ELECTRICITY DAY 8: FIELD MAPS & SUPERPOSITION

CED 10.3 · Skill 1.A · FRQ: TBR · target: field lines represent a vector field; they are not trajectories

PREDICT

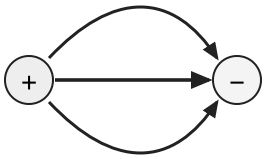
Equal positive charges sit at $x = -0.25\text{m}$ and $x = +0.25\text{m}$. Where, if anywhere, is E zero? Mark the point and justify with two arrows.

FIELD-LINE RULES

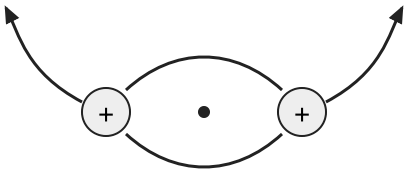
- Field-line arrows point away from + and toward –.
- The tangent to a line gives the local E direction.
- Greater line density represents greater field magnitude.
- Field lines do not cross because E has one direction at a point.
- A field line is not necessarily a charged particle's trajectory.

TWO RECURRING MAPS

A DIPOLE



B TWO EQUAL POSITIVE CHARGES



E = 0 at midpoint

QUICK At the midpoint of a dipole, draw the E contribution from each charge. Do the contributions cancel or add?

FIELD SUPERPOSITION ON A BISECTOR

WE DO Equal $+3.5\mu\text{C}$ charges sit at $(-0.25\ \text{m}, 0)$ and $(+0.25\ \text{m}, 0)$. Point P is at $(0, +0.20\ \text{m})$. Find the net field at P.

At P, the horizontal components cancel by symmetry. The vertical components add:

$$E_{\text{net}} = 2E_{\text{one}}\frac{y}{r}, \qquad r = \sqrt{x^2 + y^2}$$

INTERPRET How would the net field change if P moved farther up the perpendicular bisector? Address both magnitude and direction.

NULL POINTS

At a null point, the vector contributions have equal magnitude and opposite direction. For two like charges, a null can lie between them. It is closer to the smaller-magnitude charge.

WE DO A $+2.5\mu\text{C}$ charge is at $x = 0$; a $+5.0\mu\text{C}$ charge is at $x = 0.45\text{m}$. Find the null point between them.

EXPLAIN Why is there no null point between a positive and a negative charge?

Zero field does not mean no nearby charges. It means the vector sum at that location is zero.

PRACTICE

1. Two equal $-4.0\mu\text{C}$ charges are 0.60m apart. Locate the on-axis null point and describe the field direction just to its left.

2. At point P, one source produces $3.0 \times 10^5\text{N/C}$ east and another produces $4.0 \times 10^5\text{N/C}$ north. Find the net field.

3. On a field-line map, point A has lines twice as dense as point B. What qualitative conclusion can be made? What cannot be claimed without a scale?

4. Explain why a negative particle released with an initial sideways velocity generally does not trace a field line.