3.0 - R-C Circuits

About R-C circuits

R-C circuits utilize their resistance to decrease the current flow into and out of a capacitor, increasing the time it takes to charge and discharge. This characteristic allows R-C circuits to interact with AC signals, making them important in filtering and wave-shaping circuits.

Capacitor charging activity

1. Select the large capacitor from your electronic parts. If your multimeter has a capacitance measurement function, measure the value of the capacitor. Otherwise, just record the labelled value. **Note: This may be a polarized capacitor. Be sure to observe the correct polarity during measurement and when connecting polarized capacitors to a power supply!**

   C(labelled) = C(measured) =

2. Ensure the capacitor is discharged by shorting its leads. To confirm the capacitor is discharged, measure the potential across its leads:

   V_C =

3. Set a power supply to 10 V, then turn the power supply off. Connect the capacitor, **verifying the polarity is correct**. Connect a voltmeter to the capacitor. Observe the voltmeter as you turn the power supply on. How much time does it take to charge the capacitor?

   t_C =

4. The time constant of an R-C circuit is given by the formula: $\tau = R \times C$. Obtain a 10 kΩ resistor and, after measuring it's value, calculate the time constant of your R-C circuit.

   R = τ =

5. Draw a schematic of your resistor and capacitor connected in series with a 10 V power supply.

6. Discharge the capacitor before building your series R-C circuit. Connect your voltmeter across the capacitor. Turn on the power supply and record how long it takes to fully charge.

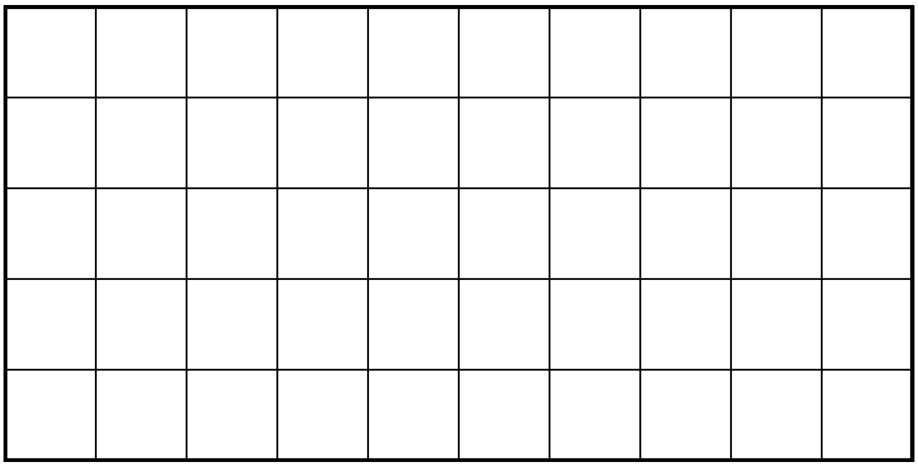
   t_{RC} =

   Teacher Check ☐

7. Does the time constant calculated in step 4 relate to the charge time in step 6. If so, how?

8. Next, measure the voltage drop across the capacitor at 10 second intervals. Graph the result.

0 s	V_C = **0 V**	10 s	V_C =	20 s	V_C =
30 s	V_C =	40 s	V_C =	50 s	V_C =
60 s	V_C =	70 s	V_C =	80 s	V_C =



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R-C circuit activity

9. Replace the large capacitor in your circuit with a small, non-polarized capacitor. Then, connect this new R-C circuit to an AC source. Measure the AC potential across each component:

   V_R = V_C =

10. The measurements in step 9 might look similar to what you would expect in a typical series resistor circuit. This means the capacitor is acting like a resistor. How can this be? Using the resistor value and its potential, calculate the circuit current. Then calculate the capacitor's resistance.

    I_R = R_C =

11. What is your capacitor's value? Use the formula for capacitive reactance, below, to calculate X_C. How close is the calculated reactance value to the equivalent resistance, R_C, above?

    C = $X_C = 1 / (2 \times 3.14 \times f \times C)$

12. Look at the reactance formula in step 11. Try to infer what would happen to the apparent resistance of the capacitor as the frequency of the AC wave increases or decreases.