July 28, 2019

Series and parallel connection of capacitors

Data:

Series

C (Capacitors in series)	V (volts) measured	Q (coulomb) = CV
$C_1 = 100\ \mu F$	5.17 V	$(5.17 * 10^{-4})$ C
$C_2 = 330\ \mu F$	1.68 V	$(5.544 * 10^{-4})$ C
	$V_{batt} = 9$	$Q_{av} = (5.357 * 10^{-4})$ C
$C_{eq} = Q_{av}/V_{batt}$	C_{eq} (measured) $= (5.952 * 10^{-5})$ F	
$1/C_{eq} = 1/C_1 + 1/C_2$	C_{eq} (predicted) $= (7.67442 * 10^{-5})$ F	

Calculations:

Converting μF to F: $C_1 = (100 * 10^{-6}) = (1 * 10^{-4})$ F: $C_2 = (330 * 10^{-6}) = (3.3 * 10^{-4})$ F

Calculating Q: $Q_1 = (1 * 10^{-4}) * (5.17) = (5.17 * 10^{-4})$ C

$Q_2 = (3.3 * 10^{-4}) * (1.68) = (5.544 * 10^{-4})$ C

Calculating $Q_{av} = (5.17 * 10^{-4}) + (5.544 * 10^{-4}) = (.0010714)/2 = (5.357 * 10^{-4})$ C

Calculating C_{eq} (measured) $= (5.357 * 10^{-4})/(9) = (5.952 * 10^{-5})$ F

Calculating C_{eq} (predicted) $= 1/C_{eq} = (1/(1 * 10^{-4}))+(1/(3.3 * 10^{-4})) = 13030.30303$ F

C_{eq} (predicted) $= (13030.30303)^{-1} = (7.67442 * 10^{-5})$ F

$V_{tot} = V_1 + V_2$: $(5.17) + (1.68) = 6.85$ V

Parallel

C (Capacitors in parallel)	V (volts) measured	Q (coulomb) = CV

$C_1 = 100\ \mu F$	7.03	$(7.03 * 10^{-4})$ C
$C_2 = 330\ \mu F$	7.03	$(2.32 * 10^{-3})$ C
C_{eq} (measured)= Q_{total}/V_{batt}	$V_{batt} = 9$	$Q_{tot} = .0030229$ C
$C_{eq} = Q_{tot}/V_{batt}$	C_{eq} (measured) = $(3.35878 * 10^{-4})$ F	
$C_{eq} = C_1 + C_2$	C_{eq} (predicted) = $(4.3 * 10^{-4})$ F	

Calculations:

Converting μF to F: $C_1 = (100 * 10^{-6}) = (1 * 10^{-4})$ F: $C_2 = (330 * 10^{-6}) = (3.3 * 10^{-4})$ F

Calculating Q: $Q_1 = (1 * 10^{-4}) * (7.03) = (7.03 * 10^{-4})$ C

$Q_2 = (3.3 * 10^{-4}) * (7.03) = (.0023199)$ C or $(2.32 * 10^{-3})$ C

Calculating $Q_{tot} = Q_1 + Q_2$: $(7.03 * 10^{-4}) + (2.32 * 10^{-3}) = .0030229$

Calculating $C_{eq} = Q_{tot}/V_{batt}$: C_{eq} (measured) = $(.0030229)/(9) = (3.35878 * 10^{-4})$ F

Calculating $C_{eq} = C_1 + C_2$: C_{eq} (predicted) = $(1 * 10^{-4}) + (3.3 * 10^{-4}) = (4.3 * 10^{-4})$ F

Analysis:

So, with the circuit wired in series we can see that the voltages differ across the capacitors. With the total voltage equaling to 6.85 V. The Q (Charges in Coulombs) also come out to about the same, which is expected for a circuit wired in series. Also, for a circuit in series, the equivalent capacitance was the inverse of one over each specific capacitance. We predicted (calculated) that this would be ($7.67442 * 10^{-5}$) F. We measured it to be ($5.952 * 10^{-5}$) F. They are about .00001 off. This could be due to the measured voltage not being exactly 9V so when using the equation $C_{eq} = Q_{av}/V_{batt}$ it could throw our calculation off. On the other hand if we used the V_{tot} we measured which was about 6.85 V, we can calculate, again, the C_{eq}. Which would look like this ($C_{eq} = (5.357 * 10^{-4})/(6.85) = 7.82044 * 10^{-5}$). Which is more in line with our prediction/calculation.

With the circuit wired in parallel we can see that the voltages are the same across the capacitors. The total voltage we measured was 7.03 V. However, this time the Q (Charges in Coulombs) were different this time, which is expected for a circuit wired in parallel. Also, for a circuit in parallel, the equivalent capacitance was simply the specific capacitance of each capacitor added together. We predicted (calculated) that this would be ($3.35878 * 10^{-4}$) F. We measured it to be ($4.3 * 10^{-4}$) F. They are about .0001 off. This again, could be due to the measured voltage not being exactly 9V so when using the equation $C_{eq} = Q_{tot}/V_{batt}$ it could throw our calculation off. On the other hand if used the Voltage that we measured (Which is the same regardless of where you measure it in a parallel series) which was 7.03 V, we can calculate, again, the C_{eq}. Which would look like this ($C_{eq} = (.0030229)/(7.03) = 4.3 * 10^{-4}$). Which is exactly what our prediction/calculation was.