POTENTIAL DAY 4: EQUIPOTENTIALS & CONDUCTORS

WARMUP PhET Flashback

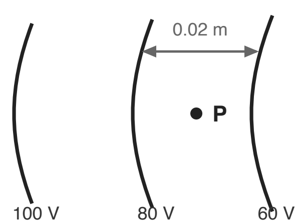
In the Unit 8 lab you traced equipotential curves. Recall: what angle did they always make with the field arrows, and where were they crowded?

EQUIPOTENTIAL SURFACES

- An equipotential is a surface of constant V — moving along it costs ZERO work ($W = q\Delta V = 0$).
- Therefore **E ⊥ equipotentials** everywhere (any parallel E component would do work).
- Closely spaced equipotentials (per fixed ΔV) = strong field: $\mathbf{E \approx \Delta V/\Delta x}$.
- Point charge: concentric spheres. Uniform field: parallel planes. Dipole: nested ovals + the V = 0 bisector plane.

WE DO Exercise 1: Read the Map

The map below shows equipotentials at 100 V, 80 V, and 60 V, spaced 0.02 m apart near point P. **(a)** Estimate |E| at P ($\Delta V/\Delta x$). **(b)** Draw E's direction at P — toward the 100 V line or the 60 V line? **(c)** Work to carry +2.0 μC ALONG the 80 V line for 5 cm: _________.



CONDUCTORS ARE EQUIPOTENTIALS

ONE METAL, ONE VOLTAGE

E = 0 inside a conductor means $\Delta V = -\int E\cdot dl = 0$ between ANY two of its points: **an entire conductor sits at a single potential** — surface included. This finally justifies the wired-spheres rule from Unit 8:

$$V_1 = V_2 \rightarrow kq_1/R_1 = kq_2/R_2 \rightarrow \mathbf{q \propto R}$$

Same V, smaller R → bigger σ and E: the lightning-rod effect, now with its real explanation.

WE DO **Exercise 2: Sphere Potential**

A conducting sphere (R = 0.5 m) carries +3.0 μC. **(a)** V at its surface (kQ/R) = _________. **(b)** V at its CENTER = _________ (careful!). **(c)** V at r = 1.5 m outside = _________.

YOU DO **Exercise 3: The Wire Justifies Itself**

Spheres R_1 = 2.0 m and R_2 = 0.5 m share +10.0 μC through a long wire. **(a)** Split the charge by $q \propto R$. **(b)** Verify both surfaces sit at the SAME potential kq/R. **(c)** Compare their surface FIELDS kq/R^2.

PAPER PRACTICE

PRACTICE PROBLEMS

P1 Map Estimate

Equipotentials at 50 V intervals sit 0.025 m apart in some region. Estimate |E| there.

P2 Zero-Work Path

Explain (two sentences, one equation) why a charge carried around ANY closed loop in an electrostatic field has zero net work done on it by the field — and what that says about the loop's start/end potential.

P3 Sphere V Profile

A conducting sphere ($R = 1.0$ m, $Q = +6.0\ \mu C$): tabulate V at r = 0, 0.5, 1.0, 2.0, 3.0 m. (Inside: constant at the surface value.) Sketch V(r).

P4 Rod Meets Sphere

Why does charge crowd onto the pointed tip of a lightning rod? Chain the logic: one conductor → one V → kq/R locally → small local R means _________ σ and _________ E. Then: why is intense surface E exactly what a lightning rod wants?