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Homework Assignment #2

ENGR 201

2.1

An electric car charges at a rate of 12.0 kW for exactly 5 hours and is then able to travel 256.4 miles on that charge. If electricity costs $0.115 per kWh, what is the cost the electrical 'fuel' to drive the car in dollars per mile driven?

Variables:

$p = 12kW \qquad t = 5hr \qquad price = \$0.115 \qquad d = 256.4mi \qquad cost = p * t * price$

Calculations:

$$cost = 12kW * 5hr * \$0.115 \Rightarrow cost = \$6.90$$

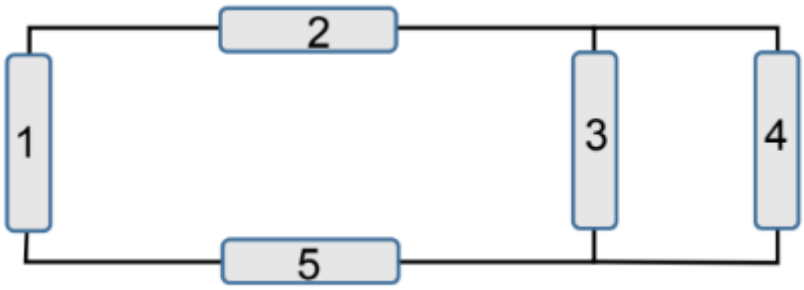
$$\frac{cost}{mile} = \frac{cost}{d} = \frac{\$6.90}{246.4mi} \Rightarrow \frac{cost}{mile} = \$0.026$$

Solution:

$$\frac{cost}{mile} = \$0.026$$

2.2

In the diagram below there are 5 circuit elements. If P1 = −50 W, P2 = 35 W, P3 = −15 W, and P4 = 50 W, what is the power, P5 in watts?



Variables:

$$P_1 = -50W \quad P_2 = 35W \quad P_3 = -15W \quad P_4 = 50W \quad P_5 = ?$$

Calculations:

P_5 can be found using the Law of Conservation of Energy $\Rightarrow \sum p = 0$

$$-50W + 35W - 15W + 50W + P_5 = 0 \Rightarrow P_5 = -20W$$

Solution:

$$P_5 = -20W$$

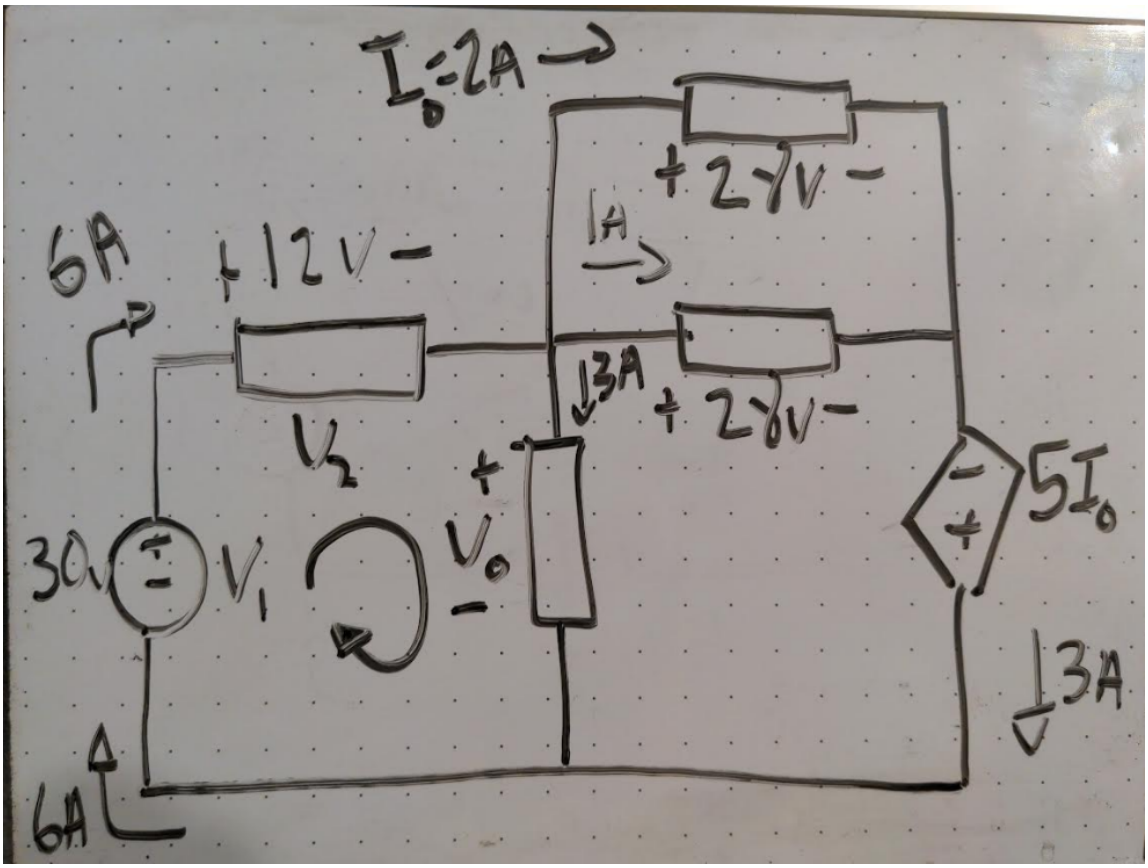
2.3

Find Vo in the circuit shown below.

To solve we must use Kirchhoff's Voltage Law, which states: The sum of all the voltages around a loop is zero at every instant

$$\sum v_{loop} = 0 \equiv \sum v_{rises} = \sum v_{drops} \; around \; the \; loop$$

We will use the loop indicated below:



Variables:

$$v_o = ? \quad v_1 = 30V \quad v_2 = 12V$$

Calculations:

$$-30V + 12V + v_o = 0 \Rightarrow v_o = 18V$$

Solution:

$$v_o = 18V$$

2.4

The resistivity (ρ) of carbon is 4.0 x 10−5 Ω · m. What length of 2.0 mm diameter carbon rod would be required to make a 1.0 Ω resistor?

Variables:

$$\rho = 4.0x10^{-5}\Omega * m \quad d = 2.0mm = .002m \quad r = \frac{d}{2} = .001m \quad R = 1.0\Omega \quad l = ?$$

Calculations:

We will use the formula $R = \rho * \frac{l}{A}$ Solve for $l \Rightarrow l = A * \frac{R}{\rho}$:

$$l = (\pi * .001^2) * \frac{1}{4.0x10^{-5}} \Rightarrow l = 0.0785m = 78.5mm$$

Solution:

$$l = 78.5mm$$

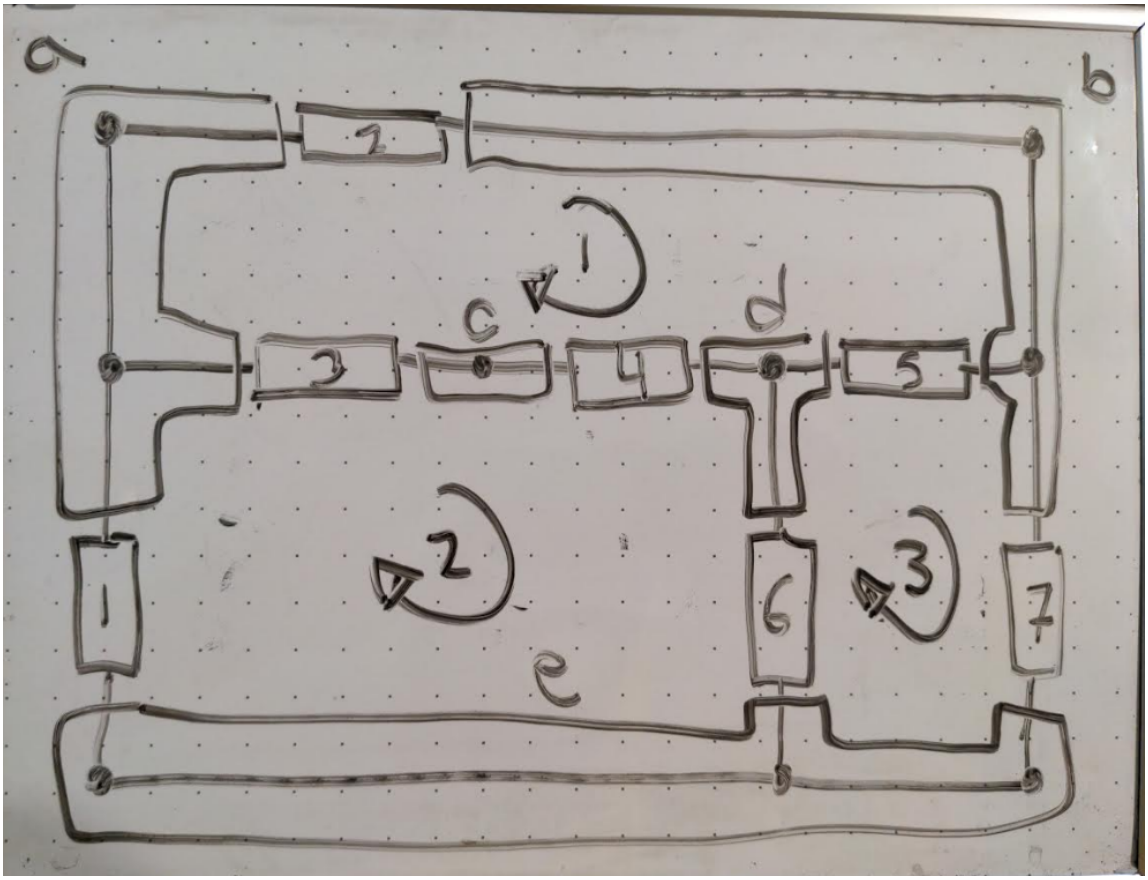
2.5

Make a sketch of the following circuit and determine:

a) the number of branches in the circuit

b) the number of nodes in the circuit (label the nodes in your sketch)

c) The number of independent loops in the circuit (show the loops in your sketch)



Solution:

a) Number of branches = 7

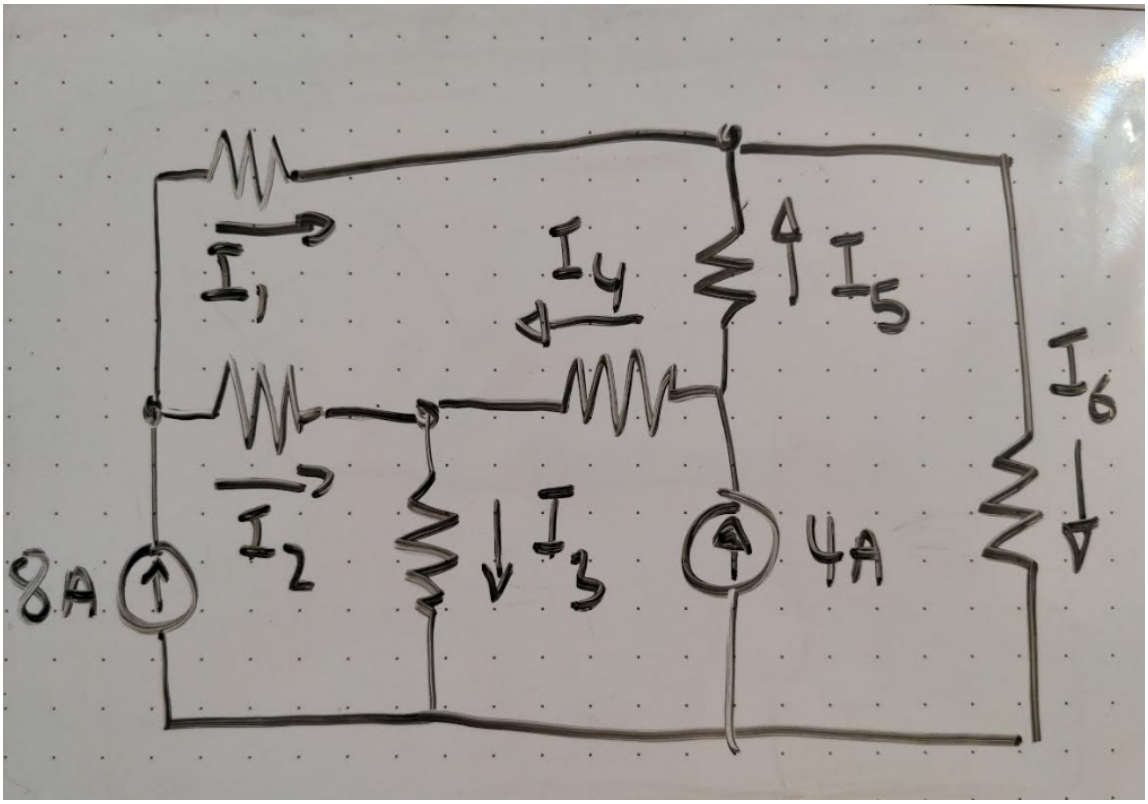
b) Number of nodes = 4

c) Number of independant loops = $b - n + 1 \Rightarrow 7 - 4 + 1 \Rightarrow 4$

2.6

The following circuit contains six unknown currents, I1 through I6 and critical nodes labeled a through e.

a) Write the KCL expression in terms of the currents for nodes a, b, c, and d. b) At this point is there enough information to solve for the currents in the circuit? Explain. c) If I2 = 2 A and I4 = 3 A what are currents I1,I3,I5, and I6 in amperes?



Solutions:

Kirchhoff's Current Law: The sum of the currents enetering a node is zero at every instant

$$\sum i = 0 \ for \ every \ node \ in \ a \ circuit$$

a)

Node A $\Rightarrow 0 = 8A - I_1 - I_2$

Node B $\Rightarrow 0 = I_2 + I_4 - I_3$

Node C $\Rightarrow 0 = 4A - I_4 - I_5$

Node D $\Rightarrow 0 = I_1 + I_5 - I_6$

Node E $\Rightarrow 0 = I_3 + I_6 - 4A - 8A$

b) There is not enough information to solve because each equation has two or more unknown variables

c) Plug in I_2 = 2 A and I_4 = 3 A into the equations and solve

Node A $\Rightarrow I_1 + 2A = 8A \Rightarrow I_1 = 6A$

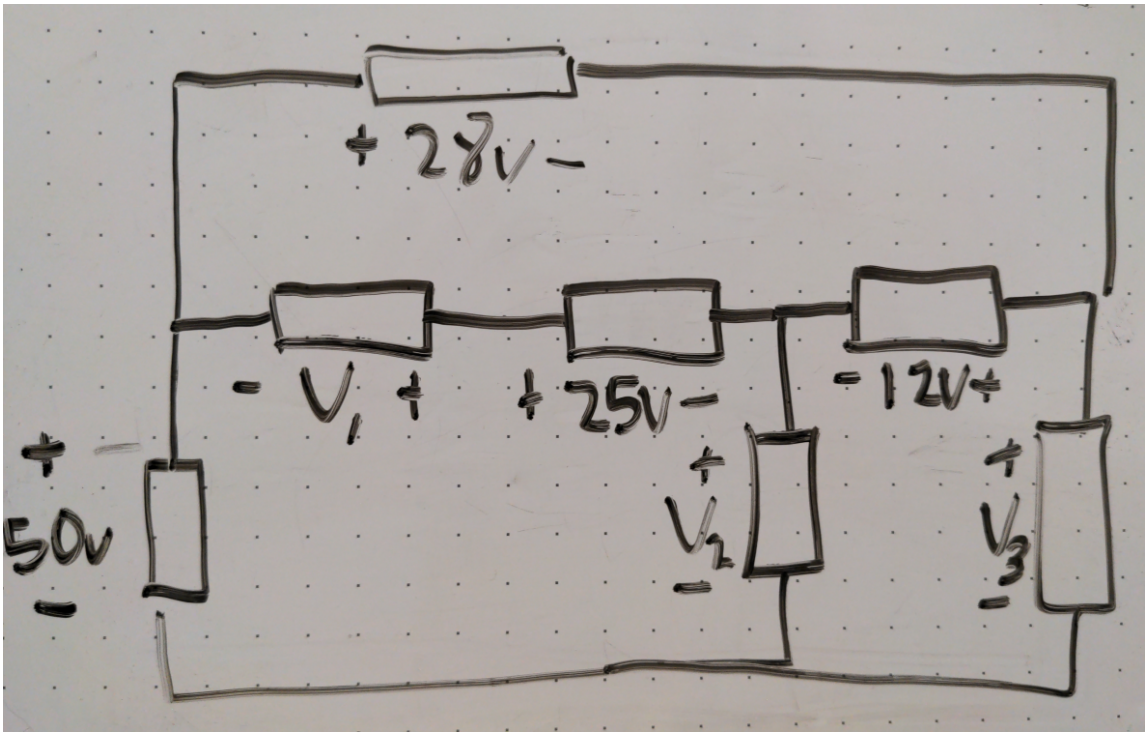
Node B $\Rightarrow I_3 = 2A + 3A \Rightarrow I_3 = 5A$

Node E $\Rightarrow I_6 = 4A + 8A - 5A \Rightarrow I_6 = 7A$

Node D $\Rightarrow I_5 = 7A - 6A \Rightarrow I_5 = 1A$

2.7

Use Kirchhoff's Laws to determine V1, V2, and V3 in the circuit below.



Solutions:

Find v_3:

$$0 = -50V + 28V + v_3 \quad solve\ for\ v_3 \Rightarrow v_3 = 50 - 28 \Rightarrow v_3 = 22V$$

Find v_2:

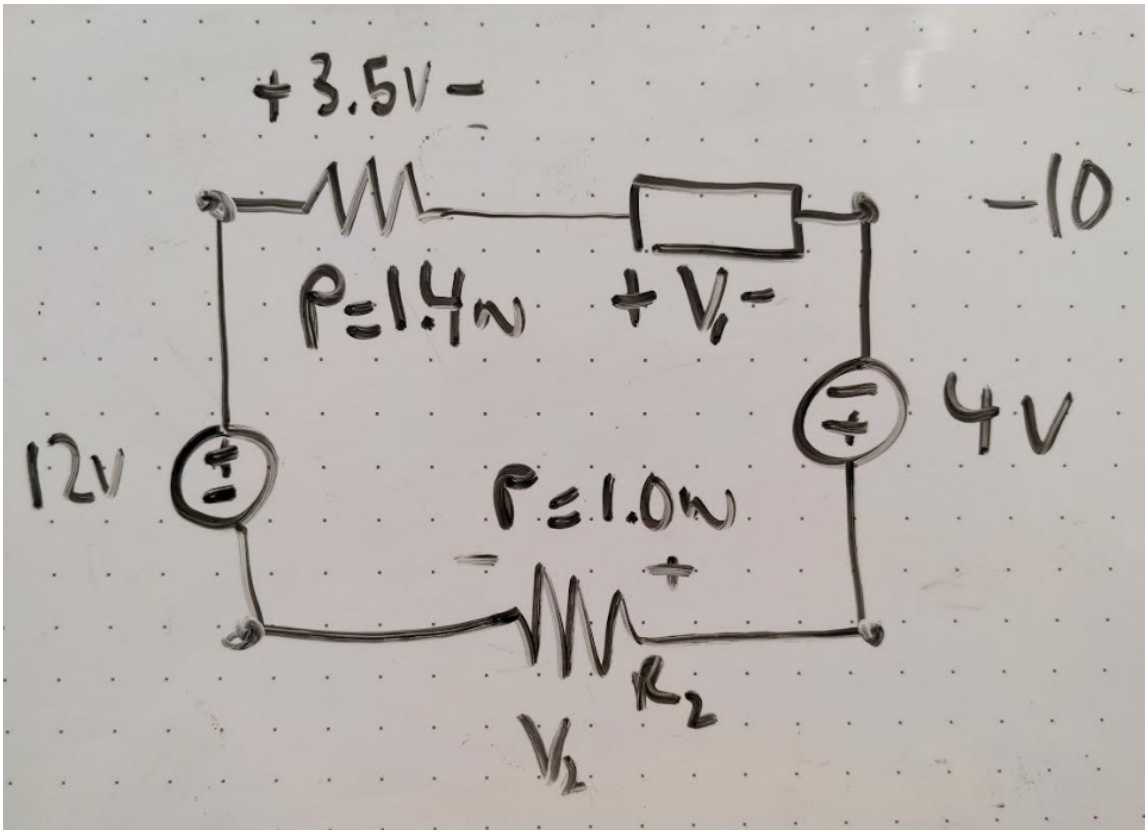
$$0 = -12V + 22V - v_2 \quad solve\ for\ v_2 \Rightarrow v_2 = 10V$$

Find v_1:

$$0 = -50V - v_1 + 25V + 10V \quad solve\ for\ v_1 \Rightarrow v_1 = -15V$$

2.8

Use KVL and power relationships to determine V1 in the circuit below:



Solution:

1. Find the current in the circuit using $i = p/v$

$$i = \frac{1.4W}{2.5W} \Rightarrow i = .4A$$

2. Find the voltage across v_2 using $v = \frac{p}{i}$

$$v_2 = \frac{1.0W}{.4A} \Rightarrow v_2 = 2.5V$$

3. Find v_1 using KVL

$$0 = -12V + 3.5V + v_1 - 4V + 2.5V \Rightarrow solve\ for\ v_1 \Rightarrow v_1 = 10V$$