

19 Combining capacitors and energy

– Part 2

Name: _____ Class: _____ Date: _____

Vocabulary

Write each word three times.

English

Write it 3 times (English)

in parallel

in series

Recall

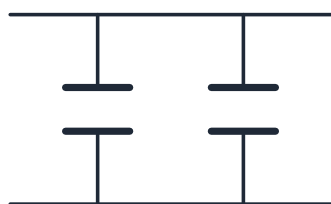
Capacitors can be joined together, and a charged capacitor stores energy ready to release.

New ideas

Read these first. Each idea has a short worked example. Then do the Practice.

■ 1 Combining capacitors

parallel



$$C = C_1 + C_2$$

series



$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$$

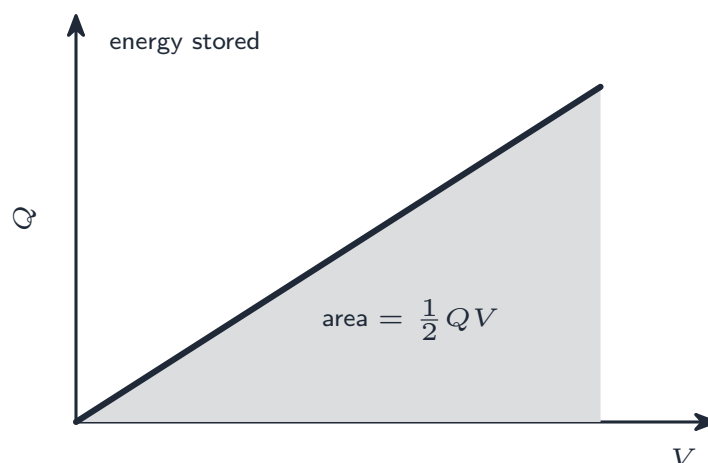
- **in parallel** , the capacitances add: $C = C_1 + C_2$;

- **in series** , the reciprocals add: $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$.

(This is the opposite of resistors.)

Worked example. Two $4\ \mu\text{F}$ capacitors. In parallel: $C = 4 + 4 = 8\ \mu\text{F}$. In series: $\frac{1}{C} = \frac{1}{4} + \frac{1}{4} = \frac{2}{4}$, so $C = 2\ \mu\text{F}$.

■ 2 Energy stored



The energy stored is the area under the Q - V graph: $W = \frac{1}{2}QV$.

Worked example. A capacitor holds $Q = 1.0 \times 10^{-3}\ \text{C}$ at $10\ \text{V}$: $W = \frac{1}{2}QV = \frac{1}{2}(1.0 \times 10^{-3})(10) = 5.0 \times 10^{-3}\ \text{J}$.

Watch out: combining capacitors is the *opposite* of combining resistors – capacitors *add* in parallel and take *reciprocals* in series. Don't mix the two rules up.

Practice

Try these in order.

19.1 How do capacitances combine *in parallel*? [1]

19.2 How do they combine *in series*? [1]

19.3 Two $2\ \mu\text{F}$ capacitors are joined in parallel. Find the total capacitance. [1]

19.4 Two $6\ \mu\text{F}$ capacitors are joined in series. Find the total capacitance. [2]

19.5 Write the formula for the *energy stored* in a capacitor. [1]

19.6 A capacitor stores $2.0 \times 10^{-3}\ \text{C}$ at $8.0\ \text{V}$. Find the energy stored ($W = \frac{1}{2}QV$). [2]

19.7 Challenge. A camera flash is powered by a capacitor that is charged up by the battery first. Explain why the capacitor, rather than the battery alone, is used to fire the flash. [2]
