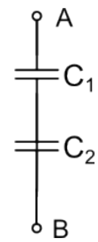
When we put resistors in series or in parallel in circuits we found that we could analyze the circuit by replacing the resistors in series or parallel with an equivalent resistance. We can do the same with capacitors.

Capacitors in series

If you have two capacitors, C_1 and C_2, connected in series across a potential different ΔV (between points A and B in the figure), we can determine the equivalent capacitance in the following way.



First, show that the amount of charge Q is the same on all the capacitor plates. You will need to use Gauss's law to do this. Hint: place the ends of your Gaussian surface inside the capacitor plates where the field is zero. Therefore, if the plate of C_1 attached to A has charge $+Q$, then the plate of C_2 attached to B will have charge $-Q$, and the other two plates (in the middle) will have charges $-Q$ and $+Q$.

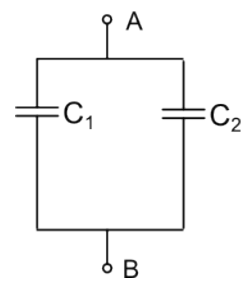
Using the fact that the sum of the voltages across the two capacitors ΔV_1 and ΔV_2 is equal to the total potential difference, show that

$\Delta V = \dfrac{Q}{C_{eq}}$, where

$$\boxed{\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}}.$$

Capacitors in parallel

If you have two capacitors, C_1 and C_2, in parallel, each connected to a potential different ΔV (between points A and B in the figure), we can determine the equivalent capacitance in the following way.



First, you know that the potential difference across the two capacitors is the same. Then, using the fact the total charge stored is equal to the sum of the charges stored in each capacitor, show that the total charge stored is

$Q_{tot} = C_{eq}\Delta V$

where

$$\boxed{C_{eq} = C_1 + C_2}$$

Exercise

Determine the equivalent capacitance of the following circuit: