In Series

In this configuration,
\[
\Delta V = \Delta V_1 + \Delta V_2
\]
while \( Q_1 = Q_2 \) since charge in a conductor between \( C_1 \) and \( C_2 \).

Let's consider some "equivalent" capacitor to \( C_1 \parallel C_2 \).

\[
\Delta V = \frac{Q}{Q_{\text{equiv}}} = \Delta V_1 + \Delta V_2
\]

\[
\frac{1}{C_{\text{equiv}}} = \frac{1}{C_1} + \frac{1}{C_2}
\]

\[
\frac{1}{C_{\text{equiv}}} = \frac{1}{C_1} + \frac{1}{C_2}
\]

When in series, sum the inverses of each capacitance to get the equivalent capacitance.

**NOTE:** \( C_{\text{equiv}} < C_1, C_2 \) always

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**Example:**

What is equivalent capacitance?

\[
C_{23} = \frac{1}{C_2} + \frac{1}{C_3}
\]

\[
C_{456} = \frac{1}{C_4} + \frac{1}{C_5} + \frac{1}{C_6}
\]

\[
\frac{1}{C_{123}} = \frac{1}{C_1} + \frac{1}{C_{23}}
\]

\[
\frac{1}{C_{\text{tot}}} = \frac{1}{C_{123}} + \frac{1}{C_{456}}
\]

\[
\frac{1}{C_{\text{tot}}} = \left[ \frac{1}{C_1} + \frac{1}{C_2 + C_3} \right]^{-1} + \frac{1}{C_4} + \frac{1}{C_5} + \frac{1}{C_6}
\]
Energy Stored in Charged Cap.

Consider 2 plates:

- Move charge, \( q \), to + plate
- \( \text{initially, no work to move it} \)
- Once some charge moved, work required
- More + more as charge deposited
- Work required to move \( dq \) to + plate (higher potential)

\[ dW = \Delta V dq = \frac{q}{C} dq \]

Total work is

\[ W = \int_{0}^{Q} \frac{q}{C} dq = \frac{1}{C} \left[ \int_{0}^{Q} dq \right] = \frac{Q^2}{2C} \]

Appears electric potential energy \( U \)

\[ U = \frac{Q^2}{2C} = \frac{1}{2} Q \Delta V = \frac{1}{2} C (\Delta V)^2 \]