SNC1D PHYSICS

THE CHARACTERISTICS OF ELECTRICITY

☞ Series & Parallel Circuits (P.450-452)

Activity#1: Series Circuit Analysis (D19/P.455)

INSTRUCTIONS

A. Read the activity "D19: Series Circuit Analysis".
B. Follow the instructions given (i.e. procedure 1 to 8).

NOTE!

- Use PhET – Circuit Construction Kit (DC only)
- Reverse the order of the instructions – start with two resistors and then add a third.

Activity#1: Series Circuit Analysis (D19/P.455)

OBSERVATIONS

		Power Supply	Resistor #1	Resistor #2	Resistor #3
Part 2	Current (A)	0.45	0.45	0.45	
	Voltage (V)	9.0	4.5	4.5	
Part 1	Current (A)	0.3	0.3	0.3	0.3
	Voltage (V)	9.0	3.0	3.0	3.0

QUESTIONS

1. In Parts 1 and 2 what did you notice about the current and voltage?

Part 1 ☞ $I_1 = I_2 = I_{source}$ $V_1 + V_2 = V_{source}$

Part 2 ☞ $I_1 = I_2 = I_3 = I_{source}$ $V_1 + V_2 + V_3 = V_{source}$

Activity#1: Series Circuit Analysis (D19/P.455)

OBSERVATIONS

		Power Supply	Resistor #1	Resistor #2	Resistor #3
Part 2	Current (A)	0.45	0.45	0.45	
	Voltage (V)	9.0	4.5	4.5	
Part 1	Current (A)	0.3	0.3	0.3	0.3
	Voltage (V)	9.0	3.0	3.0	3.0

QUESTIONS

2. When another resistor was added in series what happened to:
   (a) the current across the power supply — it decreased
   (b) the voltage across each resistor — they decreased

Activity#1: Series Circuit Analysis (D19/P.455)

OBSERVATIONS

		Power Supply	Resistor #1	Resistor #2	Resistor #3
Part 2	Current (A)	0.45	0.45	0.45	
	Voltage (V)	9.0	4.5	4.5	
Part 1	Current (A)	0.3	0.3	0.3	0.3
	Voltage (V)	9.0	3.0	3.0	3.0

QUESTIONS

3. What is the effect of adding an identical load in series in a circuit?

   the overall resistance of the circuit increases while the current decreases (since V=IR and V is constant)

Activity#2: Parallel Circuit Analysis (D20/P.456)

INSTRUCTIONS

A. Read the activity "D20: Parallel Circuit Analysis".
B. Follow the instructions given (i.e. procedure 1 to 8).

NOTE!

- Use PhET – Circuit Construction Kit (DC only)
- Reverse the order of the instructions – start with two resistors and then add a third.

Activity#2: Parallel Circuit Analysis (D20/P.456)

OBSERVATIONS

		Power Supply	Resistor #1	Resistor #2	Resistor #3
Part 2	Current (A)	1.8	0.9	0.9	
	Voltage (V)	9.0	9.0	9.0	
Part 1	Current (A)	2.7	0.9	0.9	0.9
	Voltage (V)	9.0	9.0	9.0	9.0

QUESTIONS

1. In Parts 1 and 2 what did you notice about the current and voltage?

   Part 1 ☞ $I_1 + I_2 = I_{source}$ $V_1 = V_2 = V_{source}$

   Part 2 ☞ $I_1 + I_2 + I_3 = I_{source}$ $V_1 = V_2 = V_3 = V_{source}$

Activity#2: Parallel Circuit Analysis (D20/P.456)

OBSERVATIONS

		Power Supply	Resistor #1	Resistor #2	Resistor #3
Part 2	Current (A)	1.8	0.9	0.9	
	Voltage (V)	9.0	9.0	9.0	
Part 1	Current (A)	2.7	0.9	0.9	0.9
	Voltage (V)	9.0	9.0	9.0	9.0

QUESTIONS

2. When another resistor was added in parallel what happened to:

   (a) the current across the power supply it increased

   (b) the voltage across each resistor they stayed the same

Activity#2: Parallel Circuit Analysis (D20/P.456)

OBSERVATIONS

		Power Supply	Resistor #1	Resistor #2	Resistor #3
Part 2	Current (A)	1.8	0.9	0.9	
	Voltage (V)	9.0	9.0	9.0	
Part 1	Current (A)	2.7	0.9	0.9	0.9
	Voltage (V)	9.0	9.0	9.0	9.0

QUESTIONS

3. What is the effect of adding an identical load in parallel in a circuit?

   the overall resistance of the circuit decreases while the current increases (since V=IR and V is constant)

Activity#3: Resistance in Series & Parallel

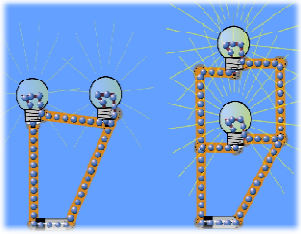
INSTRUCTIONS

A. Open the PhET Circuit Construction Kit (DC only).
B. On the same screen, build the following:
   (i) a circuit with 2 bulbs in series and
   (ii) a circuit with 2 bulbs in parallel.
C. Make observations about the brightness of the bulbs.
D. Add a third bulb to each circuit.
E. Repeat your observations.

Activity#3: Resistance in Series & Parallel

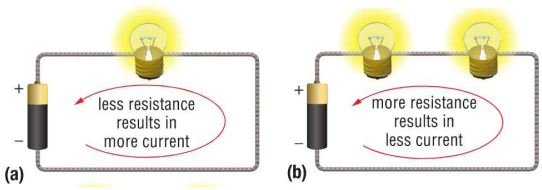
QUESTIONS

1. You should have observed that when the bulbs were connected in series, the brightness of the bulbs was less than when the lamps were connected in parallel. Why?



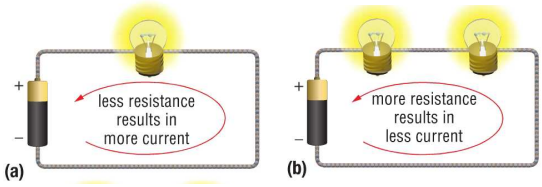
Loads in Series

If you have a circuit with one load (a), the total resistance of the circuit will be less than if you have two or more of those loads connected in series (b). The electrons have only one path to follow and with two or more loads, they have more "obstacles" to deal with. Because of this, the current flowing through circuit (b) will be less than the current flowing through circuit (a). In either case, the current is the same in all parts of a series circuit.



Loads in Series

Electrons use up all their potential energy going around a series circuit no matter how many loads are in the circuit. For example, the electrons that leave a 12-V battery will "lose" all 12 V before they return to the battery. Each load will use part of the total potential difference, depending on how much it resists the flow of electrons. So more lamps connected in series means less potential energy gets converted into heat and light and the voltage drop across each load decreases.



Loads in Series

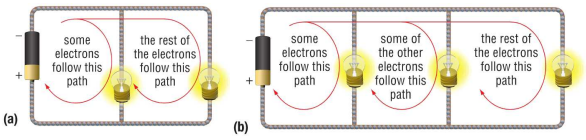
PRACTICE

1. A circuit has a 12 V battery and two 12 Ω loads connected in series.
   (a) Calculate the voltage drop across each load.
   (b) Calculate the current through each load and the circuit.
   (c) Another 12 Ω load is connected in series. Repeat (a) and (b).

   (a) V = 6 V
   (b) I = 0.50 A
   (c) V = 4 V & I = 0.33 A

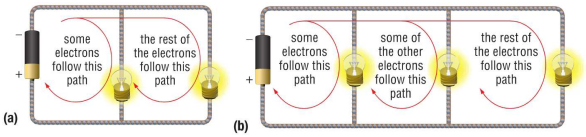
Loads in Parallel

If you have a circuit with two identical loads connected in parallel (a), electrons leaving the battery have two possible paths to follow. Since each of these paths has the same load, the current splits in two. Similarly, if you have a circuit with three identical loads connected in parallel (b), the current splits in three. So, as the number of paths increases the amount of current that flows in each is reduced accordingly.



Loads in Parallel

However, each electron that flows through any one of the branches of a parallel circuit has the same amount of energy, and electrons must expend all their energy on the path they are on. This is why the potential difference across parallel resistors will always be the same, even though the resistors themselves may have different values.



Loads in Parallel

PRACTICE

2. A circuit has a 12 V battery and two 12 Ω loads connected in parallel.
   (a) Calculate the voltage drop across each load.
   (b) Calculate the current through each load and the circuit.
   (c) Another 12 Ω load is connected in parallel. Repeat (a) and (b).

   (a) V = 12 V
   (b) I = 1.0 A
   (c) V = 12 V & I = 1.0 A

Loads in Series & Parallel

	SERIES CIRCUIT	PARALLEL CIRCUIT
Resistance	• increases as loads added	• decreases as loads added
Potential Difference	• splits based on # of loads	• same throughout
Current	• same throughout	• splits based on # of paths