ELECTRIC FIELDS AROUND TWO CHARGES

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Electric Field Equations

The electric field around a single point charge is given by Coulomb's Law, which states that the electric field E at a distance r from a point charge Q is given by:

$$E = \frac{kQ}{r^2} \tag{1}$$

Here k is Coulomb's constant ($8.99 \times 10^9\ \mathrm{N\ m^2/C^2}$), Q is the charge, and r is the distance from the charge. The direction of the field is radially outward for positive charges and radially inward for negative charges.

In this example with two charges, the total electric field at a point is the vector sum of the electric fields created by each charge. This principle is known as the superposition principle.

Field Lines

Electric field lines are a useful visual tool to represent electric fields. They start at positive charges and end at negative charges.

Note : in our case (+/-) visually the density of the field lines is proportional to the magnitude of the electric field. For two charges of opposite sign, the field lines "attract" each other, creating a pattern that squeezes together in the region between the charges. However for two point charges of the same sign, the field lines "repel" each other, creating a field pattern that densify near the plane between the charges, so in this case the density of field lines doesn't correctly represent the field intensity.

Click here to switch right charge sign !

Equipotential Lines/Surfaces

Equipotential lines or surfaces are locations where the electric potential is the same. For a point charge, these are spheres centered on the charge. In the case of two charges, the equipotential lines / surfaces will be more complex hyperboloids :

Click here to show equipotential surface in 3D !

Equipotential lines/surfaces are always perpendicular to electric field lines. This is because the electric field points in the direction of steepest descent of the potential, which is perpendicular to the equipotential surfaces.

The potential V at a distance r from a point charge Q is given by:

$$V = \frac{kQ}{r} \tag{2}$$

For two charges, the total potential at a point is the sum of the potentials due to each charge.