CAPACITORS DAY 1: CAPACITANCE & PARALLEL PLATES

WARMUP The Flash

The demo: a capacitor clipped across a battery for a second, then touched to a small bulb — a bright flash, then dark. The battery crammed charge onto two plates inside; the flash was that charge pouring back out. Between the loaded plates: $E = 4500$ V/m across a 2.0 mm gap. **(a)** ΔV across the gap = ________. **(b)** Which Gauss result made parallel-plate fields uniform in the first place?

THE CAPACITOR: COULOMBS STORED PER VOLT

$C = Q/\Delta V$ — coulombs stored per volt. Unit: the farad (1 F = 1 C/V); real devices live in μF, nF, pF.

Parallel plates: $E = \sigma/\varepsilon_0$ (uniform!), so $\Delta V = Ed = Qd/(\varepsilon_0 A)$, giving

$$\mathbf{C = \varepsilon_0 A/d} \quad (\varepsilon_0 = 8.85\times10^{-12} \text{ F/m})$$

C depends ONLY on geometry — double the charge and the volts double with it; the ratio never moves.

WE DO Exercise 1: Build One From Geometry

Plates of area $A = 0.02$ m² sit $d = 1.0$ mm apart. $C = \varepsilon_0 A/d = (8.85\times10^{-12})$(________)/(________) = ________ pF.

LOADING THE PLATES

WE DO **Exercise 2: Hook It to a Battery**

Connect Exercise 1's capacitor ($C = 177$ pF) to a 9.0 V battery. **(a)** $Q = CV =$ _________ nC. **(b)** E between the plates = $V/d =$ _________ V/m.

YOU DO **Exercise 3: The Definition, Backward**

A capacitor holds 24 μC when charged to 12 V. **(a)** Find C in μF. **(b)** The charge is doubled to 48 μC. What is C now — and why is that not a computation?

CALC **Exercise 4: Derive $C = \varepsilon_0 A/d$**

Start from the Gauss result $E = \sigma/\varepsilon_0$ between plates carrying $\pm Q$ on area A. Write σ in terms of Q and A, compute $\Delta V = Ed$, and form $C = Q/\Delta V$. Show every unit.

PAPER PRACTICE

PRACTICE PROBLEMS

P1 Definition

A capacitor stores 36 μC at 12 V. Find C.

P2 Geometry

Plates: A = 0.04 m^2, d = 0.50 mm. Find C in pF.

P3 Charge and Field

A 3.0 μF capacitor across 12 V, plates 2.0 mm apart: find Q, then E between the plates.

P4 Pull the Plates Apart

A 4.0 μF capacitor is charged to 6.0 V and DISCONNECTED (charge trapped). The gap is then doubled. Find the new C, the trapped Q, and the new voltage — and state which quantity was the invariant.