Series Circuits

OBJECTIVES

Students will…

- Discover the characteristics of a circuit when resistors are arranged in series.

MATERIALS

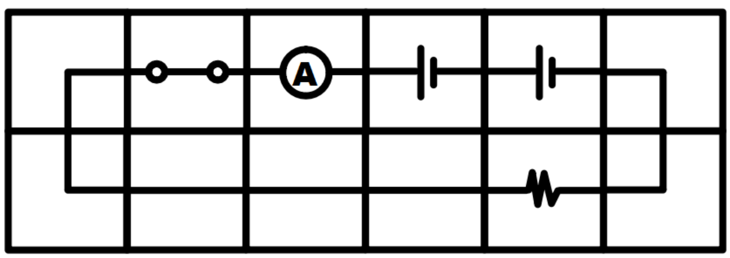
- PASCO modular circuits kit, PASCO wireless voltmeter, PASCO wireless ammeter

SAFETY

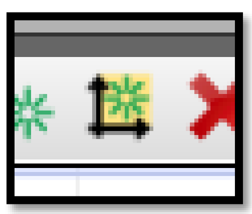
- Be vigilant not to drop or break the electric circuit kit components.
- Leave your switches in the open position when not taking measurements.

PROCEDURE

1. Create a circuit that matches the schematic diagram below. Use the 100 Ω resistor. LEAVE THE SWITCH IN THE OPEN POSITION.



2. Open Capstone and create a graph of current versus time. Then use the symbol shown below to add a second graph. Put voltage on the y-axis and time on the x-axis.

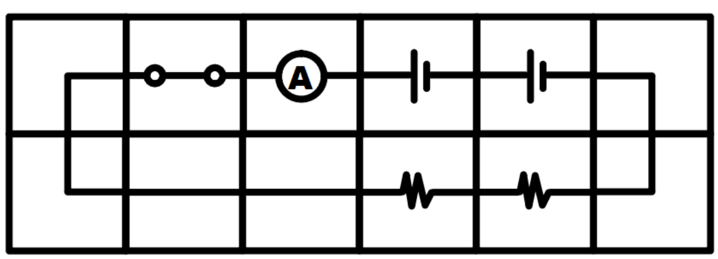


3. Turn on the ammeter. This will allow you to read the current that runs “through” the circuit. Remember to leave the switch in the open position.
4. Turn on the voltmeter and clip the red “positive” lead onto the tab on the side of the resistor that is closest to the positive end of the batteries. Clip the black “negative” lead onto the tab on the side of the resistor that is closest to the negative end of the batteries. This will allow you to measure the voltage “across” the resistor. Remember that the switch should still be in the open position.

5. Press record on Capstone. Close the switch and allow current to run through the circuit for a second or two. THEN OPEN THE SWITCH and stop recording. Be sure that the switch is open when you are not recording.
6. Highlight the portion of the graph showing the time when the current ran through the circuit. Then press the ∑ symbol at the top of the graph to find the mean current. Record the mean current in a data table like the one below. (You will fill out other values later.)

	Resistance (Ω)	Current (A)	Voltage (V)
	100	Step 6	Step 7
Totals	100	Step 8	Step 8

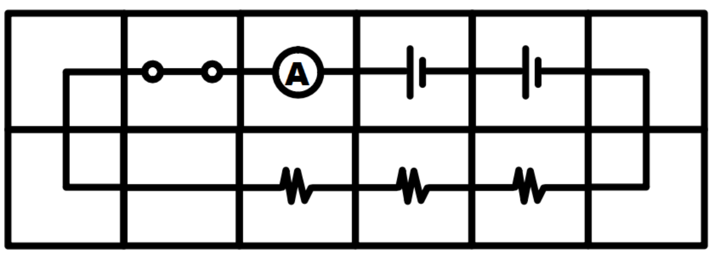
7. Highlight the portion of the Voltage versus Time graph showing the time when the current ran through the circuit. (This should be the same time period as that measured in step six.) Then press the ∑ symbol at the top of the graph to find the mean voltage across the resistor. Record it in the data table where indicated.
8. Unhook the voltmeter leads and place them across the two batteries so that the positive lead is next to the positive end of the left-side battery and the negative lead is next to the negative end of the right-side battery. (Be sure your battery terminals are oriented as shown in the schematic diagram.) Press record and close the switch for one or two seconds. THEN OPEN THE SWITCH. Then again record the current in the circuit and the voltage across the batteries.
9. Keep the 100 Ω resistor in place. Remove the plain wire block to the left of the 100 Ω resistor and replace it with the 33 Ω resistor. Your circuit should now look like the one below. KEEP THE SWITCH IN THE OPEN POSITION.



10. Attach the leads of the voltmeter across the 100 Ω resistor as before. Begin recording and close the switch for one or two seconds. THEN OPEN THE SWITCH. Record the voltage across the 100 Ω resistor and the current through the circuit as you did before in a data table like the one below.

	Resistance (Ω)	Current (A)	Voltage (V)
	100	Step 10	Step 10
	33	Step 11	Step 11
Totals	Step 13	Step 12	Step 12

11. Repeat step nine but this time connect the voltmeter across the 33 Ω resistor.
12. Place the leads of the voltmeter across the two batteries as you did in step eight. Press record and close the switch for one or two seconds. THEN OPEN THE SWITCH. Then again record the total current in the circuit and the voltage across the batteries.
13. Now let's crunch some numbers! Answer the following in writing underneath your data table.
    a. Use Ohm's law using ONLY the numbers in the "Totals" row to figure out what the total resistance might be. (In other words, use only the numbers from step twelve.)
    b. Look at the resistances of the two resistors and figure out what the relationship is between the arrangement of resistors in "series" (meaning one after the other) and the total resistance you just calculated. Write the relationship down. (Worded another way: Without knowing total current, how could one figure out the total resistance in a series circuit if one only knows the voltage in the batteries and the resistance of each resistor?)
    c. Analyze the voltage drop across each resistor and the total voltage available from the batteries to discover a rule regarding how voltage is used in a series circuit. Write that rule and justify it quantitatively. (There are actually two relationships you might observe…Challenge yourself to find both!)
14. Keep the two resistors in place. Remove the wire block to the left of the 33 Ω resistor and replace it with the 10 Ω resistor. Your circuit should now look like the one below. KEEP THE SWITCH IN THE OPEN POSITION.



15. Measure voltage and current as you did before in order to complete the data table as indicated for step 14 (below.) Record the data table in writing. BE SURE ONLY TO CLOSE THE SWITCH WHILE CAPSTONE IS RECORDING DATA.

	Resistance (Ω)	Current (A)	Voltage (V)
	100	Step 15	Step 15
	33	Step 15	Step 15
	10	Step 15	Step 15
Totals	Step 16	Step 15	Step 15

16. For the final block in the data table, apply the rule you discovered in step twelve. Does this rule apply? Show your work and write down your answer to the question to say whether the rule applied.
17. Analyze the voltages using the rule you discovered in step thirteen part c. Answer in writing: Does the rule apply? Justify your answer quantitatively.