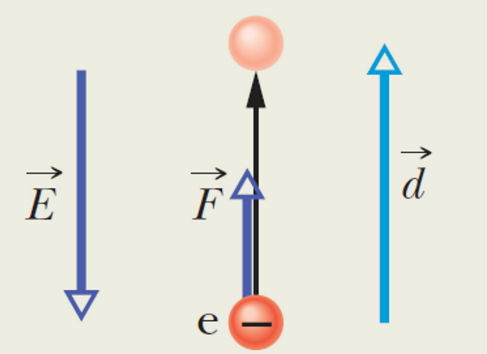
Work and potential energy in an electric field

Friday, 29 January, 2021 20:51

Near Earth's surface the electric field has the magnitude $E = 150\ N/C$ and is directed downward. What is the change in the electric potential energy of a released electron when the electrostatic force causes it to move vertically upward through a distance $d = 520\,\boldsymbol{m}$ **?**



The Electric Field Between Two Parallel Plates of Opposite Charge

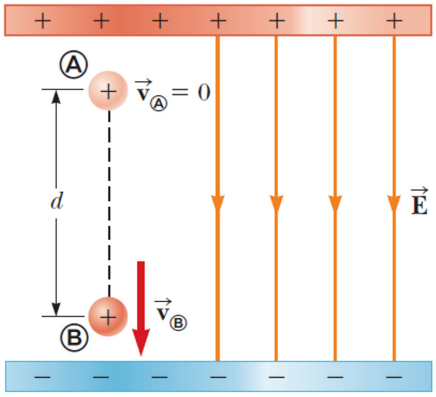
Friday, 29 January, 2021 20:52

A 12-V battery is connected between two parallel plates. The separation between the plates is $d = 0.3\,cm$ and we assume the electric field between the plates to be uniform. Find the magnitude of the electric field between the plates.

Motion of a Proton in a Uniform Electric Field

Friday, 29 January, 2021 20:52

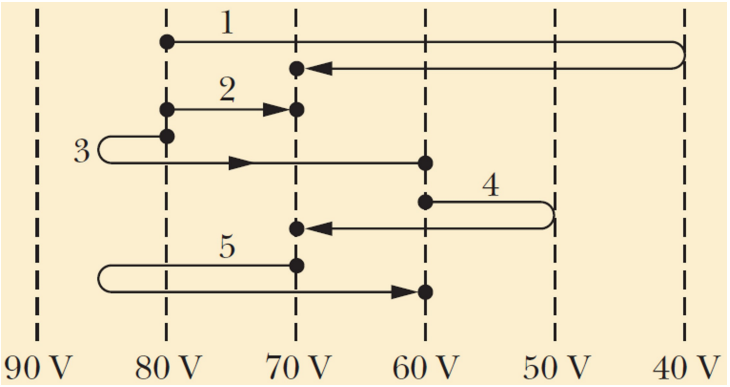
A proton is released from rest at point (A) in a uniform electric field that has a magnitude of $8 \times 10^4\ V/m$ as shown. The proton undergoes a displacement of magnitude $d = 0.5\,m$ to point (B) in the direction of $\vec{E}$. Find the speed of the proton after completing the displacement.



Equipotential surfaces

Friday, 29 January, 2021 20:53

The figure here shows a family of parallel equipotential surfaces (in cross section) and five paths along which we shall move an electron from one surface to another.

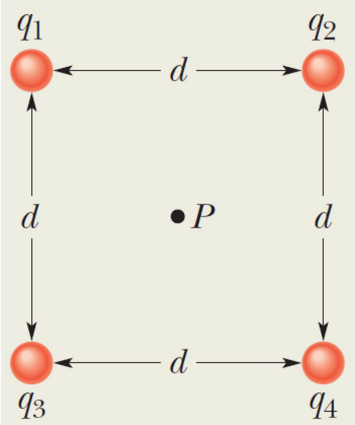


- What is the direction of the electric field associated with the surfaces?
- For each path, is the work we do positive, negative, or zero?
- Rank the paths according to the work we do, greatest first.

Net potential of several charged particles

Friday, 29 January, 2021 20:53

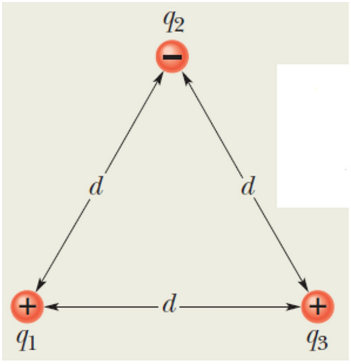
What is the electric potential at point P, located at the center of the square of point charges shown? The distance is 1.3 m, and the charges are: $q_1 = +12\,nC$, $q_2 = -24\,nC$ -24 nC , $q_3 = +31\,nC$ and $q_4 = +17\,nC$.



Potential energy of a system of three charged particles

Friday, 29 January, 2021 20:54

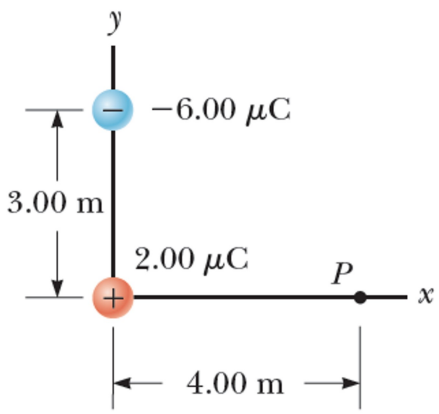
The figure shows three point charges held in fixed positions. What is the electric potential energy of this system of charges? Assume that: $d = 12\,cm$, $q_1 = +q$, $q_2 = -4q$ and $q_3 = +2q$ in which $q = 150\,nC$.



The change in potential energy

Friday, 29 January, 2021 20:54

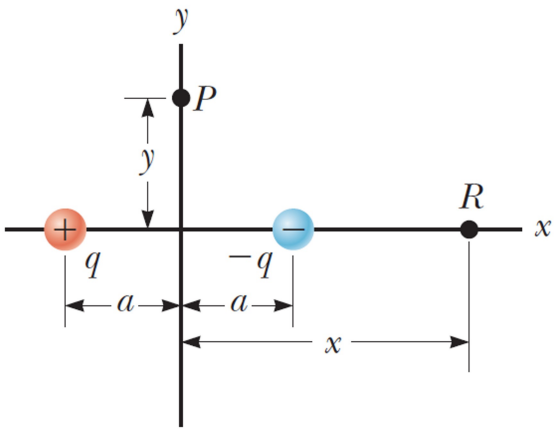
As shown in the figure, a charge $q_1 = 2\,\mu C$ is located at the origin and a charge $q_2 = -6\,\mu C$ is located at (0, 3) m. Find the change in potential energy of the system of two charges plus a third charge $q_3 = 3\,\mu C$ as the latter charge moves from infinity to point P.



The Electric Potential Due to a Dipole

Friday, 29 January, 2021 20:55

An electric dipole consists of two charges of equal magnitude and opposite sign separated by a distance $2a$ as shown. The dipole is along the x axis and is centered at the origin.

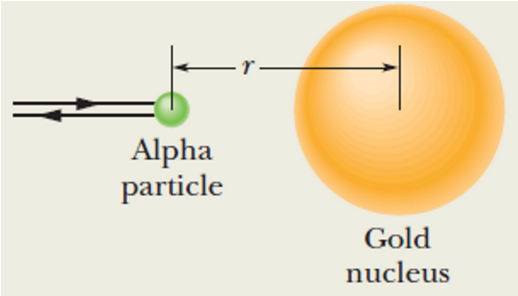


- Calculate the electric potential at point P on the y-axis.
- Calculate the electric potential at point R on the positive x-axis.
- Calculate V and E_x at a point on the x-axis far from the dipole.

Conservation of mechanical energy with electric potential energy

Friday, 29 January, 2021 20:55

An alpha particle (two protons, two neutrons) moves into a stationary gold atom (79 protons, 118 neutrons), passing through the electron region that surrounds the gold nucleus like a shell and headed directly toward the nucleus. The alpha particle slows until it momentarily stops when its center is at radial distance $r = 9.23\ fm$ from the nuclear center. Then it moves back along its incoming path. (Because the gold nucleus is much more massive than the alpha particle, we can assume the gold nucleus does not move.) What was the kinetic energy K_i of the alpha particle when it was initially far away.



Obtaining E from V

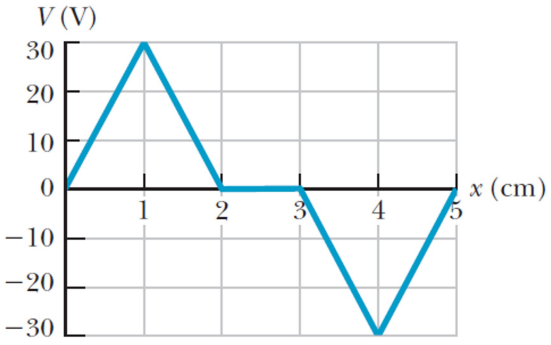
Friday, 29 January, 2021 20:56

In a certain region, the electric potential due to a charge distribution is given by the equation $V(x, y, z) = 3x^2y^2 + yz^3 - 2xz^3$, where x, y, and z are measured in meters and V is in volts. Calculate the electric field vector at the position $(x, y, z) = (1, 1, 1)$.

Obtaining E from V

Friday, 29 January, 2021 20:56

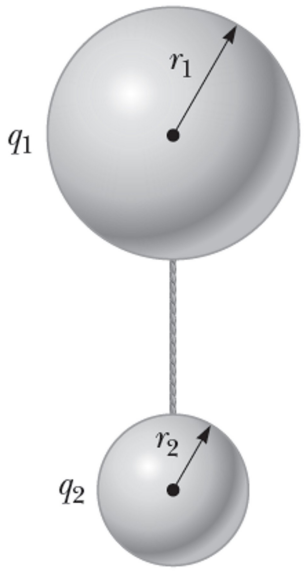
An electric field in a region of space is parallel to the x-axis. The electric potential varies with position as shown. Graph the x-component of the electric field versus position in this region of space.



Two Connected Charged Spheres

Friday, 29 January, 2021 20:57

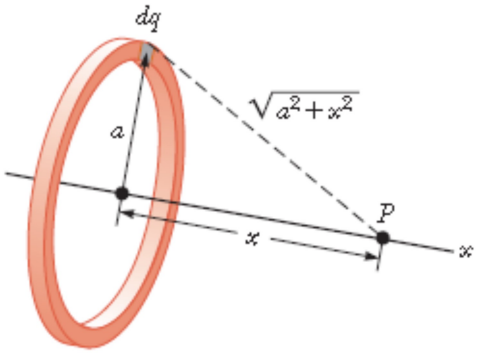
Two spherical conductors of radii r_1 and r_2 are separated by a distance much greater than the radius of either sphere. The spheres are connected by a conducting wire as shown. The charges on the spheres in equilibrium are q_1 and q_2, respectively, and they are uniformly charged. Find the ratio of the magnitudes of the electric fields at the surfaces of the spheres.



Electric Potential Due to a Uniformly Charged Ring

Monday, 1 February, 2021 21:21

Find an expression for the electric potential at a point P located on the perpendicular central axis of a uniformly charged ring of radius a and total charge Q.



Answer:

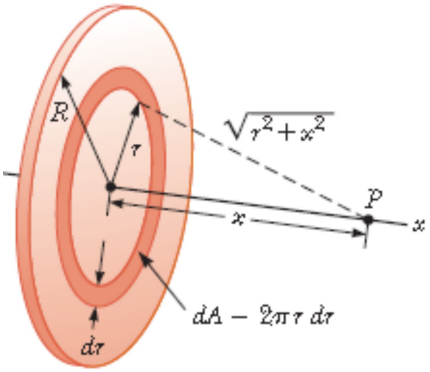
$$V = \frac{k_e}{\sqrt{a^2 + x^2}} \int_0^Q dq$$

$$V = \frac{k_e Q}{\sqrt{a^2 + x^2}}$$

Electric Potential Due to a Uniformly Charged Disk

Monday, 1 February, 2021 21:26

A uniformly charged disk has radius R and surface charge density σ. Find the electric potential at a point P along the perpendicular central axis of the disk.



Answer:

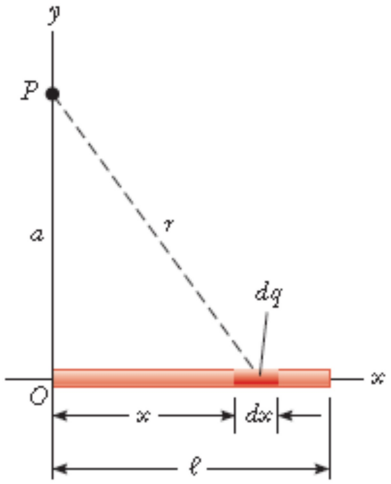
$$V = k_e \pi \sigma \int_0^R \frac{2r\, dr}{(r^2 + x^2)^{1/2}}$$

$$V = 2k_e \pi \sigma \left[(x^2 + R^2)^{1/2} - x\right]$$

Electric Potential Due to a Finite Line of Charge

Monday, 1 February, 2021 21:30

A rod of length ℓ, located along the x axis has a total charge Q and a uniform linear charge density λ. Find the electric potential at a point P located on the y axis a distance a from the origin.



Answer:

$$V = k_e \lambda \int_0^{\ell} \frac{dx}{(a + x^2)^{1/2}}$$

$$V = \frac{k_e Q}{\ell} ln\left(\frac{\ell + \sqrt{a^2 + \ell^2}}{a}\right)$$