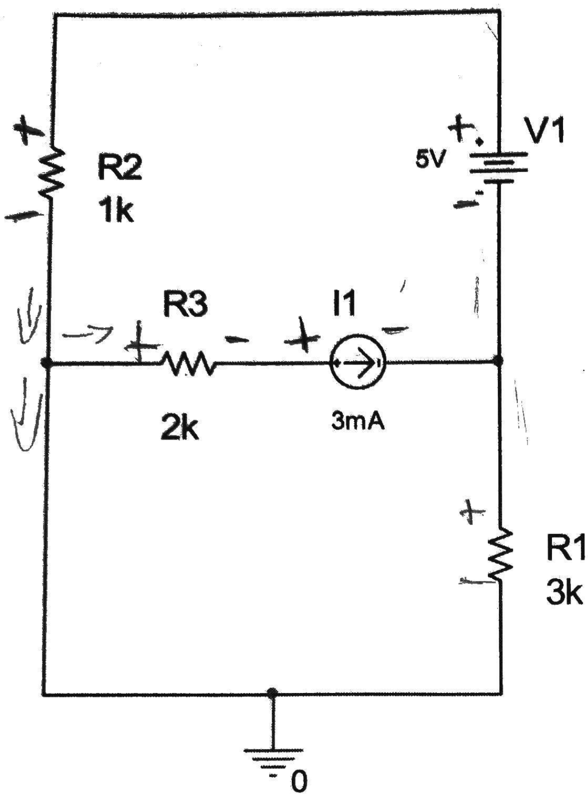
Node D: 10V

Node E: -11990V

Node F: 9V

Node G: 7V

4) KVL/KCL



In this circuit,

a) Determine three linearly independent equations for the voltage across the resistors. You will have to use a combination of Ohm's law, KCL, and KVL.

Redraw the circuit with polarities for full credit.

$-V_1 + V_{R_2} - V_{R_1} = 0$ $\quad -5 + V_{R2} - V_{R1} = 0$

$I_1 \cdot R_3 = V_{R_3}$

$\frac{V_{R2}}{R2} = I_{R3} - \frac{V_{R1}}{R_1}$

$\frac{1}{1000\,\Omega} V_{R2} + \frac{1}{3000\,\Omega} V_{R1} = 3\,mA$

b) Set up these equations in matrix/vector form.

c) Solve for the voltages across each resistor.

Answer check: VR1 = -1.5

A: $V_{R2} - V_{R1} = 5$

$V_{R3} = 6$

$\frac{1}{1000} V_{R2} + \frac{1}{3000\,\Omega} V_{R1} = 3 \times 10^{-3}$

B: $\begin{bmatrix} 1 & -1 & 0 \\ 0 & 0 & 1 \\ \frac{1}{1000} & -\frac{1}{3000} & 0 \end{bmatrix} \begin{bmatrix} V_{R2} \\ V_{R1} \\ V_{R3} \end{bmatrix} = \begin{bmatrix} 5 \\ 6 \\ 3 \times 10^{-3} \end{bmatrix}$

C: $Ax = B$

$x = A^{-1} \cdot B$

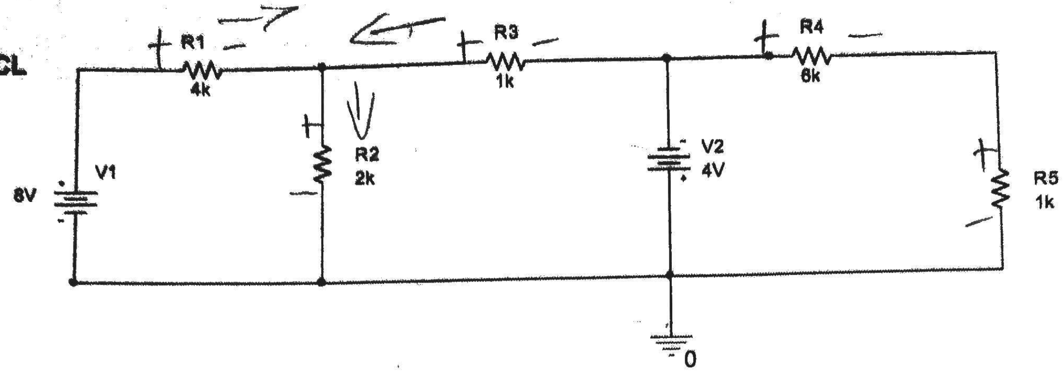
$B = \begin{bmatrix} 5 \\ 6 \\ 3 \times 10^{-3} \end{bmatrix}$

$A^{-1} = \begin{bmatrix} .25 & 0 & 750 \\ -.75 & 0 & 750 \\ 0 & 1 & 0 \end{bmatrix}$

$A^{-1} \cdot B = \begin{bmatrix} 3.5 \\ -1.5 \\ 6 \end{bmatrix} = \begin{bmatrix} V_{R2} \\ V_{R1} \\ V_{R3} \end{bmatrix}$

$\boxed{\begin{aligned} V_{R1} &= -1.5\,V \\ V_{R2} &= 3.5\,V \\ V_{R3} &= 6\,V \end{aligned}}$

5) KVL/KCL



In the above circuit,

a) Determine five linearly independent equations for the voltage across the resistors. You will have to use a combination of Ohm's Law, KCL, and KVL.

b) Set up these equations in matrix/vector form.

c) Solve for the voltages across each resistor.

Answer check: VR1 = 9.143

A:

$-V_1 + VR1 + VR_2 = 0$

$\frac{VR1}{4000} + \frac{(-VR3)}{1000} = \frac{VR2}{2000}$

$V_2 + VR4 + VR5 = 0$

$-VR_2 + VR3 - V_2 = 0$

$\frac{VR4}{6000} = \frac{VR5}{1000}$

$VR1 + VR_2 = 8V$

$\frac{VR1}{4000} - \frac{VR3}{1000} - \frac{VR2}{2000} = 0$

$VR4 + VR5 = -4V$

$-VR2 + VR3 = 4V$

$\frac{VR4}{6000} - \frac{VR5}{1000} = 0$

B:

$$\underbrace{\begin{bmatrix} 1 & 1 & 0 & 0 & 0 \\ \frac{1}{4000} & \frac{-1}{2000} & \frac{-1}{1000} & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 \\ 0 & -1 & 1 & 0 & 0 \\ 0 & 0 & 0 & \frac{1}{6000} & \frac{1}{1000} \end{bmatrix}}_{A} \underbrace{\begin{bmatrix} VR1 \\ VR2 \\ VR3 \\ VR4 \\ VR5 \end{bmatrix}}_{X} = \underbrace{\begin{bmatrix} 8 \\ 0 \\ -4 \\ 4 \\ 0 \end{bmatrix}}_{B}$$

C: $A^{-1} \cdot B = X$

$$X = \begin{bmatrix} 9.143 \\ -1.143 \\ 2.857 \\ -3.428 \\ -0.571 \end{bmatrix} = \begin{bmatrix} VR1 \\ VR2 \\ VR3 \\ VR4 \\ VR5 \end{bmatrix}$$

VR1 = 9.143 V
VR2 = -1.143 V
VR3 = 2.857 V
VR4 = -3.429 V
VR5 = -0.571 V