Electrical Circuits: Homework #1

Due on September 9, 2019 at 9:00am

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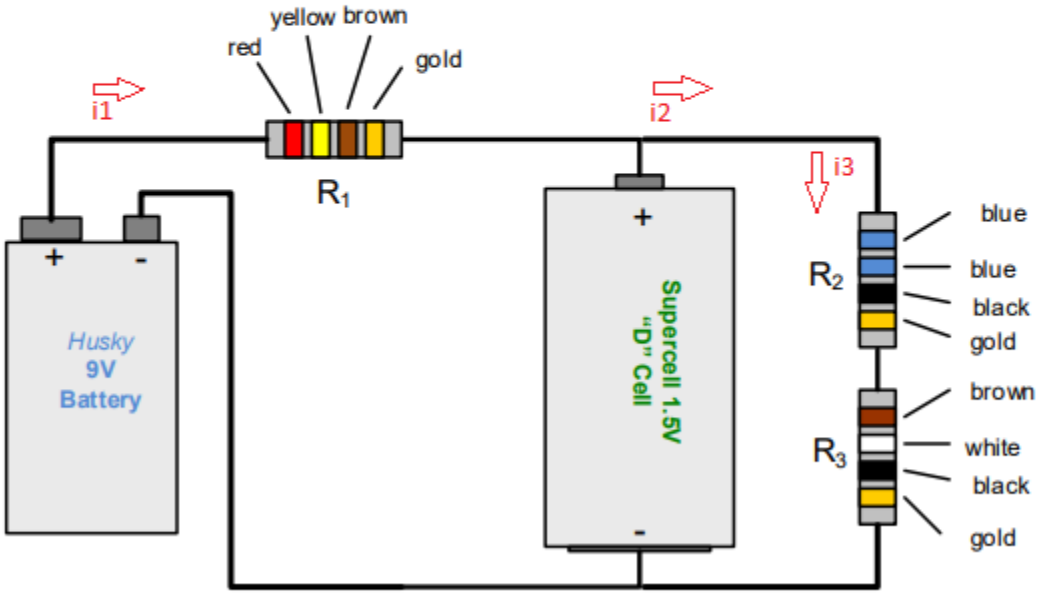
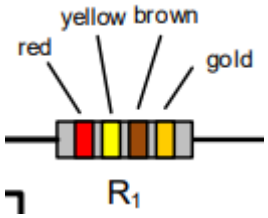
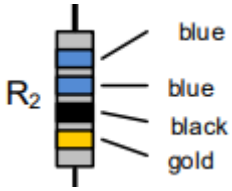
Problem 1

1. 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.

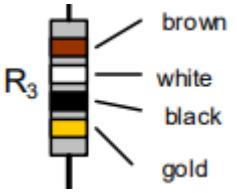




Red (2) Yellow (4) Brown $(\cdot 10^1) = 250\Omega$



Blue (6) Blue (6) Black $(\cdot 10^0) = 66\Omega$



Brown (1) White (9) Black $(\cdot 10^0) = 19\Omega$

A) Conventional current leaves the terminal of the 9V battery.

B) Electrons enter the terminal of the 9V battery.

C) Power is developed from the 9V battery (negative, leaving battery).

D) Conventional current enters the 1.5V battery.

E) p = 1.5V $\cdot I_2 = 1.5V \cdot 13.65, = 20.475mW$

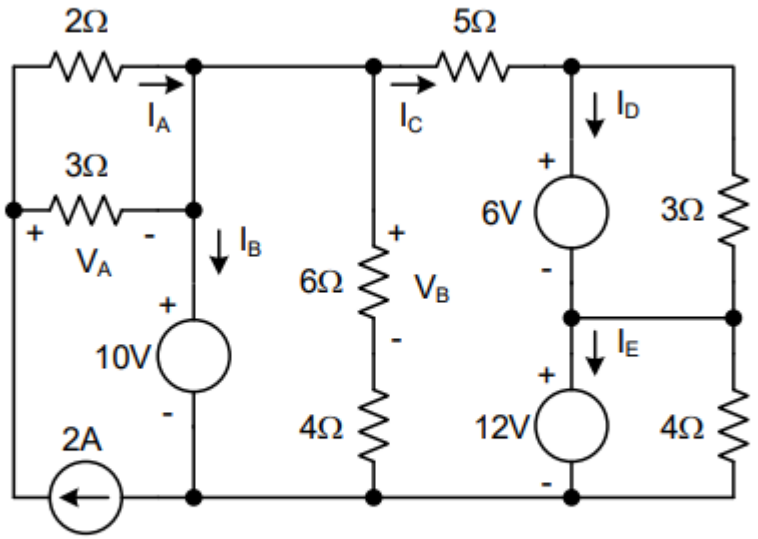
$I_2 = I_1 - I_3 = 31.25 - 17.6 = 13.65mA.$
$I_1 = \frac{9-1.5}{R_1} = \frac{9-1.5}{240} = 31.25mA.$
$I_3 = \frac{1.5}{R_2+R_3} = \frac{1.5}{85} = 17.6mA.$

F) Power in resistors:

p in $R_1 = (I_1)^2 \cdot R_1 = (31.25 \cdot 10^{-3})^2 \cdot (240) = 234.4mW$
$pinR_2 = (I_3)^2 \cdot R_2 = (17.6 \cdot 10^{-3})^2 \cdot (66) = 20.44mW$
$pinR_3 = (I_3)^2 \cdot R_3 = (17.6 \cdot 10^{-3})^2 \cdot (19) = 5.89mW$

Problem 2

2. 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?

A) Values:

$V_A = 2(1.2) = 2.4V$
$V_B = 6(I_E) = 6(1) = 6V$

$I_A = \frac{3}{2+3} \cdot 2 = 1.2A$
$I_B = 2 - (-16) - 1 = 2.6A$
$I_C = -\frac{10-18}{5} = -1.6A$
$I_D = (KCL) I_C = I_D + 2A, I_D = -2 - 1.6 = -3.6A$
$I_E = (KCL) 2 + I_D = I_E + 3, I_E = 2 - 3 - 3.6 = -4.6A$

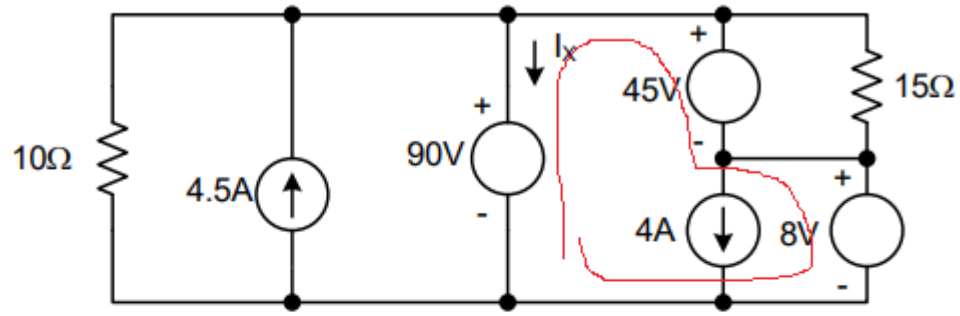
B) Values:

power 2A = (2)(-12.4) = -24.8W
power 10V = (10)(I_B) = $10 \cdot \frac{13}{5} = 26W (Dissipated)$
$power 6V = (6)(I_E) = 6(\frac{-18}{5}) = -21.6W$
$power 12V = (12)(I_E) = 12(-4.6) = -55.2W$

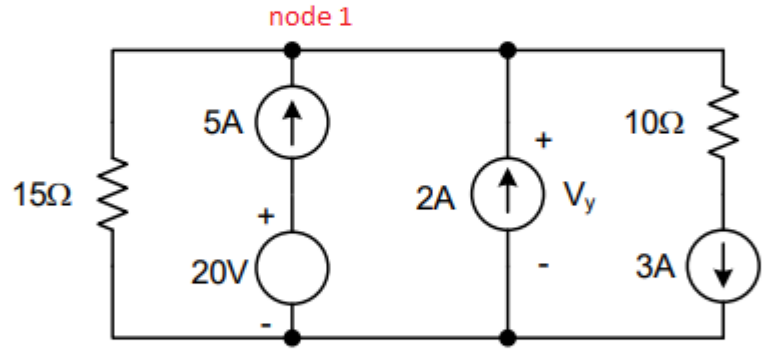
Problem 3

3. 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.

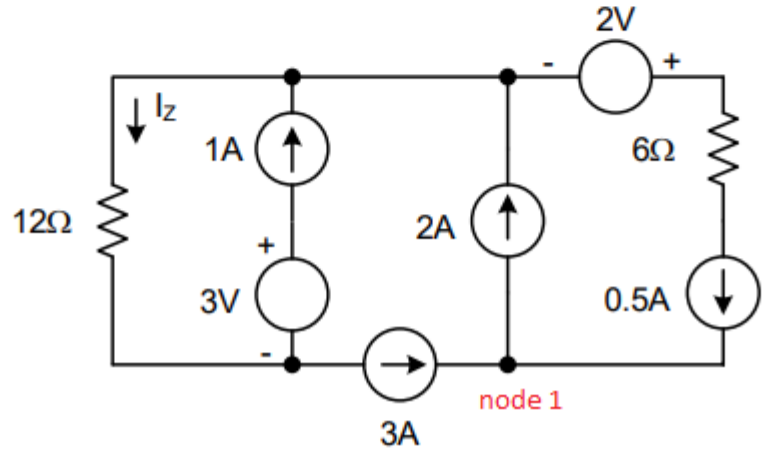
(a)



(b)



(c)



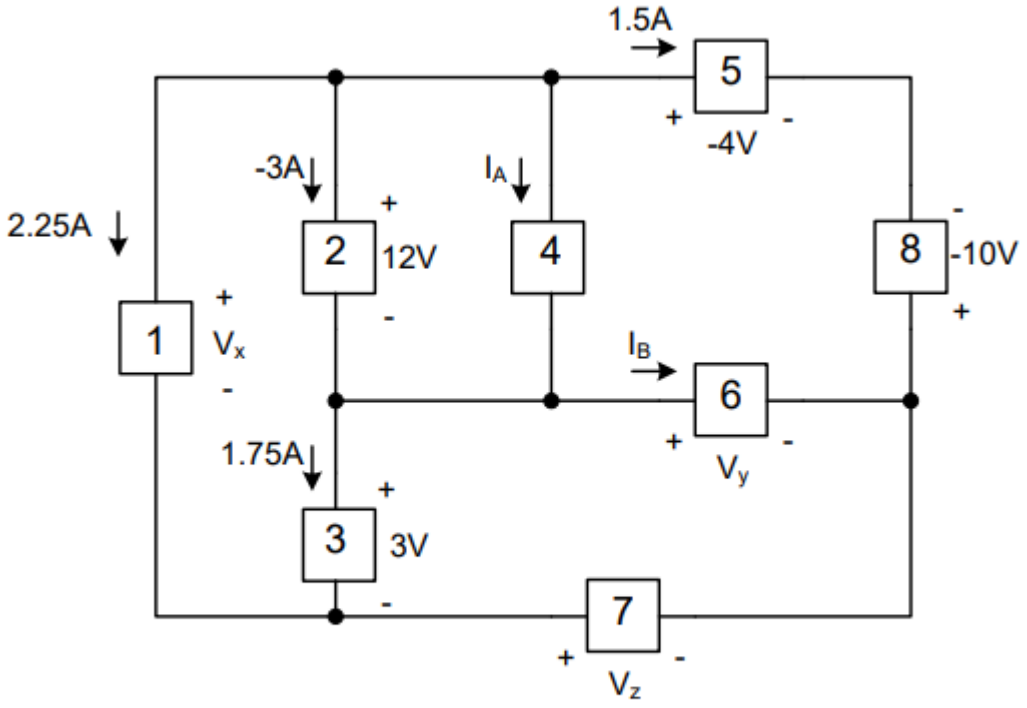
A) using KVL: -90 + 45 + 8 = 0 , -37 $\neq$ 0.Invalid Circuit.

B) using KCL (node 1): $(V_y/15) - 5 - 2 + 3 = 0, V_y = 20V, \frac{20}{15} - 5 - 2 + 3 = 0, -2.67 \neq 0$.Invalid Circuit.

C) using KCL (node 1): 3 + 0.5 = 2A , 3.5 $\neq$ 2.Invalid Circuit.

Problem 4

4. 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.

A) Values:

$V_x = (KVL) - V_x + 12 + 3 = 0, = 15V$
$V_y = (KVL) - 12 - 4 + 10 - V_y = 0, = -6V$
$V_z = (KVL) - 3 + V_y - V_z = 0, V_z = -3 + V_y = -3 - 6 = 9V$

$I_A = (KCL) I_A + 2.25 - 3 + 1.5 = 0, I_A = -0.75A$
$I_B = (KCL) I_B = -3 - 0.75 - 0.75 = -5.5A$

B) Values:
p = vi
1: (15V)(2.25) = 33.75W
2: (12V)(-3) = -36W
3: (3V)(1.75) = 5.25W
4: (12V)(-0.75) = -9W
5: (-4V)(1.5) = -6W
6: (-6V)(-5.5) = 33W
7: (-4V)(9) = -36W
8: (10V)(1.5) = 15W

C) 33.75 - 36 + 5.25 - 9 - 6 + 33 - 36 + 15 = 0
= 0 , so total power developed = total power dissipated.