Conductors and Capacitors

AP Physics C: E&M ▪ Unit 10

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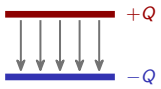
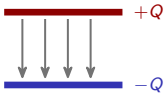


What we will cover



1 Conductors

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

2 Redistribution

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

$12\,\mathrm{nC}$ touched to a neutral twin:

each ends with $6\,\mathrm{nC}$

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

3 Capacitors

Capacitors

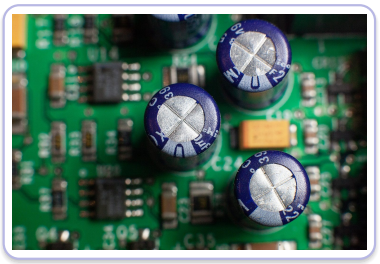
A **capacitor** 电容器 stores charge $\pm Q$ on two plates:

Capacitance and stored energy

$$C = \frac{Q}{V} = \frac{\varepsilon_0 A}{d}$$

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

Energy lives in the field: $u = \frac{1}{2}\varepsilon_0 E^2$. Combine opposite to resistors – parallel adds.



Pcb capacitors

4 Dielectrics

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*

$\kappa = 3$:

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

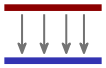
5 Recap

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**
   $C = Q/V = \varepsilon_0 A/d$; $U = \frac{1}{2}CV^2$
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. $12\,\mathrm{nC}$ 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.** $6\,\mathrm{nC}$ each **3.** it quadruples **4.** it triples