Vidyaaytan Career Institute

JEE Mains 2025 Electrostatics - 1

Q.1: A point charge $+q$ is placed at the origin. A second point charge $+9q$ is placed at $(d, 0, 0)$ in Cartesian coordinate system. The point in between them where the electric field vanishes is:

A. $(\frac{4d}{3}, 0, 0)$

B. $(\frac{d}{4}, 0, 0)$

C. $(\frac{3d}{4}, 0, 0)$

D. $(\frac{d}{3}, 0, 0)$

Answer for Q.1: (B)

Solution: Let the point where the electric field vanishes be at x (between 0 and d).

Electric field due to $+q$ at x:
$E_1 = \frac{kq}{x^2}$ (to the right)

Electric field due to $+9q$ at x:
$E_2 = \frac{k \cdot 9q}{(d-x)^2}$ (to the left)

For net electric field to vanish:
$E_1 = E_2$

So,
$$\frac{kq}{x^2} = \frac{9kq}{(d-x)^2}$$
On solving, we get
$$x = \frac{d}{4}$$

Q.2: Consider a circular loop that is uniformly charged and has a radius $a\sqrt{2}$. Find the position along the positive z-axis of the Cartesian coordinate system where the electric field is maximum if the ring was assumed to be placed in the xy-plane at the origin:

A. $\frac{a}{\sqrt{2}}$

B. $\frac{a}{2}$

C. a

D. 0

Answer for Q.2: (C)

Solution: For a ring of radius R, the electric field along the axis is maximum at $z = \frac{R}{\sqrt{2}}$.

Given: $R = a\sqrt{2}$

So, $z = \frac{a\sqrt{2}}{\sqrt{2}} = a$

Q.3: An electron is made to enter symmetrically between two parallel and equally but oppositely charged metal plates, each of 10 cm length. The electron emerges out of the field region with a horizontal component of velocity 10^6 m/s. If the magnitude of the electric field between the plates is 9.1 V/cm, then the vertical component of velocity of electron is:
(mass of electron = 9.1×10^{-31} kg and charge of electron = 1.6×10^{-19} C)

A. 1×10^6 m/s

B. 0

C. 16×10^6 m/s

D. 16×10^4 m/s

Answer for Q.3: (C)

Solution: Given:

Horizontal velocity $v_x = 10^6$ m/s

Length of plates $L = 10$ cm $= 0.1$ m

Electric field $E = 9.1$ V/cm $= 910$ V/m

$m = 9.1 \times 10^{-31}$ kg

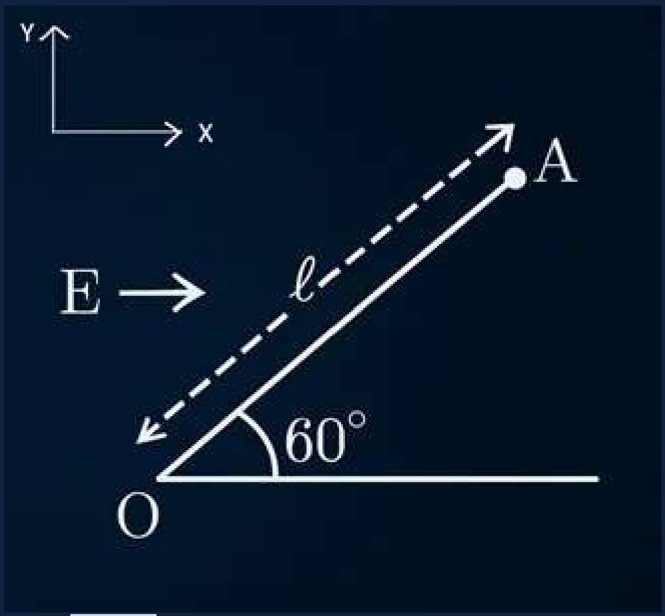
$e = 1.6 \times 10^{-19}$ C

Step 1: Time spent between plates
$t = \frac{L}{v_x} = \frac{0.1}{10^6} = 10^{-7}$ s

Step 2: Vertical acceleration
$a = \frac{F}{m} = \frac{eE}{m} = \frac{1.6 \times 10^{-19} \times 910}{9.1 \times 10^{-31}} = 1.6 \times 10^{14}$ m/s²

Step 3: Vertical velocity
$v_y = at = (1.6 \times 10^{14})(10^{-7}) = 16 \times 10^6$ m/s

Q.4: A particle of mass m and charge q is fastened to one end 'A' of a massless string having equilibrium length ℓ, whose other end is fixed at point 'O'. The whole system is placed on a frictionless horizontal plane and is initially at rest.
If uniform electric field is switched on along the direction as shown in figure, then the speed of the particle when it crosses the x-axis is:



A. $\sqrt{\frac{2qE\ell}{m}}$

B. $\sqrt{\frac{qE\ell}{4m}}$

C. $\sqrt{\frac{qE\ell}{m}}$

D. $\sqrt{\frac{qE\ell}{2m}}$

Answer for Q.4: (C)

Solution: Given:

Mass m, charge q, string length ℓ

Initial rest, smooth horizontal plane

Uniform electric field E directed along the x-axis

Angle $\theta = 60^\circ$ between string and x-axis

Work done by electric field = Gain in kinetic energy

Work done by electric force:

$W = \int \vec{F} \cdot d\vec{r} = qE \cdot \Delta x$

Here, $\Delta x = \ell \cos 60^\circ = \frac{\ell}{2}$

So, $W = qE \cdot \frac{\ell}{2}$

This work converts into kinetic energy:

$\frac{1}{2} m v^2 = qE \cdot \frac{\ell}{2}$

Solve for v:

$v = \sqrt{\frac{qE\ell}{m}}$

Q.5: Match List-I with List-II and choose the correct answer from the options given below.

List-I	List-II
(A). Electric field inside a uniformly charged spherical shell (surface charge density σ, radius R) at r > 0	**(I).** $\frac{\sigma}{\epsilon_0}$
(B). Electric field at distance r > 0 from a uniformly charged infinite plane sheet (surface charge density σ)	**(II).** $\frac{\sigma}{2\epsilon_0}$
(C). Electric field outside a uniformly charged spherical shell (surface charge density σ, radius R) at r > R	**(III).** 0
(D). Electric field between two oppositely charged infinite parallel sheets (surface charge density σ)	**(IV).** $\frac{\sigma R^2}{\epsilon_0 r^2}$

A. (A)-(IV), (B)-(I), (C)-(III), (D)-(II)

B. (A)-(IV), (B)-(II), (C)-(III), (D)-(I)

C. (A)-(II), (B)-(I), (C)-(IV), (D)-(III)

D. (A)-(III), (B)-(II), (C)-(IV), (D)-(I)

Answer for Q.5: (D)

Solution: Basic results.