ECE 2001
Fall 2019
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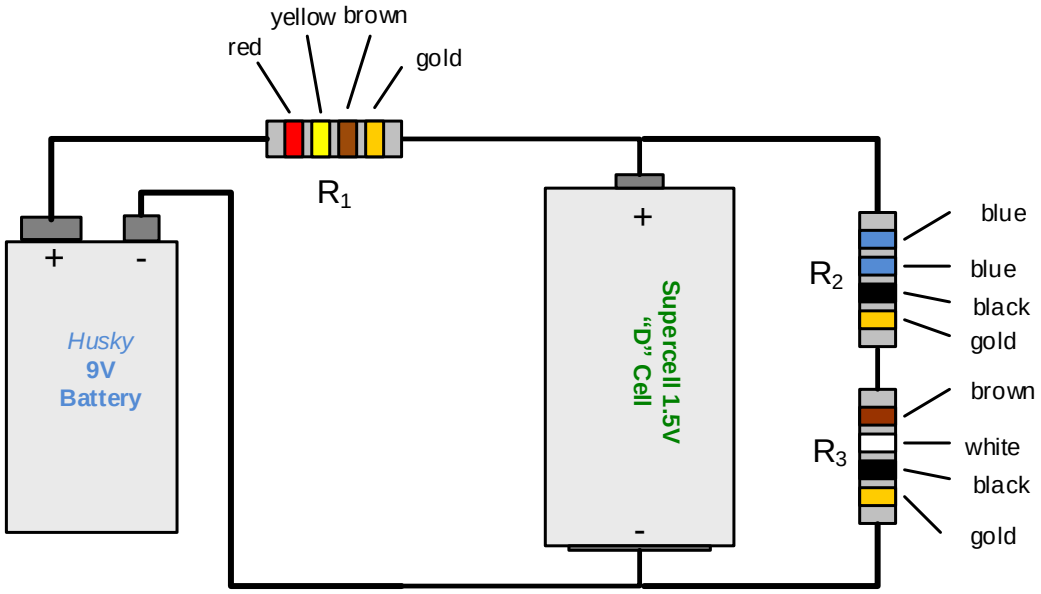
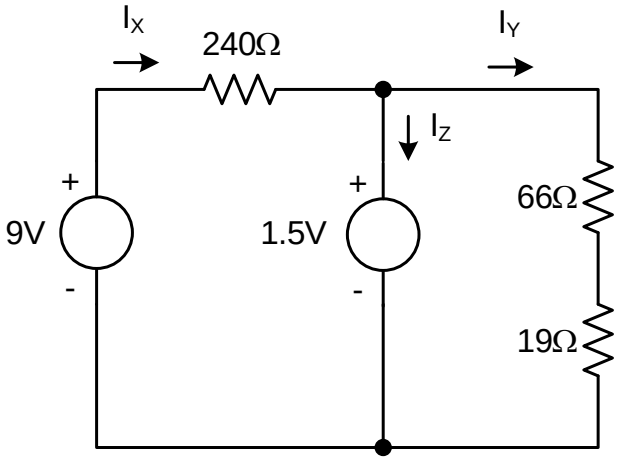
Homework Assignment 1 **SOLUTION**
Due: Friday, Sept. 6, 2019

1. (25) Two batteries and three resistors are connected as shown below. a) Does conventional current enter or leave the positive terminal of the 9 V battery? b) Do electrons enter or leave the positive terminal of the 9 V battery? c) Does the 9 V battery develop or dissipate power? d) Does conventional current enter or leave the positive terminal of the 1.5 V battery? e) What is the power for the 1.5 V battery? (Use the passive sign convention.) f) Find the power for each of the resistors.



Solution. The simplified circuit is as follows.



a) **Conventional current leaves the positive terminal of the 9V battery because**

$$I_X = \frac{9V - 1.5V}{240\Omega} = 31.25\ mA.$$

b) **Electrons enter the positive terminal of the 9V battery (opposite to the flow of conventional current).**

c) **The 9V battery develops power because**

$$P_{9V} = -(9V)(31.25\ mA) = -281.25\ mW.$$

d) **We can find the current in the 1.5 battery as follows.**

$$I_Y = \frac{1.5V}{66\Omega + 19\Omega} = 20.0\ mA \quad \text{(OHM)}$$

$$I_Z = I_X - I_Y = 11.25\ mA \ \text{(KCL)}$$

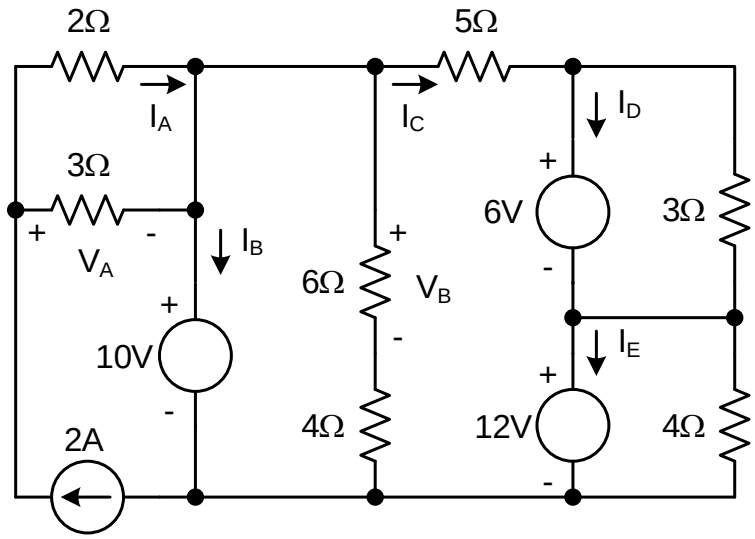
e) **The power for the 1.5V battery is**

$$P_{1.5V} = (1.5V)(11.25\ mA) = 16.875\ mW$$

f) **For the resistors,**

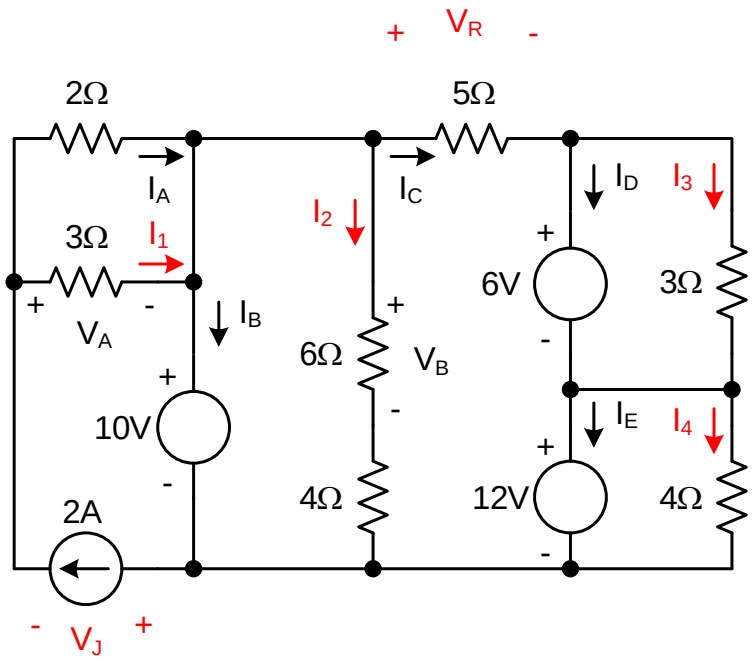
$$P_{240\Omega} = \frac{7.5V^2}{240\Omega} = 234.37\ mW,$$
$$P_{66K\Omega} = (0.02A)^2 66\Omega = 26.4\ \text{mW and}$$
$$P_{19\Omega} = (0.02A)^2 19\Omega = 7.6\ \text{mW.}$$

2. (25) Consider the resistive circuit below.



a. Find V_A, V_B, I_A, I_B, I_C, I_D, and I_E.
b. Find the power for each of the sources, using the passive sign convention. Do any of the sources *dissipate* power?

Solution. (ad hoc use of KVL, KCL, and Ohm's law)



a. CDR: $\boldsymbol{I_A = 2A\left(\frac{3\Omega}{2\Omega+3\Omega}\right) = 1.2\ A}$

CDR: $I_1 = 2A\left(\frac{2\Omega}{2\Omega+3\Omega}\right) = 0.8\,A$

Ohm: $V_A = (0.8A)(3\Omega) = 2.4\,V$

KVL: $-10 + V_R + 6 + 12 = 0 \qquad V_R = -8\,V$

Ohm: $I_C = \frac{-8V}{5\Omega} = -1.6\,A$

KVL and Ohm: $I_2 = \frac{10V}{10\Omega} = 1\,A$

VDR: $V_B = 10V\left(\frac{6\Omega}{4\Omega+6\Omega}\right) = 6\,V$

KCL: $I_B - I_A - I_1 + I_2 + I_C = 0 \qquad I_B = 2.6\,A$

Ohm: $I_3 = \frac{6V}{3\Omega} = 2\,A$

KCL: $-I_C + I_D + I_3 = 0 \qquad I_D = -3.6\,A$

Ohm: $I_4 = \frac{12V}{4\Omega} = 3\,A$

KCL: $I_E + I_4 - I_3 - I_D = 0 \qquad I_E = -4.6\,A$

b. **KVL:** $V_A + 10 + V_J = 0 \qquad V_J = -12.4\,V$

$P_{2A} = (2A)(-12.4V) = -24.8\,W$

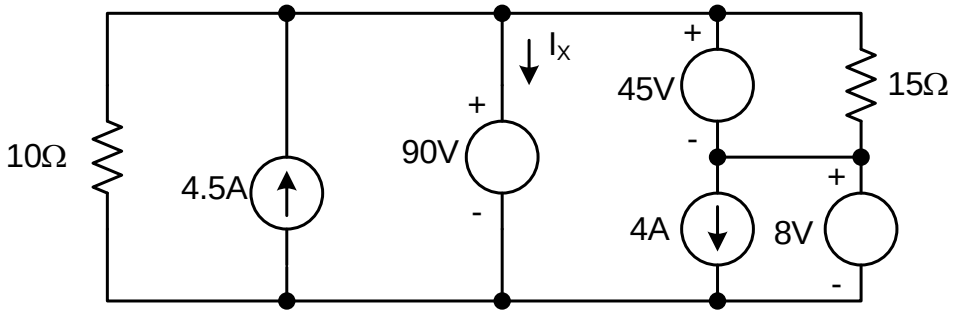
$P_{10V} = (10V)(2.6A) = 26\,W$ **(The 10V source dissipates.)**

$P_{6V} = (6V)(-3.6A) = -21.6\,W$

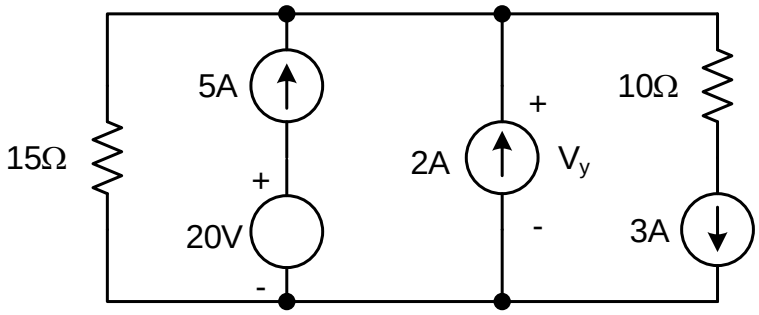
$P_{12V} = (12V)(-4.6A) = -55.2\,W$

3. (25) Consider the following three circuits.
   (a) Is circuit a valid? If it is, find I_x. If not, show a violation of Kirchhoff's laws.
   (b) Is circuit b valid? If so, determine V_y. If not, show a violation of Kirchhoff's laws.
   (c) Is circuit c valid? If so, find I_z. If not, show a violation of Kirchhoff's laws.

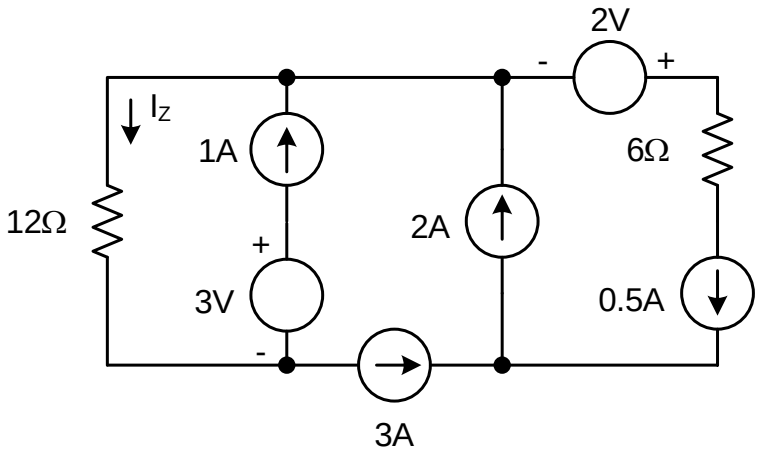
(a)



(b)

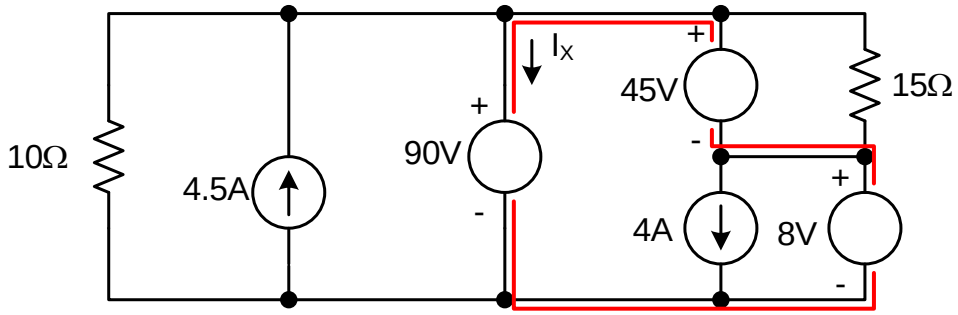


(c)



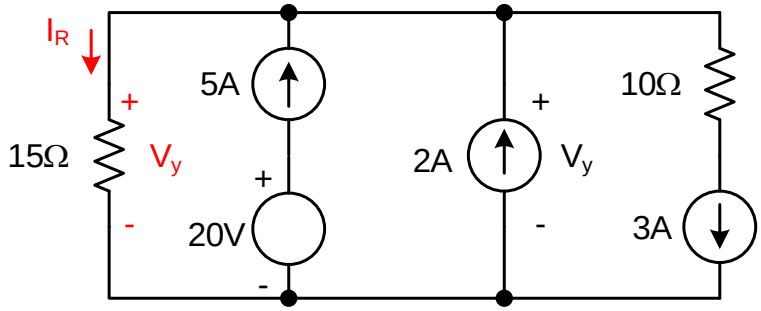
Solution.

a. NOT VALID. KVL: $-90 + 45 + 8 \neq 0$



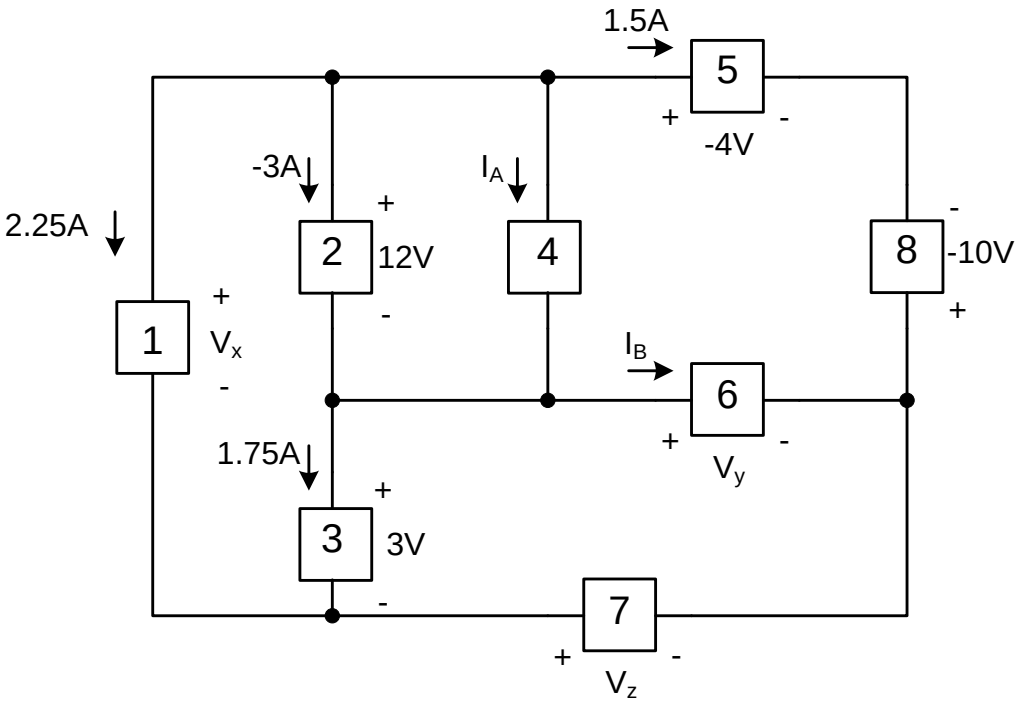
b. VALID. KCL: $I_R - 5 - 2 + 3 = 0$ $\quad I_R = 4\ A$

Ohm and KVL: $V_y = (15\Omega)(4A) = 60V$



c. **NOT VALID. KCL:** $-3 + 2 - 0.5 \neq 0$

4. (25) Consider the network below.



a. Find I_A, I_B, V_x, V_y, and V_z.
b. Find the power for each element in the circuit.
c. Show that the total power developed is equal to the total power dissipated.

Solution.

a. **KCL:** $2.25A - 3A + 1.5A + I_A = 0$ $\quad I_A = -0.75A$

KCL: $3A + 1.75A - (-0.75A) + I_B = 0$ $\quad I_B = -5.5A$

KVL: $-V_X + 12V + 3V = 0$ $\quad V_x = 15V$

KVL: $-12V + (-4V) - (-10V) - V_y = 0$ $\quad V_y = -6V$

KVL: $-3V + (-6V) - V_z = 0$ $\quad V_z = -9V$

b. $P_1 = (2.25A)(15V) = 33.75W$

$P_2 = (-3A)(12V) = -36W$

$P_3 = (1.75A)(3V) = 5.25W$

$P_4 = (-0.75A)(12V) = -9W$

$P_5 = (1.5A)(-4V) = -6W$

$P_6 = (-5.5A)(-6V) = 33W$

$P_7 = (4A)(-9V) = -36W$

$$P_8 = -(1.5A)(-10V) = 15W$$

c. Total power developed = 87W

Total power dissipated = 87W