Guide to: Parallel-plate capacitor without and with dielectric.

Applications: Electrical energy storage for rapid charge/discharge (unlike battery!).
Electric circuits. Hybrid vehicles.

Basic idea: The material property of an assembly that allows to store opposite charges.
Controls the amount of charge stored for a given potential difference applied.

Derivations: 1) Parallel plates of area A each, one charged to $+Q$, the other to -Q contain an electric field with strength $E = \frac{Q/A}{\epsilon_0}$. The plate separation is given as d,and air (or vacuum) is assumed in between. The $+Q$ plate is at high potential relative to the negative -Q plate; potential difference: $\Delta V = Ed$. This implies that potential difference and amount of charge stored on the plates are proportional $\Delta V = Ed = \frac{Qd}{\epsilon_0 A} \equiv \frac{Q}{C}$, where the capacitance (measured in farad=coulomb/volt) grows with plate area, and is inversely proportional to the plate separation. It is multiplied by the dielectric constant if the material between the plates itself contains charges that can be displaced (more effective storage).

2) Two capacitors in parallel corresponds to increased area; equivalent capacitance is additive. The same voltage drop appears across these; the amount of charge stored depends on the C-value!

3) Two capacitors in series: the same current flows; thus the amount of charge stored on each is the same. The voltage drops are different, and but up to the total voltage drop for the equivalent C.

Equations: $C = \frac{\kappa \epsilon_0 A}{d}$. Series capacitors: $\frac{1}{C_{\text{eq}}} = \frac{1}{C_1} + \frac{1}{C_2} + ...$. Unit: farad=coulomb/volt .

Problems: 18.39-45; 47-64; 77-78.

Understand the reasoning behind the series-capacitor formula.

Understand why the capacitance is defined such that it is in the denominator of the voltage-charge relationship. Understand why dielectric allow to make large-C capacitors in a small package.

Ignore the cylindrical- or spherical-geometry capacitors (PHYS2020 stuff).