

Chapter 25 The Electric Potential

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Electric Potential Energy

A charged particle q in an electric potential V has electric potential energy

$$U = qV$$

The change in potential energy is $\Delta U = -W$ where W is the work being done. If the force is not constant, the work can be calculated by dividing the path into many small segments of length dx , finding the work done in each segment, and then integrating over it.

$$W = \int_{x_i}^{x_f} F(x) \cos \theta dx$$

Parallel-Plate Capacitor

The electric potential energy of charge q in a parallel-plate capacitor is

$$U_{\text{elec}} = qEs$$

where s is the distance from the negative plate.

Two Point Charges

The potential energy of the system of two charges q_1 and q_2 is

$$U_{\text{elec}} = \frac{kq_1q_2}{r}$$

Multiple Point Charges

If more than two charges are present, their potential energy is the sum of the potential energies due to all pairs of charges.

Electric Dipole in a Uniform Electric Field

$$U_{\text{elec}} = -pE \cos \phi = -\vec{p} \cdot \vec{E}$$

Electric Potential

In the absence of other applied forces, a charged particle speeds up or slows down as it moves through a potential difference.

Parallel-Plate Capacitor

The electric potential inside a capacitor is

$$V_{\text{cap}} = \frac{s}{d} \Delta V_C$$

where s is the distance from the negative plate, d is the distance between the plates, and $\Delta V_C = Ed$ is the potential difference between the plates.

Point Charge

The electric potential of charge q is

$$V_{\text{point}} = \frac{kq}{r}$$

Charged Sphere

Outside a uniformly charged sphere, the electric potential is identical to that of a point charge Q at the center

$$V_{\text{sphere}} = \frac{kQ}{r}$$

A sphere is charged to a certain potential when that potential is on the surface of the sphere, such that a sphere of radius R that is charged to potential V_0 has total charge

$$Q = \frac{RV_0}{k}$$

Using this for Q in the electric potential equation results in

$$V_{\text{sphere}} = \frac{R}{r} V_0$$