CHARGES DAY 7: PHET LAB — CHARGES & FIELDS

LAB QUESTION

Does the field of a real (simulated) charge actually obey kq/r^2? Today you will measure fields with sensors, map a dipole, and check the law against data. Sim: phet.colorado.edu → "Charges and Fields."

PART A Single Charge: Verify $1/r^2$

Place ONE +1 nC charge. Use the sensor to measure E at five distances. (Grid squares are 0.5 m.)

r (m)	E measured (V/m ≡ N/C)	$E \cdot r^2$
0.5		
1.0		
1.5		
2.0		
3.0		

The test: if $E = kq/r^2$, the column $E \cdot r^2$ should be _____ (constant? growing?). Its value should equal $kq = (9\times10^{9})(10^{-9})$ = _____ $N \cdot m^2/C$.

PART B Linearize It

Plot E (vertical) against $1/r^2$ (horizontal) from your table. **(a)** Sketch the plot and best-fit line below. **(b)** Slope = _____ (units!). **(c)** Extract q from the slope: q = slope/k = _____ — compare with the 1 nC you placed.

PART C — MAP A DIPOLE

MAP Build and Probe

Place +1 nC and –1 nC about 2 m apart. **(a)** Sketch 6-8 field lines from the sensor arrows. **(b)** Measure E at the midpoint: _____ V/m. **(c)** Predict the midpoint value with $2 \cdot kq/r^2$ (r = half the separation) and compare: predicted _____, % difference _____.

HUNT Find the Null

Change the – charge to –4 nC (stack four). Somewhere on the far side of the +1 nC charge the field vanishes. **(a)** Hunt it down with the sensor and record its distance from the +1 nC charge: _____ m. **(b)** Verify with theory: $kq_1/x^2 = kq_2/(x+d)^2$ with your geometry. Show the check.

PART D — EQUIPOTENTIAL PREVIEW

A teaser for next unit. The sim's "equipotential" pen draws lines of constant VOLTAGE — a quantity we meet formally in Unit 9. Notice two things today; explain them in two weeks.

TRACE Draw and Notice

Around a single charge, trace equipotential rings at three radii; around the dipole, trace three curves. **(a)** Sketch both maps. **(b)** What ANGLE do equipotential lines always make with the field arrows? **(c)** Where are the rings crowded — strong field or weak?

EXIT One-Minute Check

Your E·r² column: constant to within _____%. Biggest source of measurement scatter: _____.