

A Practical Exercise

Name: \_\_\_\_\_

Section: \_\_\_\_\_

**I. Purpose.**

1. Review the construction of a DC series circuit on a quad board from a circuit schematic diagram.
2. Review the application of Kirchhoff's Voltage Law in the analysis of a DC series circuit.
3. Review the calculation of real, supplied and dissipated power in a DC series circuit.
4. Introduce the calculation of total resistance of multiple resistive elements connected in series.
5. Introduce the application of the Voltage Divider Rule in the analysis of a DC series circuit.
6. Introduce the concept of circuit ground and connecting different points of the same circuit to the circuit ground.
7. Introduce the concept of voltage subscripts and the measurement of the voltage as designated by its subscript.
8. Introduce the simplification of voltage sources to point sources in a circuit.

**II. Equipment.**

Agilent 34401A Digital Multimeter (DMM)  
Agilent E3620A Dual DC Power Supply  
Quad Board and Test Leads  
560- $\Omega$  resistor  
220- $\Omega$  resistor  
1000- $\Omega$  resistor

**III. Preparation.**

Review procedures from the *EE Studio Lab Quick Reference Guide* for measuring resistance, voltage, and current.

**IV. Lab Procedure.**

You must **read** and complete each step.

**Step One:** Measure actual resistive values.

- Using your DMM, measure and record the actual resistance of the 1000- $\Omega$  resistor, the 560- $\Omega$  resistor and the 220- $\Omega$  resistor.

	Measured Resistive Values
1000- $\Omega$ resistor	
560- $\Omega$ resistor	
220- $\Omega$ resistor	

# Real Power and Kirchhoff's Voltage Law

## *A Practical Exercise*

**Step Two:** Voltage point sources.

- In the space that is provided below draw the equivalent conventional closed looped circuit schematic of the DC series circuit represented in figure 1.

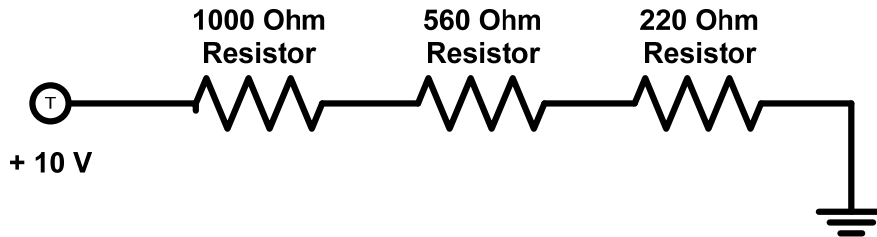


Figure 1

**Step Three:** DC Series Circuit and its total resistance.

- On a QUAD board construct the DC series circuit in Figure 1.
- Calculate the total resistance of this DC series circuit based on your measured resistive values. (Assume that the Dual DC Power Supply has no resistance.)

**Total resistance** \_\_\_\_\_

# Real Power and Kirchhoff's Voltage Law

## *A Practical Exercise*

### Step Four: Voltage Divider Rule.

The voltage across any series resistor is proportional to the magnitude of the resistor. The total voltage dropped across all resistors must equal the applied voltage source(s) by Kirchhoff's Voltage Law.

$V_X = (R_X / R_T) E$ ;  $V_X$  is the voltage across  $R_X$ ,  $R_T$  is the total resistance of series resistors, and  $E$  is the total applied voltage.

- Predict the voltages across each resistor by using the Voltage Divider Rule.

	Predict Voltage drops
1000- $\Omega$ resistor	
560- $\Omega$ resistor	
220- $\Omega$ resistor	

- Using your predicted voltage drops, verify Kirchhoff's Voltage Law in this closed loop DC series circuit.

$$\sum E_{\text{gains}} = \sum V_{\text{drops}}$$

$$\sum \underline{\hspace{2cm}} = \sum \underline{\hspace{2cm}}$$

### Step Five: Measure actual voltage values.

- Using the DMM measure the voltage values.

	Measured voltage values
Voltage Source	
1000- $\Omega$ resistor	
560- $\Omega$ resistor	
220- $\Omega$ resistor	

# Real Power and Kirchhoff's Voltage Law

## A Practical Exercise

Are your measured DC voltage values the same as your predicted DC voltage values? \_\_\_\_\_

Do your measure DC voltage values verify KVL? \_\_\_\_\_

$$\Sigma E_{\text{gains}} = \Sigma V_{\text{drops}}$$

$$\Sigma \underline{\hspace{2cm}} = \Sigma \underline{\hspace{2cm}}$$

### Step Six: Voltage Subscripts.

Voltages are the potential differences between two points. Voltage subscripts are used to designate which two points. Double subscript, e.g.  $V_{bc}$ , designates the voltage potential difference between point **b** and point **c** which can be measured by connecting the red lead from the "Input HI" on the DMM to point **b** and the black lead from the "Input LO" on the DMM to point **c**. Single subscript, e.g.  $V_d$ , designates the voltage potential difference between point **d** which respect to the circuit's common reference point, ground. In this circuit ground is point **d**.  $V_a$  can be measured by connecting the red lead from the "Input HI" on the DMM to point **a** and the black lead from the "Input LO" on the DMM to the circuit's common reference point, ground (point **d**). Furthermore double subscript represents the voltage difference between single subscripts, e.g.  $V_{bc} = V_b - V_c$  or  $V_{cb} = V_c - V_b$ .

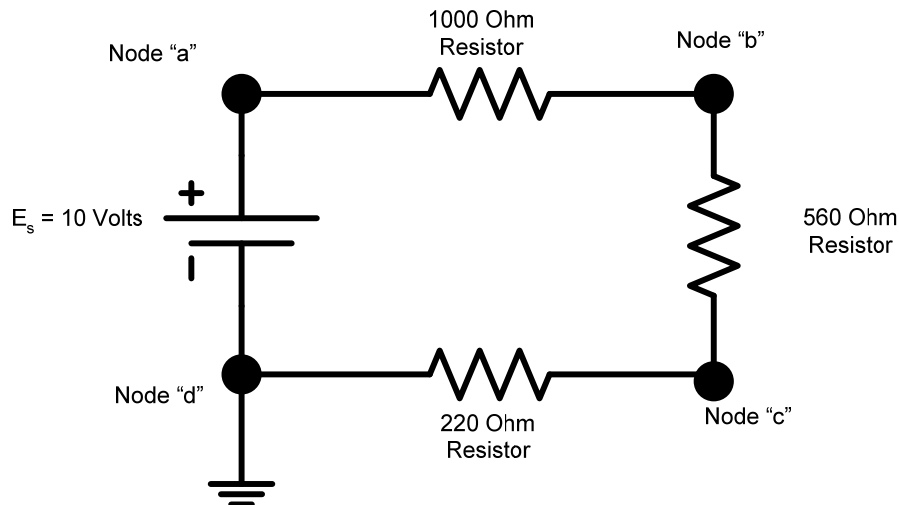


Figure 2

- Using the DMM measure the voltages at the single-subscript points designated.
- Using your measured single-subscript voltage values predict the double-subscript voltage values.
- Using the DMM measure and verify your predicted double-subscript voltage values.

# Real Power and Kirchoff's Voltage Law

## *A Practical Exercise*

	Measured single-subscript voltage values		Predicted double-subscript voltage values	Measured double-subscript voltage values
$V_a$		$V_{ab}$		
$V_b$		$V_{bc}$		
$V_c$		$V_{cb}$		
$V_d$		$V_{db}$		

**Step Seven:** Change circuit ground.

The circuit that we have built designated the “-“ side of the dual DC voltage supply as the common point of reference, ground. This is usually done for simplicity and to help maintain standardization. If we change this common point, ground, to another node of the circuit, the single subscript voltage (nodal voltages) values will change but the voltage across each element and across the source, Ohm’s Law, KVL, and the Voltage Divider Rule will still hold to be true and not change.

- Change your circuit’s common reference from node “d” to node “b” by connecting a GREEN lead from the GREEN input designated “GND” on the Dual DC Power Supply to node “b” (see figure 3).

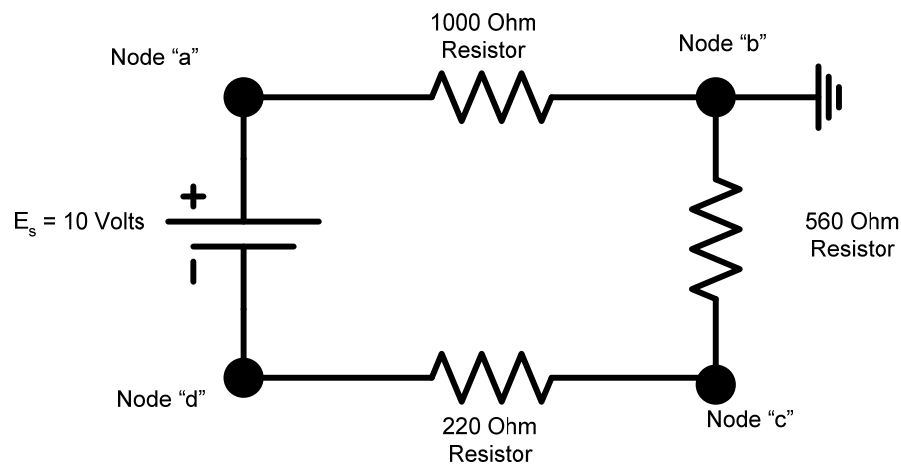


Figure 3

- Using the DMM measure the voltage values across each resistor and voltage source.

# Real Power and Kirchhoff's Voltage Law

*A Practical Exercise*

	Measured voltage values		Measured single subscript voltage values
Voltage Source		$V_a$	
1000- $\Omega$ resistor		$V_b$	
560- $\Omega$ resistor		$V_c$	
220- $\Omega$ resistor		$V_d$	