Course and Section_____ Names _____

Date_____ _____

DC CIRCUITS PH102 EXPERIMENT

Introduction

In this experiment you will determine how voltages and current are distributed in circuits with resistors. You will explore the series and parallel combinations of resistors.

Equipment

Power supply, Multimeter, three 470 Ω, one 1000 Ω, one unknown (colorless) resistor, five cables.

Theory

Resistors are electronic devices with fixed value of resistance *R*. An ideal resistor obeys the Ohm Law which states that the amount of current *I* passing through a resistor is directly proportional to the voltage difference across it.

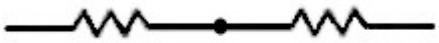
$$I = \frac{\Delta V}{R} \qquad (1)$$

The schematic symbol of a resistor or is 

Resistor can be connected in series or in parallel.

Series

In a series connection the components are connected at a single point, end to end.



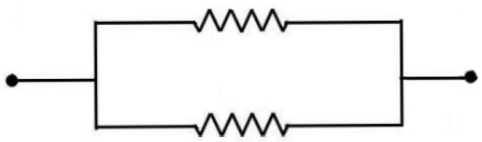
For a series connection, the current through each resistor is the same while the voltages add. The equivalent resistance R_{eq} is calculated by adding the voltages

$$IR_{eq} = V = V_1 + V_2 = I_1 R_1 + I_2 R_1 = I\,(R_1 + R_2)$$

$$R_{eq} = R_1 + R_2 \qquad (2)$$

Parallel

In the parallel connection, the components are connected together at both ends,



For a parallel connection, the voltage across each resistor is the same while the currents will add. The equivalent resistance R_{eq} is calculated by adding the currents

$$\frac{\Delta V}{R_{eq}} = I = I_1 + I_2 = \frac{\Delta V_1}{R_1} + \frac{\Delta V_2}{R_2} = \Delta V\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} \qquad (3)$$

Preliminary questions

You have three identical resistors. You connect two of them in series and to a 12V power supply. If you add the third resistor in series with the others two.

1. How does the voltage across the first two resistors changes?

2. How does the current through the first two resistors change?

You have three identical resistors. You connect two of them in parallel and to a 12V power supply. If you add the third resistors in parallel with the others two.

3. How does the voltage across the first two resistor changes?

4. How does the current through the first two resistors change?

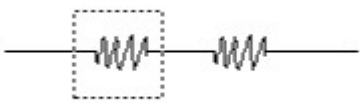
Procedure

Step 1. Turn on the power supply and set the DC voltage to 10 V.

5. Measure the actual power supply voltage V_{PS} with the multimeter and record it below

V_{PS} = _____V

Step 2. Connect two 470 Ω resistors in series.



6. Measure V_1 across R_1 (the resistor in the dashed box) and record it below.

V_1 (measured) = _____ V

Next, you want to compute the expected value of V_1 by using the given equations

7. Calculate the equivalent resistance R_{12}

8. Calculate the total current I

9. Calculate the expected value of V_1

V_1 (expected) = _____ V

10. Calculate the percentage error (assuming the exact value = measured value) of V_1

% error = (|measured - expected| / measured) x 100 = _____

By taking measurements of voltage is possible to find the resistance of the unknown resistor.

Step 3. Connect the unknown resistor R_2 (brown with no color code) in series with the R_1 = 470 Ω resistor and to the power supply.

11. Measure the voltages across each resistor

V_1 (measured) = _____ V,

V_2 (measured) = _____ V,

12. Find the resistance of the unknown resistor. Hint: think about the current I of the two resistors.

R_2 (expected) = _____ Ω.

13. Use the multimeter to measure the resistance of the unknown resistor

R_2 (measured) =

14. Calculate the percentage error assuming the exact value = R_2 (measured)

% error = (|measured - expected| / measured) x 100 = _____

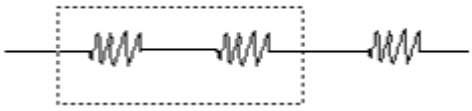
Step 4. Connect three 470 Ω resistors in series and measure the voltage across each resistor.

15. Are your results consistent with your prediction 1?

Step 5. Connect three 470 Ω resistors in parallel and measure the voltage across each resistor.

16. Are your results consistent with your prediction 3?

Step 6. Connect two 470 Ω resistors and the 1000 Ω resistors in series, put the 1000 Ω in the middle.



17. Measure the voltage across the box $V_{BOX} = V_{12}$.

V_{12} (measured) = _____ V,

Next, you want to compute the expected value of V_{12} using the given equations.

18. Calculate the equivalent resistance R_{12}

19. Calculate the equivalent resistance R_{123}.

20. Calculate the total current I

21. Given I, what is value of the the current I_{12} ?

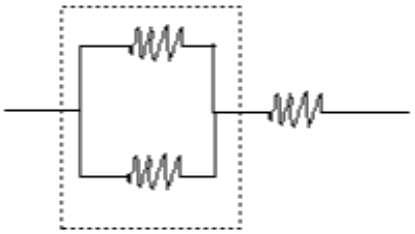
22. By knowing R_{12} calculate the expected value of the voltage across the box

V_{12} (expected) = _____ V

23. Calculate the percentage error of V_{12}

% error = (|measured - expected| / measured) x 100 = _____

Step 7. Remove the 1000 Ω resistor. Connect three 470 resistors as shown into the figure (to the right) and to the power supply.



24. Measure the voltage across the box $V_{BOX} = V_{12}$.

V_{12} (measured) = _____ V,

Next, you want to compute the expected value of V_{12} by using the given equations.

25. Calculate the equivalent resistance R_{123}.

26. Calculate the total current I

27. Calculate the voltage across V_3 (by knowing I_3 and R_3)

28. By knowing V_{PS} and V_3 calculate the expected value of the voltage across the box

V_{12} (expected) = _____ V

29. Calculate the percentage error of V_{12}

% error = (|measured - expected| / measured) x 100 = _____

TURN OFF THE MULTIMETER and THE POWER SUPPLY