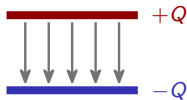


Conductors and Capacitors

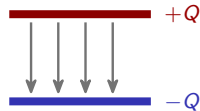
AP Physics C: E&M ■ Unit 10

AP Physics C: E&M



What we will cover

- 1 Conductors in electrostatic equilibrium
- 2 Redistribution of charge
- 3 Capacitors
- 4 Dielectrics



Conductors in electrostatic equilibrium

With charges at rest in a **conductor** 导体:

- the field is **zero** everywhere inside
- all excess charge sits on the **outer surface** 外表面
- outside, the field is **perpendicular** to the surface
- the whole conductor is one **equipotential** 等势面

A metal shell keeps its inside field zero
– a **Faraday cage** 法拉第笼.



capacitors

Redistribution of charge

Touch two conductors and charge flows until they reach a **common potential**:

- **conservation of charge** 电荷守恒 fixes the total
- a bigger conductor holds more at the same V
- an external field induces opposite charges on the two sides

Worked example – identical spheres

12 nC touched to a neutral twin:

each ends with 6 nC

Touch a much larger sphere instead and most charge flows onto it.

Capacitors

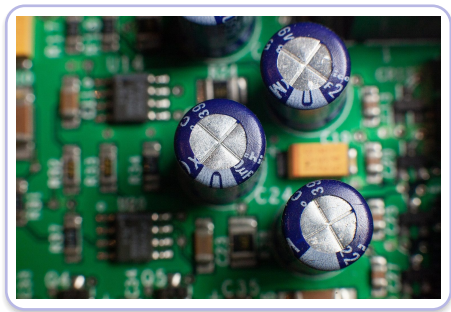
A **capacitor** 电容器 stores charge $\pm Q$ on two plates:

Capacitance and stored energy

$$C = \frac{Q}{V} = \frac{\epsilon_0 A}{d}$$

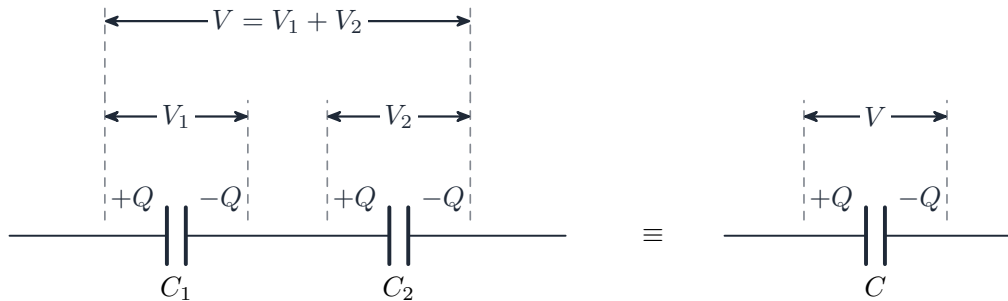
$$U = \frac{1}{2} CV^2 = \frac{1}{2} \frac{Q^2}{C}$$

Energy lives in the field: $u = \frac{1}{2} \epsilon_0 E^2$. Combine **opposite** to resistors – parallel adds.



pcb Capacitors

Capacitors



Dielectrics

A **dielectric** 电介质 is an insulator that **polarizes** 极化, building an internal field that opposes the applied one.

Sliding it in

$$C = \kappa C_0$$

the **dielectric constant** 介电常数 κ – and the field between the plates drops.

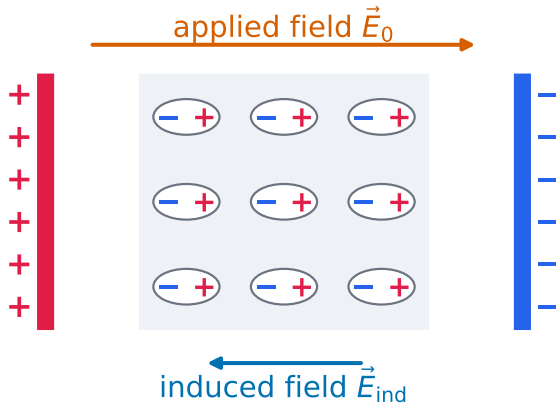
Constant charge: V and U
drop

Constant voltage: Q and U
rise

$\kappa = 3$:

$$C_0 = 5 \rightarrow 15 \mu\text{F}.$$

Dielectrics



Unit 10 – key takeaways

1 Conductors

field zero inside; charge on the surface; one equipotential

2 Redistribution

touching conductors reach a common potential

3 Capacitors

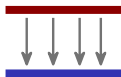
$$C = Q/V = \epsilon_0 A/d; \quad U = \frac{1}{2} CV^2$$

4 Dielectrics

$C = \kappa C_0$; effect depends on what is held fixed

Check yourself

- 1 What is the electric field inside a conductor in equilibrium?
- 2 12 nC touched to an identical neutral sphere – charge on each?
- 3 Double a capacitor's voltage – what happens to its stored energy?
- 4 Insert a dielectric ($\kappa = 3$) – what happens to the capacitance?



Answers 1. zero 2. 6 nC each 3. it quadruples 4. it triples