

Name:

Date:

Class:

Worksheet: Windshield Wipers, Pacemakers and RC Circuits- Narrative for Instructors

ACTIVITY NARRATIVE FOR INSTRUCTORS (highlighted in blue)

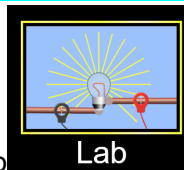
The simulations are an open-source resource and thus do not require materials to perform. If the instructor does not want the students to respond electronically, then paper copies of the activities must be made, distributed, and collected.

Student actions are color coded -Orange indicates that they are to insert a screenshot of the desired information and do something with the screenshot - add description or labels. For nonelectric versions, students could draw their observation. Yellow indicates that students are to provide a written answer in the blank or table.

ACTIVITY 1 - PRE-ACTIVITY - Familiarize yourself with the simulation

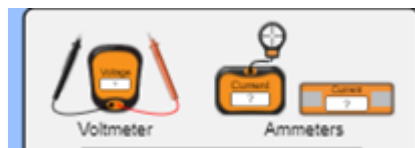
PROCEDURE:

Use the following [simulation](#) to design the circuits described in each of the challenges. The simulation is hyperlinked to the electronic worksheet. For the paper version, the link will need to be posted or inserted.

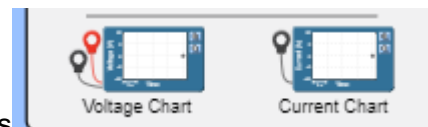


Select the Lab tab

You will change this  to  start or stop the simulation.



Use the voltmeter and ammeter to gather data and



the voltage chart and current chart to view your results

Answer any questions in the challenge to record your observations and analysis

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DESIGN CHALLENGES **Context for the Engineering challenges:** Students will design and test various circuits to fit the engineering constraints of the challenge and verify the expected relationships between voltage and current graphically.

ENGINEERING CHALLENGE #1 - Single (series) circuit

Create a circuit using 1 battery, 1 switch, two resistors, and 1 wire.

If all circles at the end of the parts(components) turn black, you have correctly attached them.

Close the switch to create a closed circuit if the blue charges move (current flows.)

YOU SUCCEEDED in this challenge.!!!

Insert a screenshot of your circuit. Label it Series Circuit **Expected label: Series Circuit**

Can you rearrange the parts(components) of your circuit to create multiple paths for the electricity to flow through all the parts? _____ **No**

On the same screen, complete Challenge #2 so you can compare the circuits.

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ENGINEERING CHALLENGE #2 - Multiple path (parallel) circuit

Create a circuit using 1 battery, 1 switch, two resistors, and 3 wires so the electrons flow (electricity moves) through each resistor **separately** and continues to flow only if the switch is closed.

If all circles at the end of the parts(components) turn black, you have correctly attached them.

After closing the switch (creating a closed circuit), if you remove just one resistor at a time and the blue charges keep moving (current flows), YOU SUCCEEDED in this challenge.!!!

Insert a screenshot of your circuit. Label it Parallel Circuit. Expected label: Parallel Circuit

ANALYSIS

How does electron flow differ going through the components of a series and a parallel circuit?

they can go independently through different paths in a parallel circuit but there is only one path for the electrons to move through (flow) in a series circuit.

COMPONENTS (PARTS)

SWITCH

What position must the switch be to allow the electricity to flow? closed

BATTERY

Click on the battery in one of your circuits (so a yellow frame appears) to answer the following:
(REMEMBER to close the circuit before answering)



How does clicking on this button change the flow of electrons? their direction changes

How does changing the voltage change the flow of electrons? their speed changes

RESISTOR

Click on a resistor in one of your circuits (so a yellow frame appears) to answer the following:
(REMEMBER to close the circuit before answering)

How does changing the resistance change the flow of electrons? their speed changes

ANALYSIS

Does maximizing the resistance in ONE resistor change the motion of electrons in the same way in both circuits you created? Explain your observations. in a series circuit the speed is changed for all the electrons, In a parallel circuit, the speed of the electrons going through the changed resistor are the only ones slowed.

Compare the results of changing the resistance of ONE resistor to 0 ohms in each circuit you created. Explain your observations. in a series circuit the speed is changed for all the electrons, In a parallel circuit, the speed of the electrons going through the changed resistor are the only ones increased.

Name:

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PROBES

Place the tips of the probes of the voltmeter in the black circles on each component (part) both circuits.




The ? disappears once you find the correct location.

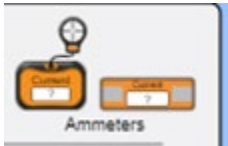
What do you note about the readings if you reverse the red and black probes on the voltmeter locations?

The voltage changes from positive to negative.

Record your readings Answers will vary

Voltage across	Battery	Resistor 1	Resistor 2	Wire
In Series Circuit				
In Parallel Circuit				

Move the ammeter probe (the ) over the center of wire or components (parts) on both circuits.



The ? disappears once you find the correct location.

Record your readings Answers will vary

Current in	Battery	Resistor 1	Resistor 2	Wire
In Series Circuit				
In Parallel Circuit				

Describe the difference in current readings when resistors are in a series circuit or a parallel circuit.

Answers should be consistent with the data they collected

Name:
CHARTS

Date:

Class:

Like the probes, note the voltage chart is created with two probes since voltage is measured across components (parts). The current chart is created with one probe since current is in components of circuits.

Place the probes of the charts in the same locations as you did the probes on the voltmeter and ammeter and observe the shape of the graph as you open and close the switch on each circuit.

Insert screenshots of graphs from both circuits include these labels.

- Chart name:
- Circuit observed: Series
- Component measured.
- Number of times the switch was opened and closed.
- **Insert** screenshots of graph here

Chart name:
Circuit observed: Parallel
Component measured.
Number of times the switch was opened and closed.
Insert screenshots of graph here

Chart name:
Circuit observed: Series
Component measured.
Number of times the switch was opened and closed.
Insert screenshots of graph here

Chart name:
Circuit observed: Parallel
Component measured.
Number of times the switch was opened and closed.
Insert screenshots of graph here

ANALYSIS

Describe the shape of the graph drawn in both the voltage and current charts.

Answers should be consistent with the screenshot students provided and should look like this



Name:
ACTIVITY 2 - Circuits

Date:

Class:

ENGINEERING CHALLENGE #3

Create a circuit using 1 battery, 1 switch, 1 resistor, 1 capacitor, 1 lightbulb and 2 wires.

If all circles at the end of the parts(components) turn black, you have correctly attached them.

When you close the switch (creating a closed circuit), IF the blue charges move (current flows) you have correctly attached the components. REMEMBER to build the circuit with the switch open until you are ready to test the circuit.

BLOW OUT UPGRADE: Insert a screenshot of your circuit where the battery catches on fire and the light explodes.

What happened to the capacitor in this circuit? The plates get filled with charges and it stops

RC Series Circuit -

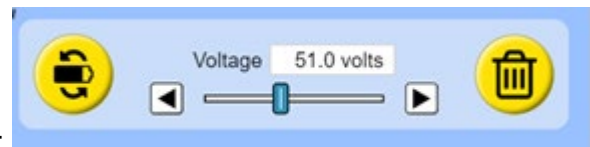
Testing series RC Circuit

Insert a screenshot of a series circuit using ONLY the supplies listed above. Remember the electricity can only flow through one path, while building the circuit **keep the switch open** until you are ready to test the circuit. It is okay to keep rebuilding the circuit to make your observations if it is too hard to see everything at once.

Record observations after the circuit is closed.:

	OBSERVATION
Current	
Lightbulb	
Capacitor	

The current flowed then stopped. The lightbulb lit up until the current stopped. The capacitor filled with charged stopping the current. Encourage students to rebuild with and without the switch to see the capacitor is the cause of stopping the current.



Click on the battery to get the yellow frame and this window:

Name:

Date:

Class:

Describe two ways you could change the battery traits listed in the blue box to get the current moving again and the light to turn back on when the circuit is closed. Changing the direction or the voltage turns the light back on.

Name:

Date:

Class:

MINI LESSON

Current that changes direction is called AC (alternating current.)
Current that only goes in one direction is called DC (direct current.)

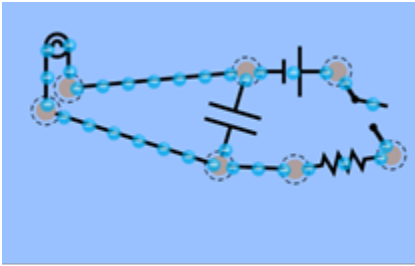
RC Parallel Circuit -

Testing parallel RC Circuit

Normally, the parts of circuits are represented by symbols in an illustration called a schematic



Use this tab below the parts window on the left to identify the parts in this parallel circuit schematic.



Identify the names of the components in the schematic above in the table below.

Symbol	Name
	Wire

Answers for table: battery, lightbulb, resistor, capacitor, switch

Name:
PROCEDURE

Date:

Class:

Build the parallel RC circuit illustrated above using pictures or symbols. REMEMBER to build the circuit with the switch open until you are ready to test the circuit. Observe the current as you open and close the switch.

Insert a screenshot of your circuit.

Using sentences describe the circuit you constructed.

Answers should be consistent with the screenshot students provided

Why do you think it is called a RC circuit? contains resistors and capacitors

CHARTS

Like the probes, note the voltage chart is created with two wires since voltage is measured across components (parts). The current chart is created with one wire since current is in components of circuits.

Place the wires of the charts in the same locations as you would the probes on the voltmeter and ammeter and observe the shape of the graph as you open and close the switch. You can use the voltmeter and ammeter to verify you are getting a reading before placing the probes for the charts in those locations, if needed.

Insert Screenshots of graphs from the circuit include these labels.

Chart name:

Circuit observed: Parallel

Component measured.

Number of times the switch was opened and closed.

Insert screenshots of graph here

Answers should be consistent with the screenshot students provided and should have a slight curve to it

instead of just 

ANALYSIS

Describe the shape of the graph drawn in both the voltage and current charts on the parallel circuit as you open and close the circuit.

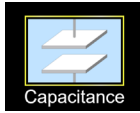
Name:

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ACTIVITY 3 - Coulomb's Law and Capacitors

Using this [simulation](#), study the nature of capacitors. The simulation is hyperlinked to the electronic worksheet. For the paper version, the link will need to be posted or inserted.



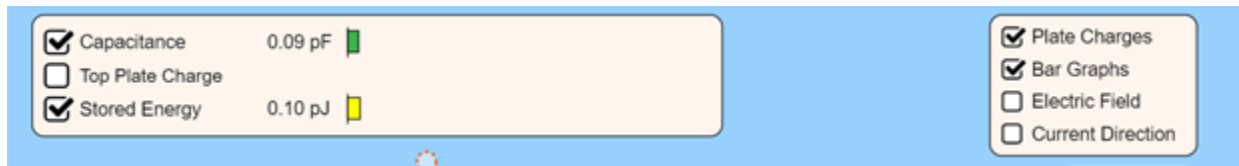
Select this tab

OBJECTIVE: Students will relate the nature of capacitors to Coulomb's Law

BACKGROUND: Coulomb's Law relates the magnitude of charges and distances between them to the electrostatic forces between them. The capacitance of a capacitor is the ratio of charge stored on the plates to the resulting voltage (potential difference) between the plates of the capacitor. Capacitance is directly proportional to the electrostatic force field between the plates.

PROCEDURE - Familiarize yourself with the simulation

Select Capacitance tab, Stored energy, Plate Charges, and Bar Graphs



1. What are the units for Capacitance? Farads for this simulation picoFarads
2. What are the units for Stored Energy? Joules for this simulation picoJoules
3. What type of circuit is used in this simulation? Series
4. Does the simulation start with an open or closed circuit? closed
5. What is the effect of changing the distance between plates on capacitance?
Distance and capacitance are indirectly related
6. What is the effect of changing the plate area on capacitance? Plate area and capacitance are directly related
7. What is the effect of changing the voltage on the battery on capacitance? Voltage and capacitance are independent of each other

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Open the Circuit and observe the changes in capacitance. You select other changes and make observations to complete the table. See above for expected answers. Independent student changes and answers should be consistent.

Change	Change in Capacitance
Decrease distance between plates	
Decrease plate area	
Increase battery voltage to 1.5 v	

Coulomb's Law states that increase in distance between plates decreases the electrostatic force between the charges. What data did you collect that supports this claim? Answers should be consistent with the data students collected.

Coulomb's Law states that an increase in charge increases the electrostatic force between the charges. Capacitance is directly proportional to the electrostatic force field between the plates. Voltage is a measure of electromotive force that pushes a current through a circuit.

Insert two screenshots where one shows few charges on the plates and the reading on the voltmeter and the second screenshot that shows many charges on the plates and the reading on the voltmeter. (Remember the probes must touch different plates to get a reading.) The ? disappears once you find the correct location.



Name:

Date:

Class:

ANALYSIS

Describe the pattern seen in the screenshots you inserted. Answers should be consistent with the screenshots students provided.

Did the capacitance change for your two screenshots? Answers should be consistent with the data students collected.

Was this an expected result? Why or why not? Answers should be consistent with the data students collected.

Insert two screenshots where you have only changed the distance between the plates and the reading on the



voltmeter. (Remember the probes must touch different plates to get a reading.) The ? disappears once you find the correct location.

ANALYSIS

Describe the pattern seen in the screenshots you inserted. Answers should be consistent with the screenshots students provided.

Did the capacitance change for your two screenshots? Answers should be consistent with the data students collected.

Was this an expected result? Why or why not? Answers should be consistent with the data students collected.