TEST

JEE Mains PYQs Electric Charge & Field (Physics Master Academy)

QUESTIONS

SECTIONS

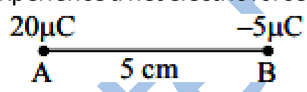
1. Section A - 35 Questions

Section 1 : Section A - 35 Questions

SECTION INSTRUCTIONS

This section contains 35 qs. Each qs is compoulsary. 4 marks for every correct answer, - 1 for evry incorrect answer.

1 Two particles A and B having charges 20μC and – 5μC respectively are held kxed with a separation of 5cm. At what position a third charged particle should be placed so that it does not experience a net electric force?



- At 5cm from 20μC on the left side of system
- At 5cm from – 5μC on the right side
- At 1.25cm from – 5μC between two charges
- At midpoint between two charges

Correct: +4 · Incorrect: -1

2 Two identical tennis balls each having mass 'm' and charge 'q' are suspended from a kxed point by threads of length 'l'. What is the equilibrium separation when each thread makes a small angle 'θ' with the interval?

- d = $\left(\dfrac{q^2 l}{2\pi\varepsilon_0 mg}\right)^{1/2}$
- d = $\left(\dfrac{q^2 l}{2\pi\varepsilon_0 mg}\right)^{1/3}$
- d = $\left(\dfrac{q^2 l^2}{2\pi\varepsilon_0 m^2 g}\right)^{1/3}$

- d = $\left(\frac{q^2 l^2}{2\pi\varepsilon_0 m^2 g^2}\right)^{1/3}$

Correct: +4 · Incorrect: -1

3 A certain charge Q is divided into two parts q and (Q – q). How should the charges Q and q be divided so that q and (Q – q) placed at a certain distance apart experience maximum electrostatic repulsion?

- Q = q/2
- Q = 2q
- Q = 4q
- Q = 3q

Correct: +4 · Incorrect: -1

4 Three charges +Q, q and +Q are placed respectively, at distance, d/2 and d from the origin, on the x axis. If the net force experienced by +Q, placed at x = 0, is zero, then value of q is

- -Q/4
- +Q/2
- +Q/4
- -Q/2

Correct: +4 · Incorrect: -1

5

Charge is distributed within a sphere of radius R with a volume charge density p(r) = $\frac{A}{r^2}e^{-2r/a}$ where A and a are constants. IF Q is the total charge of this charge distribution, the radius R is

- $a\log\left(1-\frac{Q}{2\pi aA}\right)$
- $\frac{a}{2}\log\left(\frac{1}{1-\frac{Q}{2\pi aA}}\right)$
- $a\log\left(\frac{1}{1-\frac{Q}{2\pi aA}}\right)$

○ $\frac{a}{2}\log\left(1-\frac{Q}{2\pi aA}\right)$

Correct: +4 · Incorrect: -1

6 Two identical conducting spheres A and B, carry equal charge. They are separated by a distance much larger than their diameter, and the force between them is F. A third identical conducting sphere, C is uncharged. Sphere C is krst touched to A, then to B, and then removed. As a result, the force between A and B would be equal to

○ $\frac{3F}{4}$

○ $\frac{F}{2}$

○ F

○ $\frac{3F}{8}$

Correct: +4 · Incorrect: -1

7 A uniformly charged disc of radius R having surface charge density σ is placed in the xy plane with its center at the origin. Find the electric keld intensity along the z axis at a distance Z from origin.

○ E = $\frac{\sigma}{2\varepsilon_0}$¿

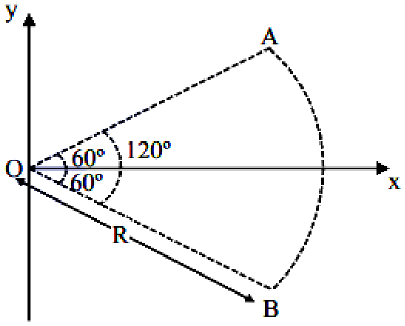
○ E = $\frac{\sigma}{2\varepsilon_0}$¿

○ E = $\frac{2\varepsilon_0}{\sigma}\left(\frac{1}{(Z^2+R^2)^{1/2}}+Z\right)$

○ E = $\frac{\sigma}{2\varepsilon_0}\left(\frac{1}{(Z^2+R^2)}+\frac{1}{Z^2}\right)$

Correct: +4 · Incorrect: -1

8 Figure shows a rod AB, which is bent in a 120° circular arc of radius R. A charge (- Q) is uniformly distributed over rod AB. What is the elastic keld $\vec{E}$ at the centre of curvature O?



- $\frac{3\sqrt{3}Q}{8\pi\varepsilon_0 R^2}(\hat{i})$
- $\frac{3\sqrt{3}Q}{8\pi^2\varepsilon_0 R^2}(\hat{i})$
- $\frac{3\sqrt{3}Q}{16\pi^2\varepsilon_0 R^2}(\hat{i})$
- $\frac{3\sqrt{3}Q}{8\pi^2\varepsilon_0 R^2}(-\hat{i})$

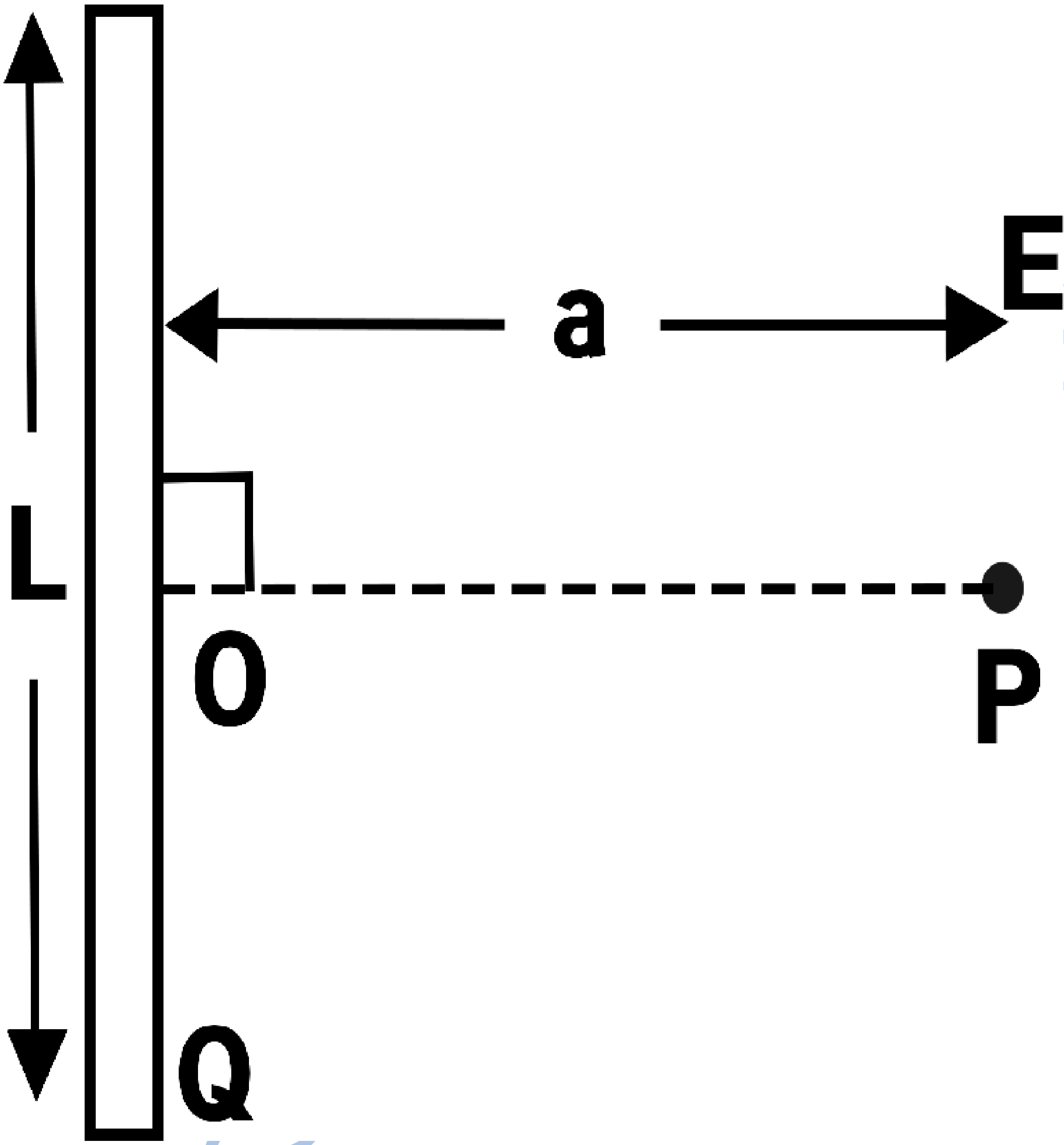
Correct: +4 · Incorrect: -1

9 An oil drop of radius 2mm with a density 3 g cm^{-3} is held stationary under a constant electric keld 3.55×10^5 Vm^{-1} in the Millikan's oil drop experiment. What is the number of excess electrons that the oil drop will process? Consider g = 9.81 m/s^2.

- 1.73×10^{12}
- 1.73×10^{10}
- 48.8×10^{11}
- 17.3×10^{10}

Correct: +4 · Incorrect: -1

10 Find the electric keld at point P (as shown in kgure) on the perpendicular bisector of a uniformly charged thin wire of length L carrying a charge Q. The distance of the point P from the centre of the rod is a = $\frac{\sqrt{3}}{2}L$.



○ $\frac{Q}{3\pi\varepsilon_0 L^2}$

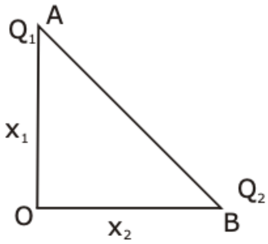
○ $\frac{Q}{4\pi\varepsilon_0 L^2}$

○ $\frac{\sqrt{3}Q}{4\pi\varepsilon_0 L^2}$

○ $\frac{Q}{2\sqrt{3}\pi\varepsilon_0 L^2}$

Correct: +4 · Incorrect: -1

11 Charges Q_1 and Q_2 are a point A and B of right triangle OAB (see kg). The resultant electric keld at point O is perpendicular to the hypotenuse, the Q_1a/Q_2 s proportional to



- $\frac{x_1^3}{x_2^3}$
- $\frac{x_2}{x_1}$
- $\frac{x_1}{x_2}$
- $\frac{x_2^2}{x_1^2}$

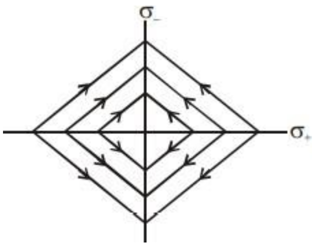
Correct: +4 · Incorrect: -1

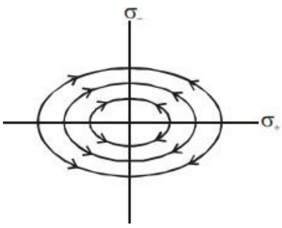
12 Consider the force F on a charge 'q' due to a uniformly charged spherical shell of radius R carrying charge Q distributed uniformly over it. Which one of the following statements is true for F, if 'q' is placed at distance r from the center of the shell?

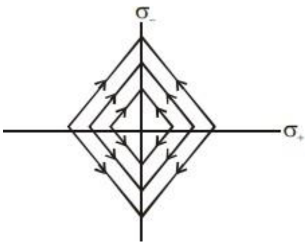
- F = $\frac{1}{4\pi\varepsilon_0}\frac{Qq}{R^2} for r < R$
- F = $\frac{1}{4\pi\varepsilon_0}\frac{Qq}{R^2} > F > 0 for r < R$
- F = $\frac{1}{4\pi\varepsilon_0}\frac{Qq}{R^2} for r > R$
- F= $\frac{1}{4\pi\varepsilon_0}\frac{Qq}{R^2} for all r$

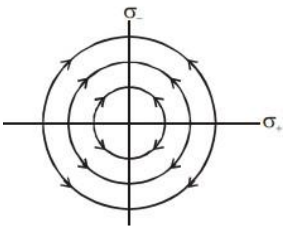
Correct: +4 · Incorrect: -1

13 Two charged thin inknite plane sheets of uniform surface charge density σ_+ and σ_- where $|\sigma_+| > |\sigma_-|$ intersect at right angle. Which of the following best represents the electric keld lines for this system?

○ 

○ 

○ 

○ 

Correct: +4 · Incorrect: -1

14 A particle of charge q and mass m is subjected to an electric keld $E = E_0(1 - ax^2)$ in the x direction where a and E_0 are constants. Initially the particle was at rest at x =0. Other than the initial position the kinetic energy of the particle biomes zero when the distance of the particle form the origin is

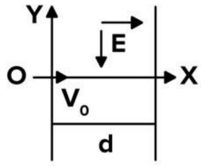
○ a

○ $\sqrt{\frac{2}{a}}$

○ $\sqrt{\frac{3}{a}}$

○ $\sqrt{\frac{1}{a}}$

15 A charged particle (mass m and charge q) moves along X axis with velocity V_0. When it passes through the origin it enters region having uniform keld
$\vec{E}$
= - E
$\hat{j}$
which extends upto x = d. Equation of path of electron in the region x > d is



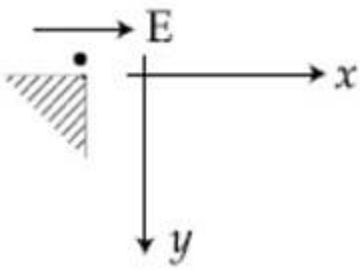
○ y = $\frac{qEd}{mV_0^2}(x-d)$

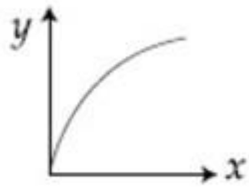
○ y = $\frac{qEd}{mV_0^2}\left(\frac{d}{2}-x\right)$

○ y = $\frac{qEd}{mV_0^2}x$

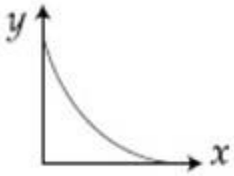
○ y = $\frac{qEd^2}{mV_0^2}x$

16 A small point mass carrying some positive charge on it, is released from the edge of the table. There is uniform electric keld in this region in the horizontal direction. Which of the following options then correctly describe the trajectory of the mass>? (Curves are drawn schematically and are no to scale).

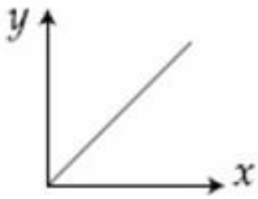


○ 

○

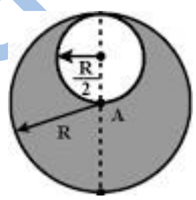


○ 

○ 

Correct: +4 · Incorrect: -1

17 Consider a sphere of radius R which carries a uniform charge ρ. If a sphere of radius R/2 is carved out of R as shown, the ratio $\left|\frac{\vec{E}_A}{\vec{E}_B}\right|$ of magnitude of electric keld $\vec{E}_A$ and $\vec{E}_B$ = respectively at points A and B due to remaining portion is



○ 21/34

○ 18/34

○ 17/54

○ 18/54

Correct: +4 · Incorrect: -1

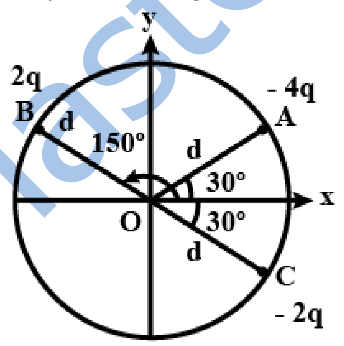
18 An electric dipole moment $\vec{p}$ = ($\hat{i}$ $- 3$ $\hat{j}$ $+ 2$

$\hat{k}$) ×10^{-29} Cm is at the origin (0, 0, 0). The electric keld due to this dipole at
$\vec{r}$
= +
$\hat{i}$
+ 3
$\hat{j}$
+ 5
$\hat{k}$
(note that
$\vec{r}$
.
$\vec{p}$
= 0) is parallel to:

- ○ $(+\hat{i} - 3\hat{j} - 2\hat{k})$
- ○ $(-\hat{i} + 3\hat{j} - 2\hat{k})$
- ○ $(+\hat{i} + 3\hat{j} - 2\hat{k})$
- ○ $(-\hat{i} - 3\hat{j} + 23\hat{k})$

Correct: +4 · Incorrect: -1

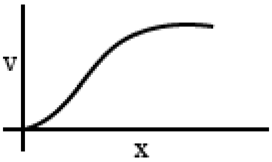
19 Three charged particles A, B and C with charges – 4q, 2q and – 2q are present on the circumference of a circle of radius d. The charged particles A, B and C and centre O of the circle formed an equilateral triangle as shown in kgure. Electric keld at O along x direction is

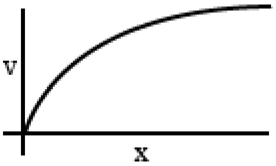


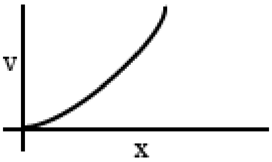
- ○ $\frac{\sqrt{3}q}{\pi \varepsilon_0 d^2}$
- ○ $\frac{2\sqrt{3}q}{\pi \varepsilon_0 d^2}$
- ○ $\frac{\sqrt{3}q}{4\pi \varepsilon_0 d^2}$
- ○ $\frac{3\sqrt{3}q}{4\pi \varepsilon_0 d^2}$

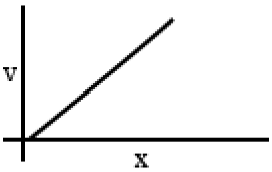
Correct: +4 · Incorrect: -1

20 A particle of mass m and charge q is released from rest in a uniform electric keld. If there is no other force on the particle, then dependence of its speed v on the distance x travelled by it is correctly given by (graphs are schematic and not drawn to sale)

- 

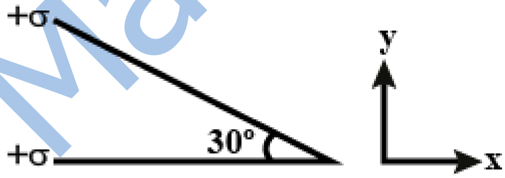
- 

- 

- 

Correct: +4 · Incorrect: -1

21 Two inknite particles each with uniform surface charge density $+\sigma$ are kept in such a way that the angle between them is 30°. The electric keld in the region shown between them is given by



- $\frac{\sigma}{2\epsilon_0}\left[\left(1+\sqrt{3}\right)\hat{y}-\frac{\hat{x}}{2}\right]$
- $\frac{\sigma}{\epsilon_0}\left[\left(1+\frac{\sqrt{3}}{2}\right)\hat{y}+\frac{\hat{x}}{2}\right]$
- $\frac{\sigma}{2\epsilon_0}\left[\left(1+\sqrt{3}\right)\hat{y}+\frac{\hat{x}}{2}\right]$
- $\frac{\sigma}{2\epsilon_0}\left[\left(1-\sqrt{3}\right)\hat{y}-\frac{\hat{x}}{2}\right]$

Correct: +4 · Incorrect: -1

22 A particle of mass m and charge q has an initial velocity $\vec{v}$ = v_0
$\hat{j}$
. IF an electric keld
$\vec{E}$
= E_0
$\hat{i}$
has magnetic keld
$\vec{B}$
= B_0
$\hat{i}$
act on the particle, its speed will double after a time:

○ $\frac{2 m v_0}{q E_0}$

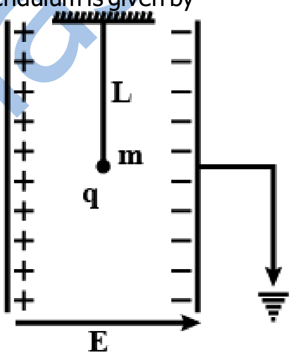
○ $\frac{3 m v_0}{q E_0}$

○ $\frac{\sqrt{3} m v_0}{q E_0}$

○ $\frac{\sqrt{2} m v_0}{q E_0}$

Correct: +4 · Incorrect: -1

23 A simple pendulum of length L is placed between the plates of a parallel plate capacitor having electric keld E, as shown in kgure. Its bob has mass ma and charge q. The time period of the pendulum is given by



○ $2\pi\sqrt{\frac{L}{\left(g+\frac{qE}{m}\right)}}$

○ $2\pi\sqrt{\frac{L}{\sqrt{g^2-\frac{q^2E^2}{m^2}}}}$

○

$2\pi\sqrt{\frac{L}{\left(g+\frac{qE}{m}\right)}}$

○ $2\pi\sqrt{\frac{L}{\sqrt{g^2+\left(\frac{qE}{m}\right)^2}}}$

Correct: +4 · Incorrect: -1

24 Four point charges – q, +q, +q and – q are placed on y axis at y = - 2d, y = -d, y = +d and y = +2d, respectively. The magnitude of the electric keld E at a point on the x axis at x = D with D >>d will behave as

○ $E \propto \frac{1}{D^3}$

○ $E \propto \frac{1}{D}$

○ E $\propto \frac{1}{D^4}$

○ $E \propto \frac{1}{D^2}$

Correct: +4 · Incorrect: -1

25 The bob of a simple pendulum has mass 2g and charge at 5.0 μC. It is at rest in a uniform horizontal electric keld of intensity 2000 V/m. At equilibrium, the angle that the pendulum makes with the vertical is (take g = $10 m/s^2$)

○ $\tan^{-1}(2.0)$

○ $\tan^{-1}(0.2)$

○ $\tan^{-1}(5.0)$

○ $\tan^{-1}(0.5)$

Correct: +4 · Incorrect: -1

26 For a uniformly charged ring of radius R, the electric keld on its axis has the largest magnitude at a distance h from its centre. The value of h is

○ $\frac{R}{\sqrt{5}}$

○ $\frac{R}{\sqrt{2}}$

○ R

○ $R\sqrt{2}$

Correct: +4 · Incorrect: -1

27 A body of mass M and charge q is connected to a spring of spring constant k. It is oscillating along x direction about its equilibrium position, taken to be at x = 0, with an amplitude A. An electric keld E is applied along the x direction. Which of the following statements is correct?

○ The total energy of the system is $\frac{1}{2}m\omega^2 A^2 + \frac{1}{2}\frac{q^2E^2}{k}$

○ The new equilibrium position is at a distance 2qE/k from x =- 0

○ The new equilibrium position is at a distance qE/k from x =- 0

○ The total energy of the system is $\frac{1}{2}m\omega^2 A^2 - \frac{1}{2}\frac{q^2E^2}{k}$

Correct: +4 · Incorrect: -1

28 A solid ball of radius R has a charge density ρ is given by

$\rho = \rho_0\left(1 - \frac{r}{R}\right)$

for 0 ≤ r ≤ R. The electric keld outside the ball is

○ $\frac{\rho_0 R^3}{\varepsilon_0 r^2}$

○ $\frac{4\rho_0 R^3}{3\varepsilon_0 r^2}$

○ $\frac{3\rho_0 R^3}{4\varepsilon_0 r^2}$

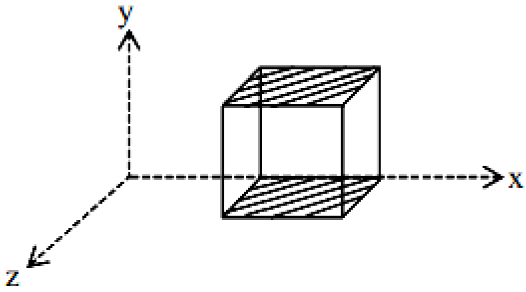
○ $\frac{\rho_0 R^3}{12\varepsilon_0 r^2}$

Correct: +4 · Incorrect: -1

29 A cube is placed inside an electric keld, $\vec{E}$ = 150y^2

$\hat{j}$

. The side of the cube is 0.5m and is placed in the keld as shown in kgure. The charge inside the cube is



- 3.8×10^{-11}C
- 8.3×10^{-11}C
- 3.8×10^{-12}C
- 8.3×10^{-12}C

Correct: +4 · Incorrect: -1

30 Choose the incorrect statement:

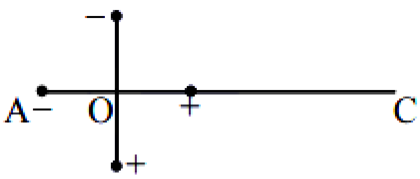
A. The electric lines of force entering into a Gaussian surface provide negative flux.
B. A charge 'q' is placed at the center of a cube. The flux through all the faces will be the same.
C. In a uniform electric keld net flux through a closed Gaussian surface containing no net charge is zero.
D. When electric keld is parallel to a Gaussian surface, it provides a knite non zero flux.

Choose the most appropriate answer from the options given below:

- C and D only
- B and D only
- D only
- A and C only

Correct: +4 · Incorrect: -1

31 Two ideal electric dipoles A and B having their dipole moment $p_1$and p_2 respectively are placed on a plane with their centres at O as shown in kgure. At point C on the axis of dipole A, the resultant electric keld is making an angle of 37° with the axis. The ratio of the dipole moment of A and B, p_1/p_2 is: (take sin 37° = 3/5)



- 3/8
- 3/2

○ 2/3

○ 4/3

Correct: +4 · Incorrect: -1

32 Two identical electric point dipoles on the x axis at distance 'a' from each other. When released they move along x axis with the direction of their dipole moments remaining unchanged. If the mass of each dipole is 'm'. their speed when they are inknitely far apart is

○ $\frac{p}{a}\sqrt{\frac{1}{\pi\varepsilon_0 ma}}$

○ $\frac{p}{a}\sqrt{\frac{1}{2\pi\varepsilon_0 ma}}$

○ $\frac{p}{a}\sqrt{\frac{2}{\pi\varepsilon_0 ma}}$

○ $\frac{p}{a}\sqrt{\frac{2}{2\pi\varepsilon_0 ma}}$

Correct: +4 · Incorrect: -1

33

In knding the electric keld using Gauss law the formula $|\vec{E}|=\frac{q_{enc}}{\varepsilon_0 \vee A \vee ¿¿}$ is applicable. In the formula ε_0 is permittivity of free space, A is the area of Gaussian surface and q_{enc} is charge enclosed by the Gaussian surface. This equation can be used in which of the following situation?

○ Only when the Gaussian surface is an equipotential surface

○ Only when the Gaussian surface is an equipotential surface and $|\vec{E}|$ is constant on the surface

Only when $|\vec{E}|$ = constant on the surface.
○

○ For any choice of Gaussian surface.

Correct: +4 · Incorrect: -1

34 Let a total charge 2Q be distributed in a sphere of radius R with the charge density given by $\rho(r) = kr$, where r is the distance from the centre. Two charges A and B of – Q each are placed on diametrically opposite points, at equal distance a, from the centre. IF A and B do not experience any force, then

$a = 8^{-1/4}R$

○

$a = 3R/2^{1/4}$

○

○ $a = 2^{-1/4}R$

○ $a = R/\sqrt{3}$

Correct: +4 · Incorrect: -1

35 An electric keld of 1000 V/m is applied to an electric dipole at angle of 45°. The value of electric dipole moment is 10^{-29}C.m. What is the potential energy of the electric dipole?

○ -20×10^{-18}J

○ -7×10^{-27}J

○ -10×10^{-29}J

○ -9×10^{-20}J

Correct: +4 · Incorrect: -1

TEST

JEE Mains PYQs Electric Charge & Field (Physics Master Academy)

ANSWERS

SECTIONS

1. Section A - 35 Questions

Section 1 : Section A - 35 Questions

1 At 5cm from – 5μC on the right side

2 d = $\left(\frac{q^2 l^2}{2\pi\varepsilon_0 m^2 g}\right)^{1/3}$

3 Q = 2q

4 -Q/4

5 $\frac{a}{2}\log\left(\frac{1}{1-\frac{Q}{2\pi aA}}\right)$

6 $\frac{3F}{8}$

7 E = $\frac{\sigma}{2\varepsilon_0}$¿

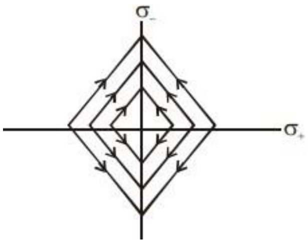
8 $\frac{3\sqrt{3}Q}{8\pi^2\varepsilon_0 R^2}(\hat{i})$

9 1.73×10^{10}

10 $\frac{Q}{2\sqrt{3}\pi\varepsilon_0 L^2}$

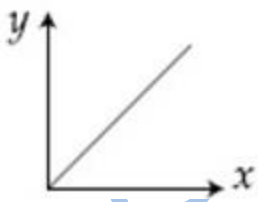
11 $\frac{x_1}{x_2}$

12 $F = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{R^2} for r > R$

13 

14 $\sqrt{\frac{3}{a}}$

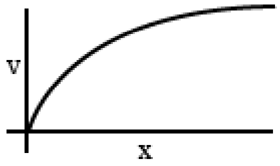
15 $y = \frac{qEd}{mV_0^2}(\frac{d}{2} - x)$

16 

17 18/34

18 $(+\hat{i} + 3\hat{j} - 2\hat{k})$

19 $\frac{\sqrt{3}q}{\pi\varepsilon_0 d^2}$

20 

21 $\frac{\sigma}{2\epsilon_0}\left[\left(1-\sqrt{3}\right)\hat{y}-\frac{\hat{x}}{2}\right]$

22 $\frac{\sqrt{3}mv_0}{qE_0}$

23 $2\pi\sqrt{\frac{L}{\sqrt{g^2+\left(\frac{qE}{m}\right)^2}}}$

24 $E\propto\frac{1}{D^2}$

25 $\tan^{-1}(0.5)$

26 $\frac{R}{\sqrt{2}}$

27 The total energy of the system is $\frac{1}{2}m\omega^2A^2+\frac{1}{2}\frac{q^2E^2}{k}$

28 $\frac{\rho_0R^3}{12\varepsilon_0r^2}$

29 $8.3\times10^{-11}C$

30 D only

31 2/3

32 $\frac{p}{a}\sqrt{\frac{1}{2\pi\varepsilon_0 ma}}$

33 Only when the Gaussian surface is an equipotential surface

34 $a = 8^{-1/4}R$

35 -7×10^{-27}J

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