Chapter 24: Electric Potential

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General

Quantities

$$
\begin{aligned}
\vec{E} &= \text{electric field} \\
V &= \text{electric potential} \\
U &= \text{electric potential energy} \\
W &= \text{work} \\
\vec{F} &= \text{electrostatic force} \\
q &= \text{point charge} \\
r &= \text{distance} \\
\epsilon_0 &= \text{vacuum permittivity constant} \\
k &= \text{Coulomb's law constant}
\end{aligned}
$$

Constants

$$
\begin{aligned}
\epsilon_0 &= 8.85 \times 10^{-12} \, \frac{\mathrm{C}^2}{\mathrm{N\,m}^2} \\
k &= \frac{1}{4\pi\epsilon_0} = 9.0 \times 10^9 \, \frac{\mathrm{N\,m}^2}{\mathrm{C}^2}
\end{aligned}
$$

1 Electric Potential

Electric Potential and Electric Potential Energy V is the electrical potential which can be thought of as the "electrical pressure" at a certain point. To move a charged particle across an electric potential, there will be a change in electrostatic potential energy (U) in the particle.

$$U = -W \tag{1}$$

$$V = \frac{-W_\infty}{q_0} = \frac{U}{q_0} \tag{2}$$

$$U = qV \tag{3}$$

$$\Delta U = q\Delta V = q\left(V_f - V_i\right) \tag{4}$$

2 Equipotential Lines

Equipotential lines are lines where the electric potential is the same. This means that there is no change in electrical potential energy when moving a particle along these lines. These lines are perpendicular to electric field lines and tend to make loops around charges.

3 Potential Due To a Charged Particle

Note that the sign *is* used when calculating electric potential.

Potential Due To A Charged Particle

$$V = \frac{1}{4\pi\epsilon_0}\frac{q}{r} = k\frac{q}{r} \tag{5}$$

Potential Due To A Group Of Charged Particle

$$V = \sum_{i=1}^{n} V_i = \frac{1}{4\pi\epsilon_0}\sum_{i=1}^{n}\frac{q_i}{r_i} \tag{6}$$

In other words:

$$V = V_1 + V_2 + \ldots + V_n \tag{7}$$

4 Electric Potential Energy Of a System Of Charged Particles

Note that the sign *is* used when calculating electric potential energy.

$$U = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r} = k\frac{q_1 q_2}{r} \tag{8}$$

$$U = U_1 + U_2 + \ldots + U_n \tag{9}$$

Electrostatic Equation Grid

	Pair of Charges	**Point in Space**
Vector Quantities	$\vec{F} = k\frac{\lvert q_1\rvert\,\lvert q_2\rvert}{r^2}$ Electric Force	$\vec{E} = k\frac{\lvert q\rvert}{r^2}$ Electric Field
Scalar Quantities	$U = k\frac{q_1 q_2}{r}$ Electric Potential Energy	$V = k\frac{q}{r}$ Electric Potential