POTENTIAL DAY 1: ELECTRIC POTENTIAL ENERGY

WARMUP **Unit 3 Bridge**

In mechanics, lifting a mass stored U = mgh; the work integral against gravity built it. Today's force is Coulomb's. **(a)** To push two POSITIVE charges together, is your work positive or negative? **(b)** To pull + and – apart?

ELECTRIC POTENTIAL ENERGY OF A PAIR

Integrating Coulomb's force from infinity (U(∞) = 0, exactly like –GMm/r in Unit 3):

$$U = kq_1q_2/r$$ (signed! no r^2, no absolute values)

Like charges: U > 0 (you paid work to assemble them). Opposite charges: U < 0 (a bound well, like gravity). Work done BY you to assemble a configuration = the total U, summed over every PAIR.

μC arithmetic: $k(\mu C)^2/m = 9\times10^{-3}$ J — millijoules for tabletop charges.

WE DO **Exercise 1: One Pair, Both Signs**

Compute U for +4.0 μC and +2.0 μC at 1.0 m: U = _____ J. Now flip one sign (+4, –2): U = _____ J. **(c)** Which configuration would fly apart if released, and how does the SIGN of U tell you?

ASSEMBLIES: SUM OVER PAIRS

Every pair counts once. Three charges have three pairs (12, 13, 23); four charges have six. $U_{total} = \Sigma\, kq_i q_j / r_{ij}$ — scalar addition, signs included.

WE DO Exercise 2: The Triangle

Charges +2.0 μC, +2.0 μC, and −1.0 μC sit at the corners of an equilateral triangle of side 1.0 m. List the three pairs, compute each U with sign, and total them.

YOU DO Exercise 3: Work to Bring the Third

+3.0 μC and +3.0 μC already sit 2.0 m apart. How much work must YOU do to bring a +1.0 μC charge from far away to the midpoint between them? (W = ΔU = the two NEW pair energies.)

CALC Exercise 4: Escape Speed, Electric Edition

A +2.0 μC, 0.010 kg bead sits 1.0 m from a fixed +4.0 μC charge, then is released. **(a)** Its U now; U at infinity. **(b)** Use energy conservation to find its speed far away. (Same playbook as gravitational escape in Unit 3.)

PAPER PRACTICE

PRACTICE PROBLEMS

P1 Pair Energy

U for –3.0 μC and +6.0 μC at 2.0 m — sign and magnitude.

P2 Separation Work

How much work must you do to pull that (–3, +6 μC) pair apart from 2.0 m to very far? (W = U_final – U_initial.)

P3 Square Assembly (Setup + Two Terms)

Four +2.0 μC charges at the corners of a 1.0 m square: how many pairs? Which two DISTINCT pair distances appear? Compute one pair energy of each kind (side pair; diagonal pair).

P4 Energy Inventory

A +5.0 μC charge is released from rest 0.5 m from a fixed +5.0 μC charge. Find its kinetic energy when it reaches 2.0 m away ($\Delta K = U_i - U_f$), and its KE "at infinity."