

Mississippi State University
Department of Physics and Astronomy
PH 2223 Lab

Resistance and Capacitance in a DC Circuit

Equations 24.5 and 24.7 (P.821, P.822; Sears and Zemansky's University Physics, Ed.12) gives the dependence of capacitors in series and in parallel to the effective capacitance. There is a more fundamental description of capacitance for simple flat plate capacitors. Read up *Section 24.1* (P.816 - 818; Sears and Zemansky's University Physics, Ed.12). We will use *Equation 24.2* to visualize and then derive the same expressions as in *Equations 24.5 and 24.7*.



Capacitors in Parallel

1. Looking at Fig.1, write equation (*Equation 24.2*) for capacitors 1 and 2 separately and call the C_1, C_2 respectively.
2. Now imagine we put them together as in Fig.1. What would be the new area? The distance of separation between the plates is kept constant.
3. Write the equation (*Equation 24.2*) for the new capacitor which consists of 2 smaller capacitors. Call this capacitance C_p . Substitute in the values of C_1 and C_2 back into the equation.

Capacitors in Series

1. Looking at Fig.2, write equation (*Equation 24.2*) for capacitors 1 and 2 separately and call the C_1, C_2 respectively.
2. Now imagine we put the 2 individual capacitors as in Fig.2. so the (equal and) oppositely charged plates in the middle just cancel out their charges when they are brought in contact. Also assume that the thickness of these plates is infinitesimally small.
3. What is the effective d ? The area of cross section is kept constant at A .
4. Write the equation (*Equation 24.2*) for the new capacitor which consists of 2 smaller capacitors in parallel. Call this capacitance C_p .
5. Take the inverse of C_s . Now substitute C_1 and C_2 back into C_s equation.

That was for 2 capacitors. By simply looking at the answers can you gauge what would the relations look like for n capacitors in series/ parallel?

Challenge

Do this activity for a spherical and cylindrical composite capacitor. The spherical composite capacitor consists of many shells which comprise of individual capacitors. In cylindrical composite capacitor, there are co axial cylinders acting as individual capacitors. How do capacitors add up in these systems?