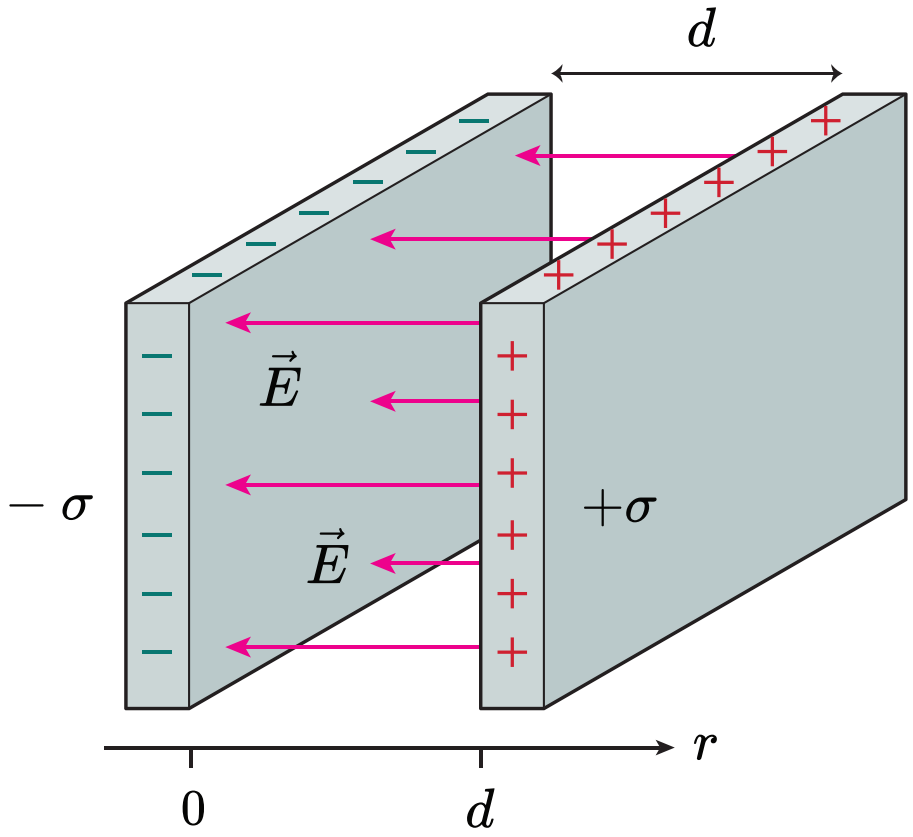
PHY-112
Principles of Physics-II
Akiful Islam (AZW)
Spring-24 | Class-11

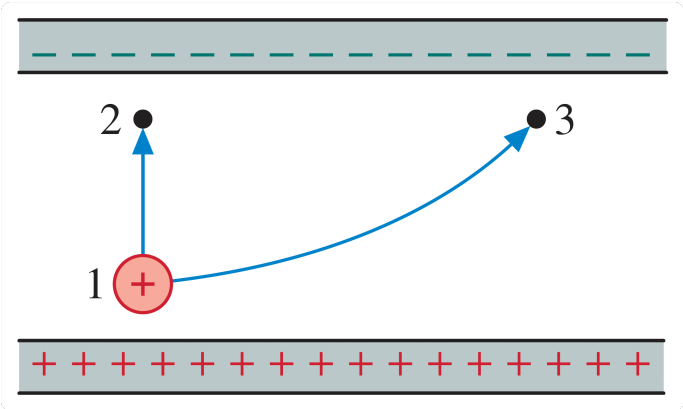
Potential between Parallel-Plate Capacitors



$$\Delta V = -\int_{\text{start}}^{\text{end}} \vec{E} \cdot d\vec{r} = Ed.$$

Testing Concepts (1)

Q: Two protons are launched with the same speed from point 1 inside the parallel-plate capacitor. Points 2 and 3 are the same distance from the negative plate.



- Is $\Delta U_{1\to 2}$, the change in potential energy along the path $1 \to 2$, larger than, smaller than, or equal to $\Delta U_{1\to 3}$?
- Is the proton's speed v_2 at point 2 larger than, smaller than, or equal to v_3? Explain.

Potential of a 3D Charge

$$
\begin{aligned}
V &= -\int_{\infty}^{r<R} E dr^{'} \\
&= -\int_{\infty}^{R} E_{\mathsf{out}} dr^{'} - \int_{R}^{r<R} E_{\mathsf{in}} dr^{'} \\
&= -\frac{Q}{4\pi\epsilon_0}\int_{\infty}^{R} \frac{1}{r^2} dr^{'} - \frac{Q}{4\pi\epsilon_0 R^3}\int_{R}^{r<R} r dr^{'} \\
&= \frac{Q}{4\pi\epsilon_0 R} + \frac{Q}{8\pi\epsilon_0 R^3}(R^2 - r^2) \\
&= \frac{Q(3R^2 - r^2)}{8\pi\epsilon_0 R^3}
\end{aligned}
$$

Testing Concepts (2)

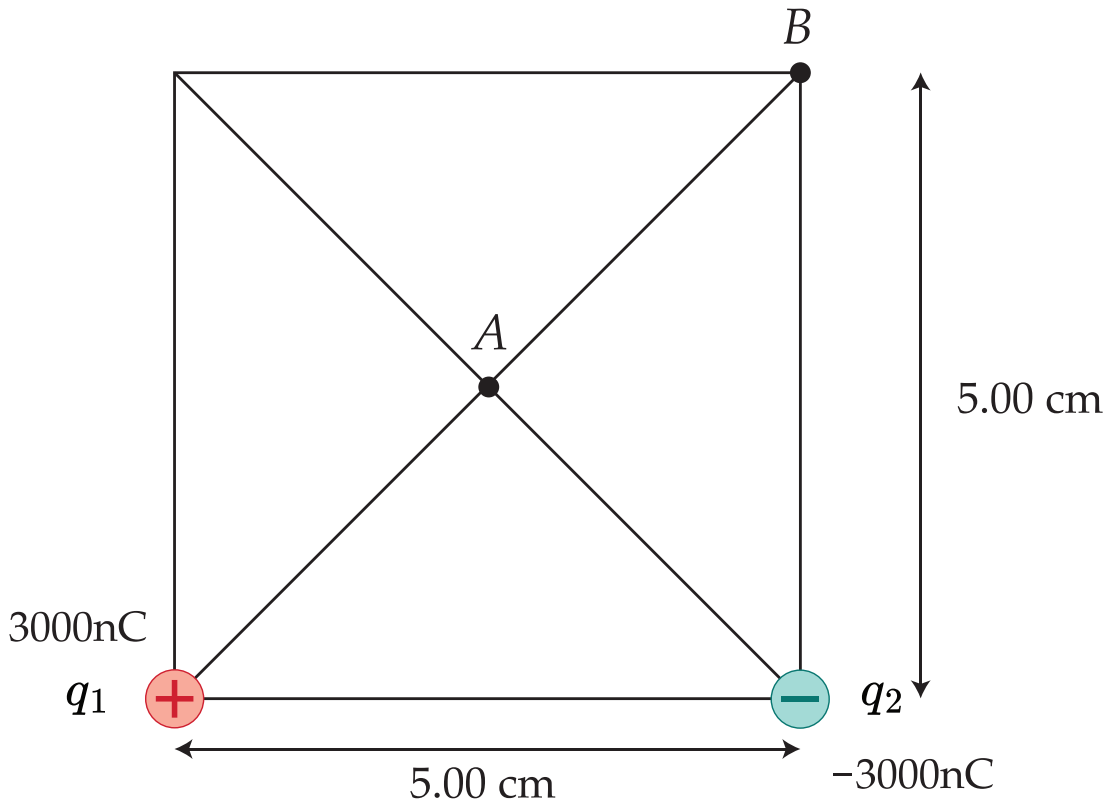
Q: What are **(a)** the charge and **(b)** the charge density on the surface of a conducting sphere of radius $0.15\,\text{m}$ whose Potential is $200\,\text{V}$ (with $V = 0$ at infinity)?

Testing Concepts (3)

Q: An empty hollow metal sphere has a potential of $+400\,\text{V}$ with respect to ground (defined to be at $V = 0$) and has a charge of 5.0×10^9 C. Find the electric Potential at the center of the sphere.

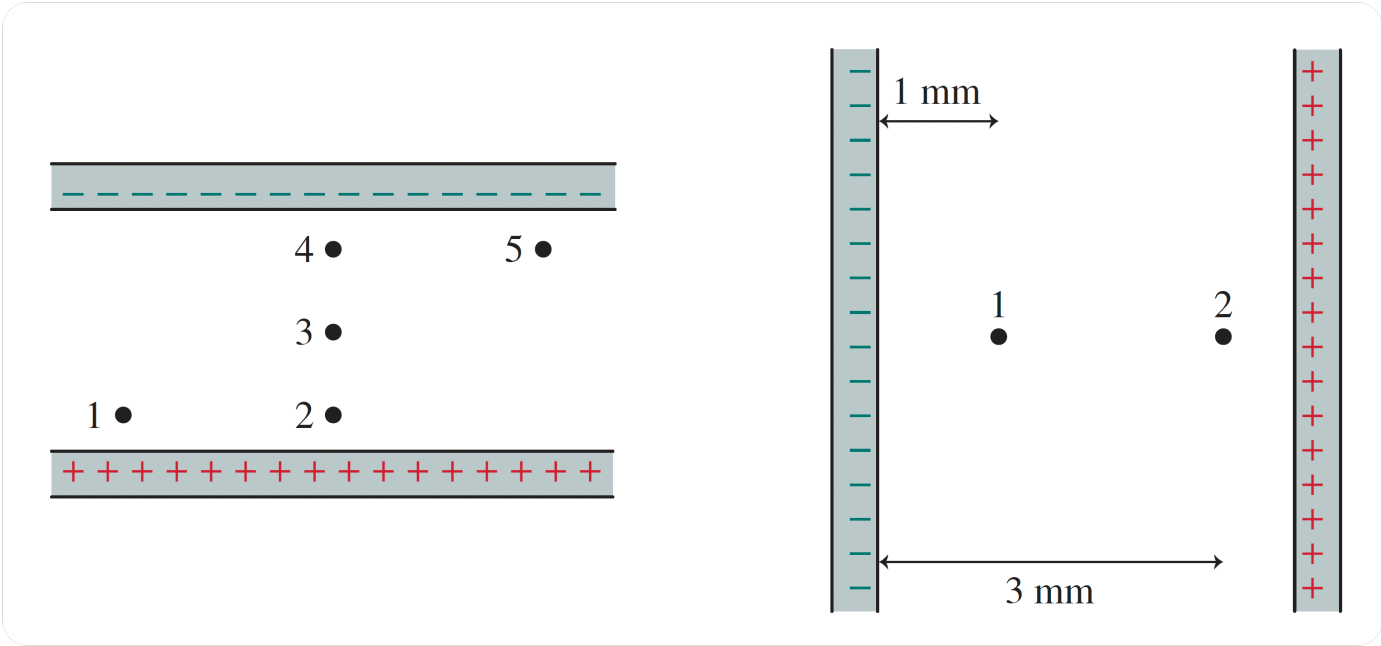
Testing Concepts (4)

Q: **(a)** Find $V_B - V_A$. A third point charge $q_3 = -6.00\,\mu\text{C}$ moves from point A to point B. **(b)** Does q_3 gain/lose any potential energy?



Testing Concepts (5)

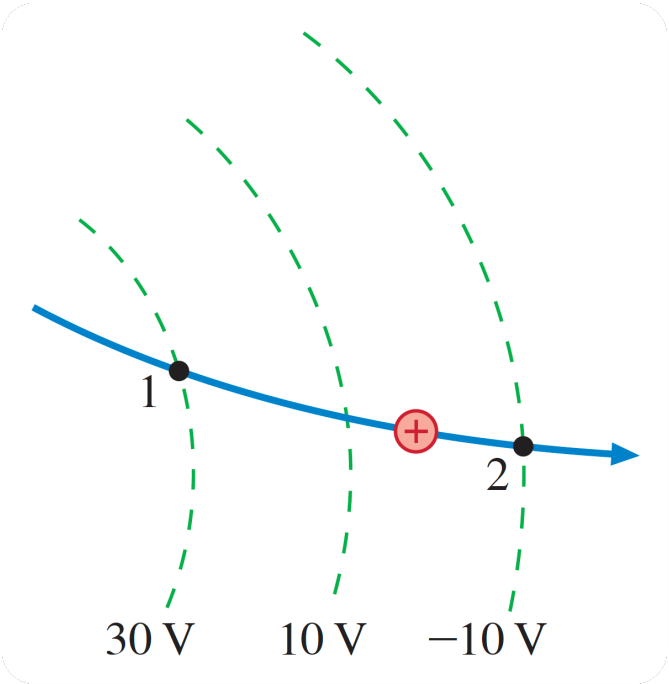
Q: (Left) Rank in order, from largest to smallest, the electric potentials V_1 to V_5 at points 1 to 5.



Q: (Right) In the right diagram, two points inside a capacitor are spotted. Let $V = 0\,\text{V}$ at the negative plate. Find $V_1 : V_2$ and $E_1 : E_2$.

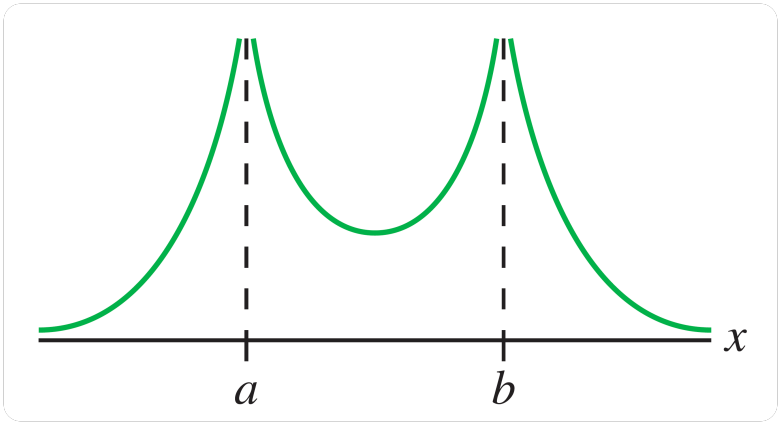
Testing Concepts (6)

Q: A proton's speed as it passes point 1 is $50000\,\mathrm{m\,s^{-1}}$. It follows the trajectory shown in the diagram below. What is the proton's speed at point 2?



Testing Concepts (7)

Q: Two point charges q_a and q_b are located on the x-axis at $x = a$ and $x = b$. The figure represents a graph of V, the electric potential.



- What are the signs of q_a and q_b?
- Find $\dfrac{q_a}{q_b}$.