CAPACITORS DAY 6: UNIT REVIEW

BIG IDEAS TO REMEMBER

- **$C = Q/\Delta V$** — pure geometry; parallel plates $\varepsilon_0 A/d$.
- **$U = Q^2/2C = \frac{1}{2}QV = \frac{1}{2}CV^2$**; density $u = \frac{1}{2}\varepsilon_0 E^2$ fills the gap.
- **Recipe for any shape:** $\pm Q \rightarrow$ Gauss $E \rightarrow \Delta V = \int E \cdot dr \rightarrow C$. Spherical $ab/[k(b-a)]$; isolated a/k; cylinder needs $\ln(b/a)$.
- **Dielectric:** $E = E_0/\kappa$ inside, $C = \kappa C_0$ — then ask: Q fixed (V, U drop) or V fixed (Q, U rise)?
- **Parallel adds C** (same V); **series adds 1/C** (same Q).

A Fixed Q or Fixed V? (The Unit's Central Question)

For each move, state what happens to C, V, Q, and U (rise/fall/fixed), with one reason: **(a)** disconnected capacitor, plates pulled apart; **(b)** battery-connected capacitor, dielectric inserted; **(c)** disconnected capacitor, dielectric inserted.

MIXED PRACTICE

B Plate Chain

Plates A = 0.02 m², d = 0.50 mm, filled with κ = 2 dielectric. Find C (pF), then the charge at 12 V (nC), then E inside (V/m).

C Network Chain

A 3.0 μF and a 6.0 μF capacitor in series across 18 V. Find C_eq, the charge Q, the voltage on the 3.0 μF, and the total stored energy.

D Spherical Chain

Spherical capacitor a = 0.5 m, b = 2.0 m, filled with κ = 3: C = κ·ab/[k(b−a)]. Find C, then Q at 3000 V, then U = ½CV².

AP-STYLE PRACTICE

E Short FRQ: Spherical Capacitor, Derived

Shells of radii a and b (a < b) carry ±Q.

a. **Derive** ΔV between the shells from E = kQ/r² (show the integral).

b. **Form** C = Q/ΔV and check the limit b → ∞ names a familiar object.

c. **Explain** in one sentence why C grew when the shells moved closer.

F Reflection

Which of these can you least reliably do on your own — the charging integral, the geometry recipe, dielectric bookkeeping, or networks? Name it, and write your plan to fix it before the test:

Test Reminder: series C is SMALLER than every member; the dielectric question is always "what's held fixed?"; μF·V = μC and μC·V = μJ — let the prefixes ride along.