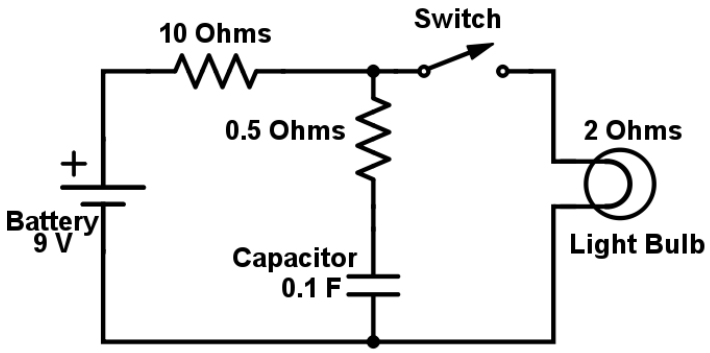
Capacitors in Circuits Activity

Physics

Part One: DC Circuit with Capacitor

Using the simulation "Circuit Construction Kit (AC + DC)" from the Phet website, build the circuit below. Start with the switch in the open position (disconnecting the light bulb from the circuit).

1. Wait for a few seconds with the switch open – what happens with the circuit? Explain, using the information from the Electrostatics unit, what is going on with the capacitor and how that relates to the voltage of the battery. (You don't need to analyze the capacitor mathematically, but you should be able to explain what you see in general terms.)
2. Close the switch, connecting the light bulb to the circuit. Describe what you see – both immediately after closing the switch and also in the couple of seconds afterwards. If you open the switch, wait for a few seconds, and then close it, the behavior should repeat each time.
3. Explain qualitatively (without worrying about numbers or equations) what happens with the circuit after you close the switch. Why does the current flow the way that it does? What role does the capacitor play in the flow of current?
4. Change the value of the resistors, the capacitor, and the resistance of the light bulb in order to explore how changing these parameters affects the way the circuit works. Make a note of any interesting behavior you observe.
5. What sorts of purposes might this circuit be used for? (Hint – you almost certainly use devices with these types of circuits every day.)

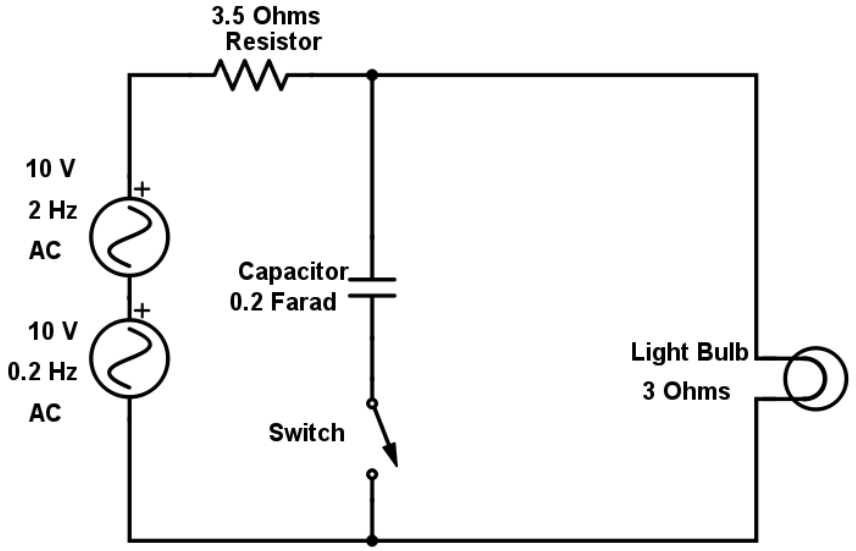


Part Two: AC Circuit with Resistor in Series; Capacitor in Parallel

Using the same Phet simulation, build the circuit below. Note that there are two AC voltage sources in series with each other; the two voltage sources have different frequencies. Make sure that the switch connecting the capacitor to the circuit is open (i.e., current will not flow through that branch of the circuit). We haven't talked about AC voltage yet – we will – but in the meantime all you need to understand is that AC voltage sources do not have a constant voltage difference between the terminals. Instead, one of the terminals varies, typically in a

sine wave pattern, between a positive voltage and an equal negative voltage. You'll see the effects of this type of voltage in the currents generated by the circuit you build.

6. With the switch open (and the capacitor disconnected from the circuit) describe the movement of current and the resulting behavior of the light bulb. You do not need to use numbers or math; just explain in words what you are seeing on the screen.
7. Use the Voltage Chart tool to observe the voltage drop across the light bulb (place the positive lead of the tool on the wire at the top of the light bulb and the negative lead of the tool on the wire at the bottom of the light bulb). Adjust the zoom by clicking the "+" or "-" buttons until the wave being drawn just barely fits into the window (you'll need to let the current flow for a minute or so as the voltage is constantly changing). Draw a picture of the graph you see and explain in words what you think is going on. Think about the two AC voltage sources and explain how you think the frequency of those voltage sources would be represented in the appearance of the graph.
8. Now close the switch (connect the capacitor to the circuit). Take a few moments to observe the graph. Draw the new graph and describe the main differences in appearance between the graphs before and after the switch was closed.
9. From a mathematical standpoint, what does this circuit do when the capacitor is connected? Use your existing understanding of sine waves and wave frequency (from your math or other science classes) to explain your response.
10. What do you think some purposes of this circuit might be? Hint – if you have a car, you almost certainly have a device in your car that has a circuit just like this. If you want, you can do some internet research to help you come up with specific uses for this circuit.



Part Three: AC Circuit with Capacitor in Series; Resistor in Parallel

Change your circuit so that it looks like the circuit below (if possible, use two computers so you can keep the circuit from Part Two active in order to compare and contrast the graphs). Again,

make sure the switch is open when you build the circuit, and set up the Voltage Chart to measure the voltage drop across the light bulb.

11. With the switch open (and the resistor disconnected from the circuit) describe the movement of current and the resulting behavior of the light bulb. As above, you do not need to use numbers or math; just explain in words what you are seeing on the screen.
12. Adjust the Voltage Chart so the wave just fits in the window, and draw a picture of the graph you see and explain in words what you think is going on. (This should be almost identical to what you noticed in question 6 above.)
13. Now close the switch (connect the resistor to the circuit). Take a few moments to observe the graph. Draw the new graph and describe the main differences in appearance between the graphs before and after the switch was closed. Also explain the differences between the new graph and the graph you saw in the second circuit when the resistor was connected.
14. From the standpoint of sine waves and wave interactions, what does this circuit do when the resistor is connected? Compare your answer to this question to your answer to question 9 above. Make sure that, to the best of your ability, you explain what is going on mathematically with the wave form you are seeing.
15. What do you think some purposes of this circuit might be? Hint – the same device in your car that has the second circuit probably has this circuit as well. See you if can figure out what the device is, how the circuits are connected, and when/why you would use them (the internet will be very helpful in solving this problem).