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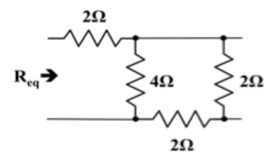
ECE 2312
Exam #1 Redo
9/27/2012

Exam 1 Redo

Question 1a:

Problem Description:

Compute the equivalent resistance for the network shown to the right.



Concepts Used:

I will use the following equations to help solve this.

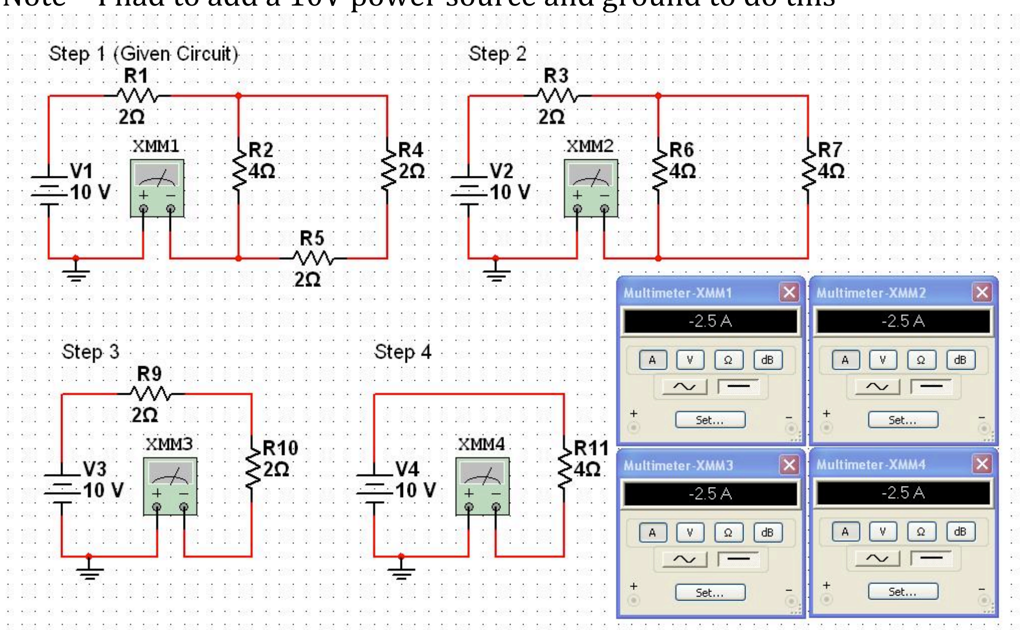
- $Req\_in\_series = R1 + R2$
- $Req_{in_{parallel}} = \left(\frac{1}{R1} + \frac{1}{R2}\right)^{-1}$

My Work:

1. Combine the two 2 Ohm resistors on the right in series by 2 + 2 = 4 to give circuit as seen in Multi-sim step 2.
2. We now have two 4 Ohm resistors in parallel. We now use our parallel equation of $\left(\frac{1}{4} + \frac{1}{4}\right)^{-1} = 2\ Ohm$ to give us the circuit as seen in Multi-sim step 3.
3. Finally, we are left with the two remaining resistors in series. We then add then up 2+2=4 to give us a final equivalent resistance of 4 Ohms.

Multi-sim Work:

Note – I had to add a 10V power source and ground to do this



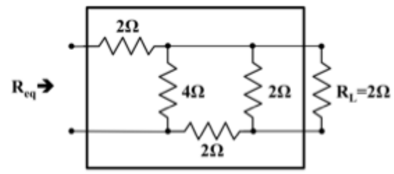
Conclusion:
Equivalent resistance = 4 Ohm.

It can be seen that the current is identical in each step of my Multi-sim simulation. If this were not the case then my

Question 1b:

Problem Description:

1(b). A 2Ω resistor is placed as a load on this network. Computer the equivalent resistance and explain any changes in the overall resistance that you observe.



Concepts Used:

I will use the following equations to help solve this.

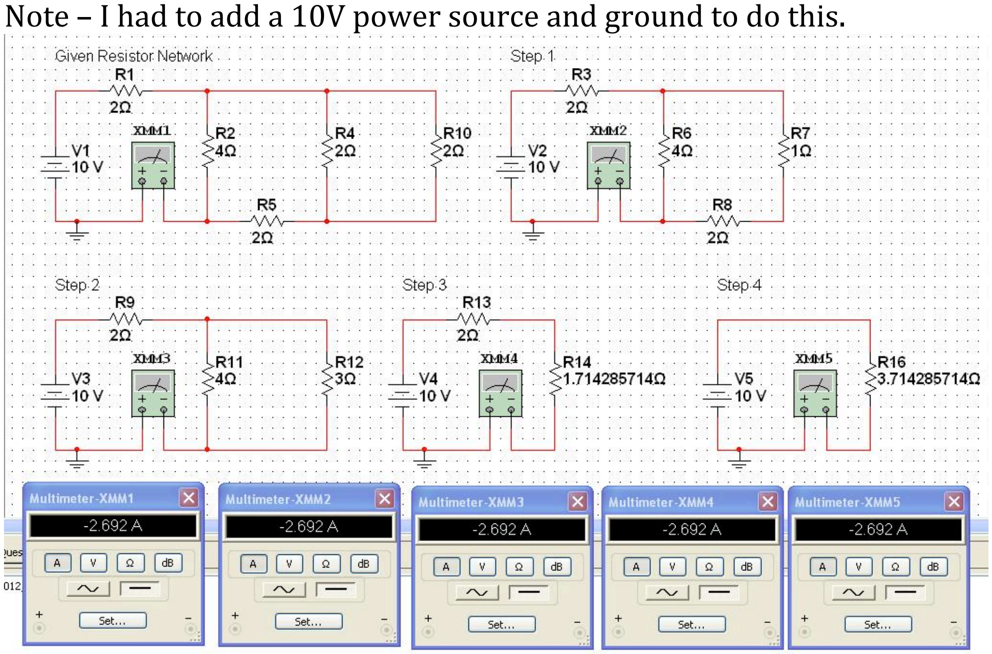
- $Req\_in\_series = R1 + R2$
- $Req_{in_{parallel}} = \left(\frac{1}{R1} + \frac{1}{R2}\right)^{-1}$

My Work:

1. Add the two resistors on the right in parallel to get $\left(\frac{1}{2} + \frac{1}{2}\right)^{-1} = 1\ Ohm$ as seen in step 1 of the Multi-sim diagram.
2. Add the 1 Ohm and 2 Ohm resistor in series 1 + 2 = 3 to get 3 Ohm as seen in step 2 of the Multi-sim diagram.
3. Add the 3 Ohm and 4 Ohm resistors in parallel to get $\left(\frac{1}{3} + \frac{1}{4}\right)^{-1} = 12/7\ Ohm$ as seen in step 3 of the Multi-sim diagram.
4. Add the 12/7 Ohm and 2 Ohm resistor in series to get 26/7 Ohm.

Multi-sim Work:

Note – I had to add a 10V power source and ground to do this.



Conclusion:
Equivalent resistance = 26/7 Ohm.

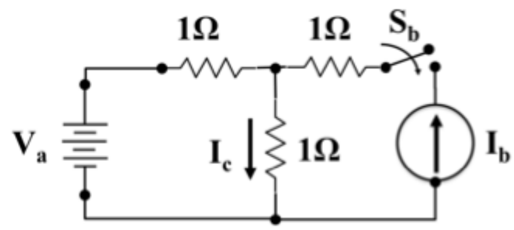
It can be seen that the current is identical in each step of my Multi-sim simulation. If this were not the case then my

Question 2a:

Problem Description:

2. Consider the circuit shown to the right.

2(a). Set V_a = 1 VDC and compute the current in the center resistor, I_c.



Concepts Used:
In this problem I will use KVL to solve. KVL states that all voltages in a loop must add up to 0.

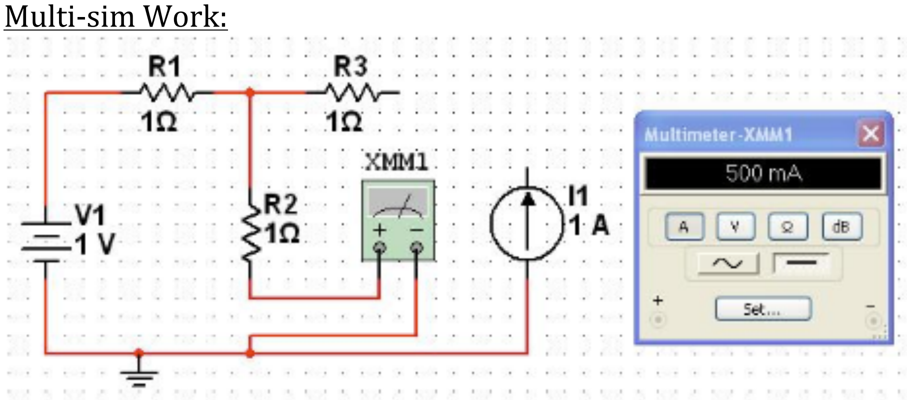
V = IR

It is important to note that **THE SWITCH IS OPEN,** ergo we can ignore the Ib current source and the 1Ohm resistor in that portion of the circuit.

My Work:
To do KVL we start at the Va source and continue clockwise through the circuit. Substituting the voltages for the resistor as Ic * Resistor we can then solve for our unknown Ic.

Va - Voltage at 1st 1 Ohm Resistor - Voltage at 2nd 1 Ohm Resistor = 0
1 - (1 Ohm * Ic) – (1 Ohm * Ic) = 0
Ic = 1/2

Multi-sim Work:

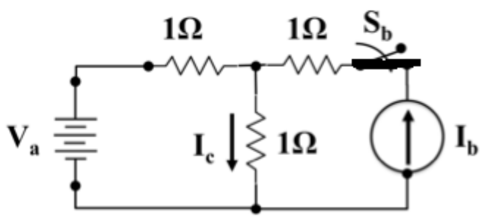


Conclusion:
Ic = ½ A

This is verified as seen above in my Multi-sim simulation.

Question 2b:

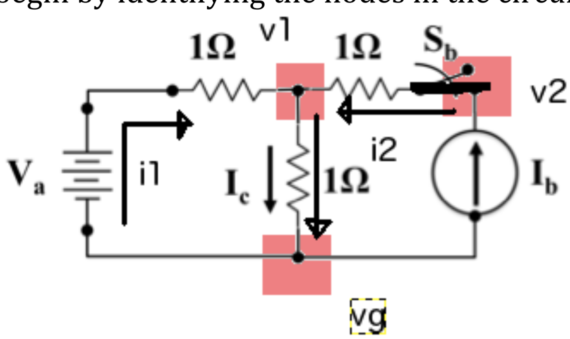
Problem Description:
Set Va = 0 VDC, close the switch Sb and set Ib = 1A.
Compute the current in the resistor Ic.



Concepts Used:
In this problem I will use nodal analysis to calculate nodal voltages V1 and V2 as seen in the below picture.

It is important to note that **THE SWITCH IS CLOSED**. Also, Va is set to 0, so we can essentially ignore it in our calculations.

My Work:
I begin by identifying the nodes in the circuit, v1, v2 and vg (ground).



Secondly, I identify current names and direction. I1, Ic, I2 and Ib.

Third, I setup KCL equations for each of the identified nodes.

V1: $I1 + I2 = Ic$

V2: $Ib = I2$

Vg:
$Ib + I1 = Ic \rightarrow I2 + I1 = Ig$

Identify the equation for each current.
$I1 = (Vg - V1)/1$
$I2 = (V2 - V1)/1$
$Ic = (V1 - Vg)/1$
$Ib = 1$

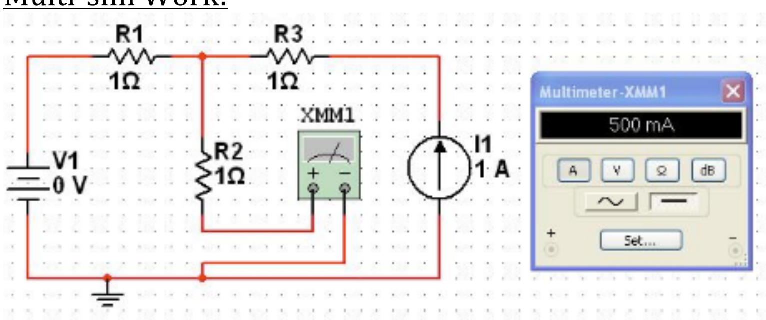
Now that we know the equations for the currents we then put them into our equations for our KCL. This will allow us to solve for the unknown V1 voltage and will finally allow us to determine the current Ic.

V1:
(Vg – V1) /1 + (V2 – V1)/1 = (V1 – Vg)/1

V2:
(Ib = I2)
1 = (V2 – V1)/1

We are left with 2 equations and 2 unknowns. Solving for V1 we get V1 = 1/2 volt. Putting ½ volt into our equations for Ic will allow us to solve for Ic.

Multi-sim Work:

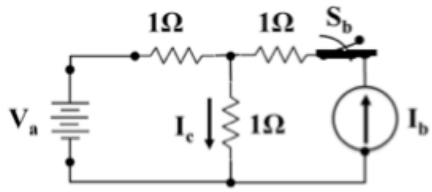


Conclusion:
V1 = ½
Putting V1 into Ic = (V1 – Vg)/1 gets us…
Ic = ½ A

This is verified as seen above in my Multi-sim simulation.

Question 2c and d:

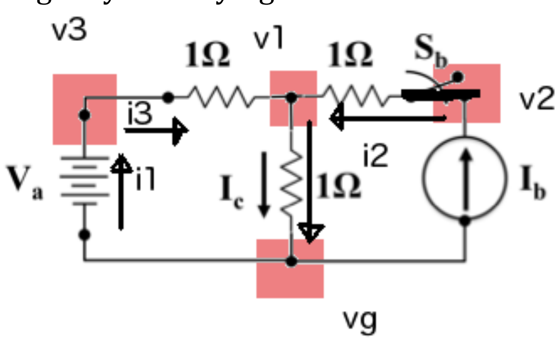
Problem Description:



Set V_a = 1 VDC, close the switch S_b, and set I_b = 1 A. Compute the current in the resistor, I_c.

Concepts Used:
To solve this circuit we will need the voltage going through the path Ic travels. In order to do this we will use nodal analysis and KCL.

My Work:
I begin by identifying the nodes in the circuit, v1, v2, v3 and vg (ground).



Secondly I label currents I1, I2, Ib and Ic and their direction.

Third, I identify the equations for each current.
$i1 = ???$
$i3 = (v3 - v1)/1$
$i2 = (v2 - v1)/1$
$ic = (v1 - Vg)/1$
$ib = 1$

Fourth, I can then determine my KCL equations for each node v1, v2, v3 and vg and then substitute the current equations in so that I can solve for Ic.

V1:
$i2 + i3 = ic$

$$\frac{v2 - v1}{1} + \frac{v3 - v1}{1} = \frac{v1 - vg}{1}$$

V2:
$i2 = ib$

$$\frac{v2 - v1}{1} = 1$$

V3:
$i1 = i3$

$$i1 = \frac{v3 - v1}{1}$$

Vg:
$ib + i1 = ic$

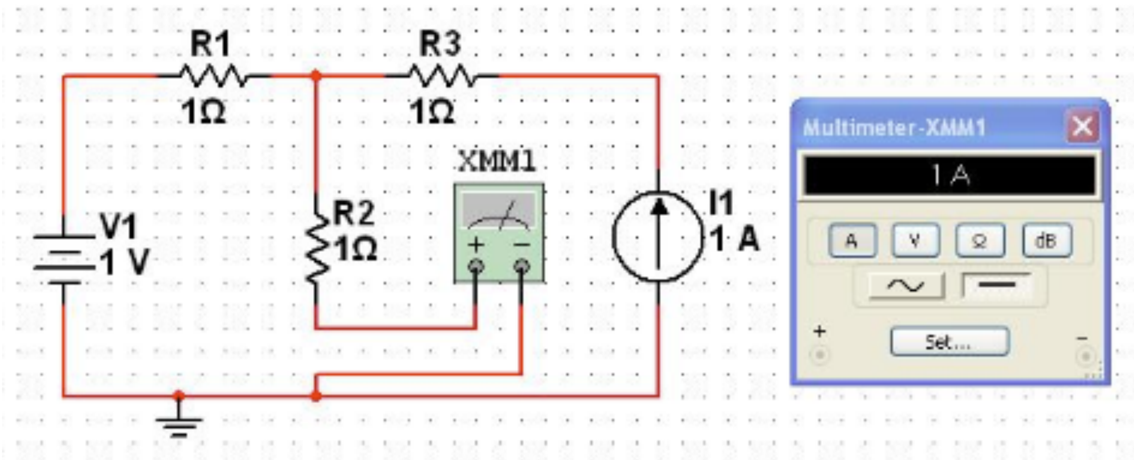
$$1 + i1 = \frac{v1 - vg}{1}$$

To find v1 we will have to use the equations for the nodal voltage at V1 and V2 and the fact that v3 = 1v. Doing so will give us two equations with two unknowns.

Solving for V1 gives us a voltage of 1.

This voltage can then be put into our equation for Ic to get a current of 1A.

<u>Multi-sim Work:</u>



<u>Conclusion:</u>
It can be seen that Multi-sim matches with my calculated answer. Therefor it can be said that my answer is correct.

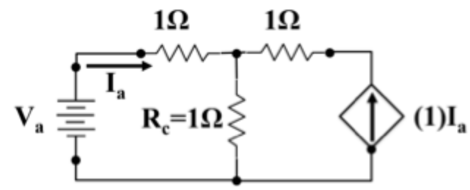
It can also be seen that our previous two answers are the same. It is because each previous problem basically represents both sides of the circuit. Conservation of energy states that these would both add up to be double due to both of them being equal to each other.

Question 3a:

Problem Description:

3. For the circuit shown to the right, assume V_a = 1 VDC:

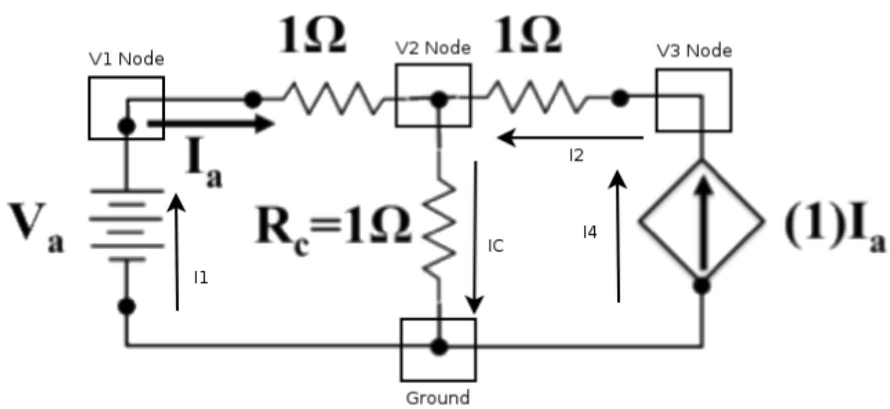
3(a). Compute the power dissipated in R_c.



Concepts Used:
To solve this circuit we will need the voltage and current going through the Rc resistor and use that to calculate power with P= IV or V^2/R.

My Work:
I begin by identifying the nodes in the circuit, v1, v2, v3 and vg (ground).

Secondly I label currents I1, I2 and Ic and their direction.



Third, I identify the equations for each current.

$i1 = ???$

$ia = (v1 - v2)/1$

$i2 = (v3 - v2)/1$

$ic = (v2 - Vg)/1$

$i4 = ia = (v1 - v2)/1$

Also note that V1 = 1 v.

I can then determine my KCL equations for each node v1, v2 and v3 and then substitute the current equations in so that I can solve for V2 and the current through Rc.

V1:

$i1 = ia$

$i1 = 1 - v2$

ΩV2:
$ia + i3 = ic$
$3v2 - v3 = 1$

V3:
$i4 = i3$
$1 = v3$

Using the systems of equations above for V2 and V3 I can then solve for v2 and determine that…

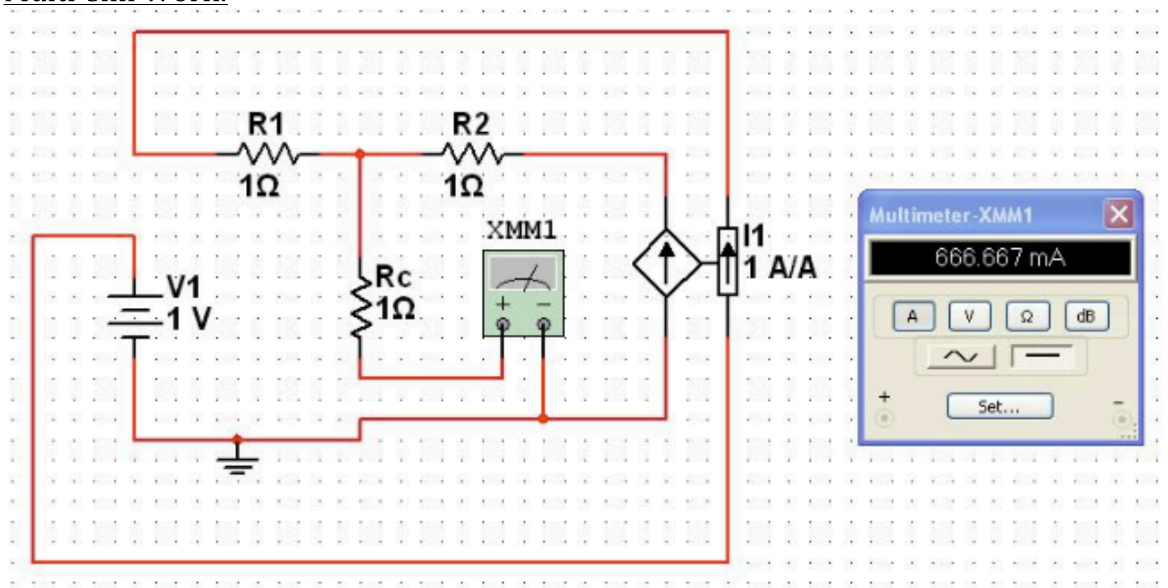
V2 = 2/3 V

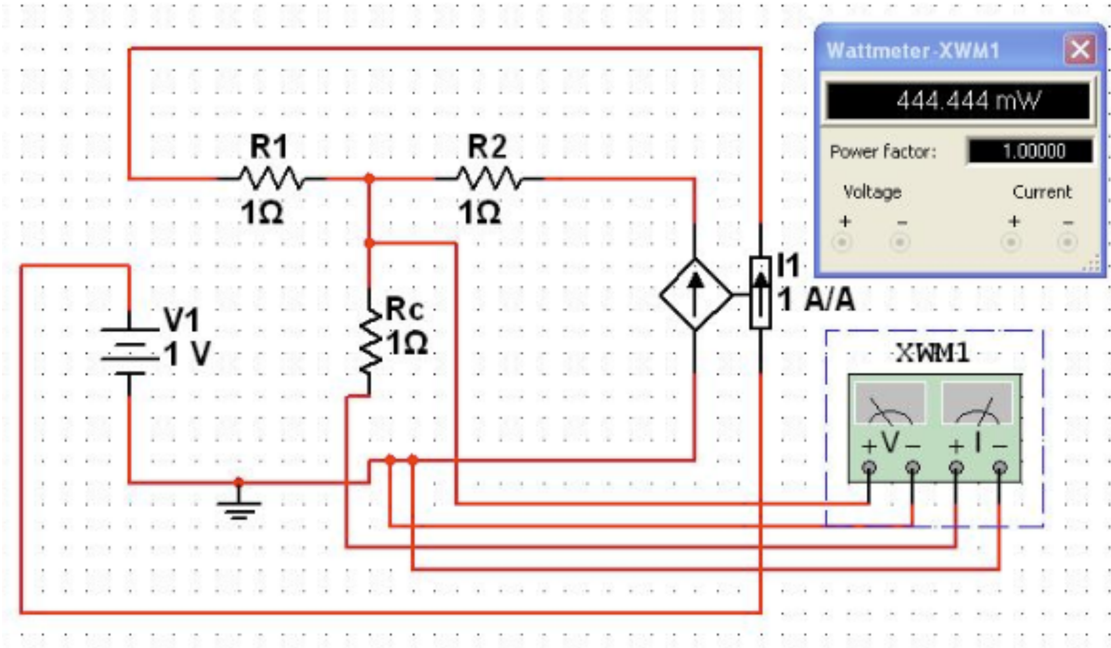
$ic = (v2 - Vg)/1$
$ic = (\frac{2}{3} - 0)/1$ = 2/3A.

Now that we have v2 and ic we can then use P = IV to determine that

P = (2/3)*(2/3) = 4/3 W.

<u>Multi-sim Work:</u>





Conclusion:
My worked results and Multi-sim both verify that the following answers are correct.

V2 = 2/3 V

$ic = (v2 - Vg)/1$
$ic = (\frac{2}{3} - 0)/1$ = 2/3A.

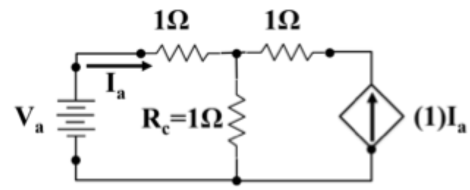
P = (2/3)*(2/3) = 4/3 W.

Question 3b:

Problem Description:

3. For the circuit shown to the right, assume V_a = 1 VDC:

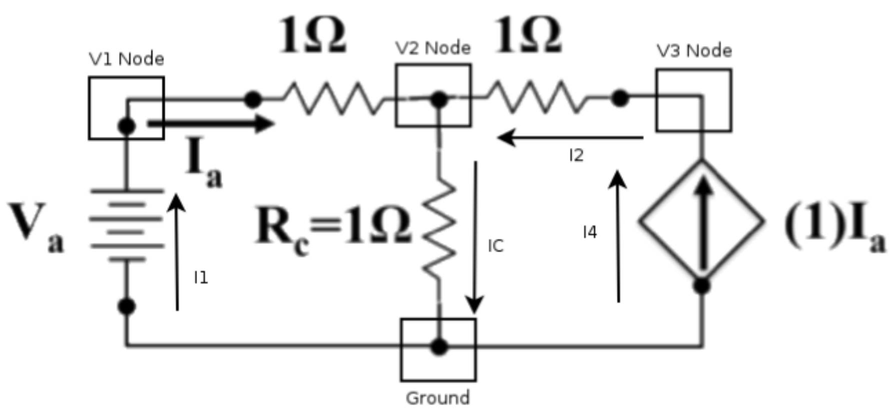
3(a). Compute the power dissipated in R_c.



Concepts Used:
To solve this circuit we will need the voltage and current going through Va and use that to calculate power with P= IV or V^2/R.

My Work:
I begin by identifying the nodes in the circuit, v1, v2, v3 and vg (ground).

Secondly I label currents I1, I2 and Ic and their direction.



Third, I identify the equations for each current.
$i1 = ???$
$ia = (v1 - v2)/1$
$i2 = (v3 - v2)/1$
$ic = (v2 - Vg)/1$
$i4 = ia = (v1 - v2)/1$

Also note that V1 = 1 v.

I can then determine my KCL equations for each node v1, v2 and v3 and then substitute the current equations in so that I can solve for V2 and the current through Rc.

V1:
$i1 = ia$
$i1 = 1 - v2$

V2:
$ia + i3 = ic$
$3v2 - v3 = 1$

V3:
$i4 = i3$
$1 = v3$

Using the systems of equations above for V2 and V3 I can then solve for v2 and determine that...

V2 = 2/3 V

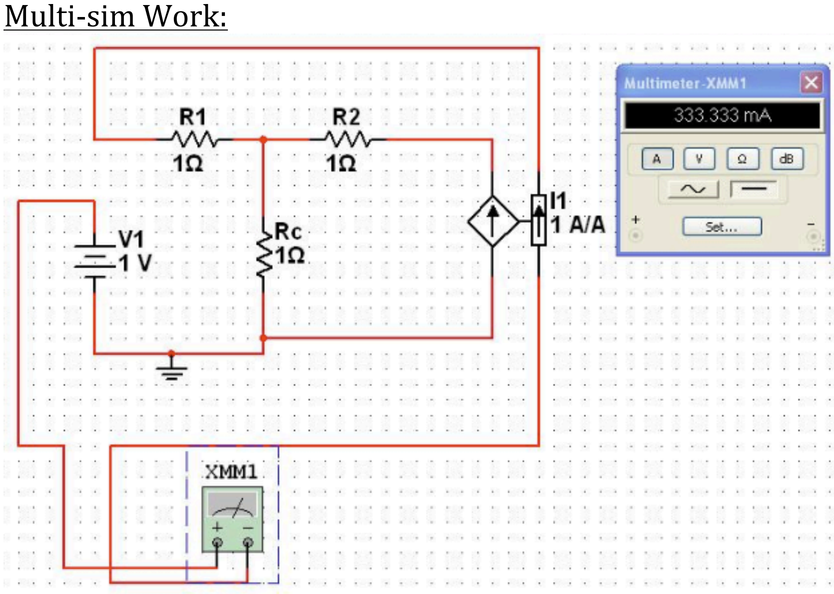
Now that we know that V2 = 2/3v we can then use V2 in our equation for the V1 node to determine that Ia

i1 = 1 – 2/3 = 1/3A.

Now that we have v1 and i1 we can then use P = IV to determine that
$ia = (v1 - v2)/1$
$$ia = \frac{1 - \frac{2}{3}}{1} = 1/3A$$
With this we know that i1 = 1/3 and can determine the power output with the equation found below.

P = (1/3) * (1) = 1/3W.

<u>Multi-sim Work:</u>



Conclusion:

My worked results and Multi-sim both verify that the following answers are correct.

V2 = 2/3 V

$$ia = \frac{1 - \frac{2}{3}}{1} = 1/3A$$

With this we know that i1 = 1/3 and can determine the power output with the equation found below.

P = (1/3) * (1) = 1/3W.