



# PHYSICS

# **BOOKS - CENGAGE PHYSICS (HINGLISH)**

# **ELECTRIC CHARGES AND FIELDS**

**Question Bank** 

1.  $10^{12} \alpha$ - particles (Nuclei of helium) per second falls on a neutral sphere,

calculate time in which sphere gets charged by  $2\mu C$ .

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2. An infinite number of charges, each equal to q, are placed along the x axis at x = 1, x = 2, x = 4, x = 8, etc. The electric field at the point x = 0 due to the set of charges is  $\frac{q}{n\pi\varepsilon_0}$ . Find n.



**3.** Three charges, each of value q, are placed at the comers of an equilateral triangle. A fourth charge Q is placed at the centre of the triangle. If the value of Q for which charges remain stationary is  $\left(\frac{-q}{\sqrt{n}}\right)$ , then find n.

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**4.** A circular wire of radius r has a uniform linear charge density  $\lambda = \lambda_0 \cos^2 \theta$ , The total charge on the wire is  $\alpha \pi \lambda_0 r_2$  Find  $\alpha$ .

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5. A point charge  $q=100\mu C$  is located in the x-y plane at the point with position vector  $\overrightarrow{r}_0=2\hat{i}+3\hat{k}+\hat{k}$ . What is the magnitude of



7. Two infinite linear charges are placed parallel to each other at a distance 0.1m -from each other. If the linear charge density on each is  $5\mu \frac{C}{m}$ , then the force (in N / m ) acting on a unit length of each linear charge will be

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**8.** A uniform electric field E=500 N /C passes through a hemispherical surface of radius R=1.2 mas shown in the figure. The net electric flux (in SI units) through the hemispherical surface only is  $N\pi$ . Find the value of N. '(##CEN\_KSR\_PHY\_JEE\_C18\_E01\_008\_Q01##)'



**9.** Linear charge densities of the two rods are given as  $\lambda_1 = \frac{-\lambda_0 x}{I^2}$  and  $\lambda_2 = \frac{+\lambda_0 y}{l^2}$ . If the dipole moment of the system of rods is  $\frac{\sqrt{m}\lambda_0 l}{n}$ , then find (m + n).

'(##CEN\_KSR\_PHY\_JEE\_C18\_E01\_009\_Q02##)'

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**10.** Two point charges exert a force  $F_{(d)}$ , on each other when placed in vacuum. If the charges are increased to four times, separation between them is doubled and the system is placed in an insulating medium, then

also they experience the same force. What should be the dielectric constant of the medium?

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**11.** A linear charge having linear charge density  $\lambda$ , penetrates a cube diagonally and that it penetrates a sphere diametrically as shown. The ratio of flux coming out of the cube and the sphere is  $\frac{\sqrt{x}}{y}$ , Find (xy). '(##CEN\_KSR\_PHY\_JEE\_C18\_E01\_011\_Q03##)'

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**12.** 'Two short dipoles  $p\hat{k}$  and  $\frac{p}{2}\hat{k}$  are located at (0, 0, 0) and  $(1(\neg m), 0, 2(\neg m))$ , respectively. The resultant electric field due to the two dipoles at the point (1, m, 0, 0) is  $\frac{4np}{32\pi\varepsilon_0}k$ . Find n.

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**13.** Two charges, each of -q, are fixed and separated by a distance 2d. A third charge q of mass m is placed at the mid-point of the two fixed charges. q is displaced slightly by  $x(x\langle)$ , perpendicular to the line joining the two fixed charged as shown in the figure. q will perform simple harmonic oscillation if the time period of (SHM) is  $T = \frac{\alpha \pi^3 \varepsilon_0 m d^3}{q^2} \Big]^{\left[\frac{1}{2}\right)}$ . Find  $\alpha$ 

'(##CEN\_KSR\_PHY\_JEE\_C18\_E01\_013\_Q04##)'

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14. A charged particle enters at point A and comes out from point B. Its velocity vector makes angle  $\alpha$  and  $\beta$  with electric field at these two points, respectively. The ratio of kinetic energy of the charged particle at these two points  $\left(\frac{K_{\delta}}{K_A}\right)$  will be (Given  $\alpha = 60^{\circ}$  and  $\beta = 30^{\circ}$ ). '(##CEN\_KSR\_PHY\_JEE\_C18\_E01\_014\_Q05##)'

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**15.** A clock face has negative charges -q, -2q, -3q, ..., -12(q) fixed at the position of the corresponding numerals on the dial. The clock hands do not disturb the net field due to point charges, At time x: 30, the hour hand point in the same direction of electric field at the centre of the dial. Find x.

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16. In a certain region,  $\overrightarrow{B}$  increases radially as  $\overrightarrow{E} = 90r(-\hat{r})$ . The magnitude of electric charge (in  $\mu C$ ) contained within-a sphere of radius 2m centered at the origin is.

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17. The electric field in a region is radially outward with magnitude E = Ar. The charge contained in a sphere of radius a centered at the region is  $(b \times 10^{-4})C$ . Find b. (Take  $A = 1000V \frac{)}{m^2}$  and `a=30 cm ).

**18.** The total flux through the faces of the cube with side of length a ,if a charge q is placed at B (mid-point of an edge of the cube), is  $\phi$ , and if a charge q is placed at C (centre of a face of the cube), is  $\phi_2$ . Find  $\frac{\phi_2}{\phi_1}$ . '(##CEN\_KSR\_PHY\_JEE\_C18\_E01\_018\_Q06##)'

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**19.** A thin insulating uniformly charged (linearly charged density  $\lambda$ ) rod is hinged about one of its ends. It can rotate in vertical plane. If the rod is in equilibrium by applying vertical electric field E as shown in figure, then find the value of  $E( \in (N/C))$ . (*Given*: Massofrod = 2kg, lambda=10 C / m, l=1 m g=  $10\frac{m}{s^2}$ )

'(##CEN\_KSR\_PHY\_JEE\_C18\_E01\_019\_Q07##)'

**20.** Find the magnitude of uniform electric field E in N / C (direction shown in figure) if an electron entering with velocity 100 m / s and making 30° with the x -direction comes out making 60° with the x -direction, after a time numerically equal to  $\frac{m}{e}$  of electron.

'(##CEN\_KSR\_PHY\_JEE\_C18\_E01\_020\_Q08##)'

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**21.** A particle having charge  $q = +2.00\mu C$  and mess m = 0.0100kg is connected to a string having length L=1.50 m and is tied to the pivot point P shown in the figure. The particle, string, and pivot point all lie op a frictionless horizontal table. The particle is released from rest when the string makes an angle  $\theta = 60^{\circ}$  with a uniform electric field of magnitude E=300 V / m .The speed (in m / s ) of the particle when the string is parallel to the electric field (shown in figure) is x. Find 10x. '(##CEN KSR PHY JEE C18 E01 021 Q09##)' **22.** The volume charge density as a function of distance x from one face inside a unit cube is varying as shown in the figure. The total flux (in SI units) through the cube is.

'(##CEN\_KSR\_PHY\_JEE\_C18\_E01\_022\_Q10##) A particle having charge  $q = +2.00\mu C$  and mess m = 0.0100kg is connected to a string having length L=1.50 m and is tied to the pivot point P shown in the figure. The particle, string, and pivot point all lie op a frictiontess horizontal table. The perticle is released from rest when the string makes an angle  $\theta = 60^{\circ}$  with a uniform electric field of magnitude E=300 V / m .The speed (in m / s ) of the particle when the string is parallel to the electric field (shown in figure) is x. Find 10x.

'(##CEN\_KSR\_PHY\_JEE\_C18\_E01\_021\_Q09##)'

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**23.** A particle of charge q and mass m moves rectilinearly under the action of an electric field E = A - Bx, where B is a positive constant and x is a distance from the point where the particle was initially at rest.

The distance travelled by the particle till it comes to rest is  $\frac{\alpha A}{\beta B}$ . Find  $(\alpha + \beta)$ .

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24. An electric field given by  $\overline{E} = 4\hat{i} - \leq ft(3y^2 + 2)\hat{j}$  pierces Gaussian's cube of side 1 m placed at origin such that its three sides represents  $x_1y$  and z axis. The net charge enclosed within the cube is given by  $-ne_o$ . Find the value of n.

'(##CEN\_KSR\_PHY\_JEE\_C18\_E01\_024\_Q11##)'

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**25.** Two mutually perpendicular infinite wires along x -axis and y -axis carry charge densities  $\lambda_1$  and  $\lambda_2$ , respectively. The electric line of force at P is along, the line  $y = \frac{1}{\sqrt{3}}x$ , where P is also a point lying on the same line. Find  $\frac{\lambda_2}{\lambda_1}$ . '(##CEN\_KSR\_PHY\_JEE\_C18\_E01\_025\_Q12##)' **26.** In a uniform electric field, a cube of side 1 cm is placed. The total energy stored in the cube is  $8.85\mu J$ . The electric field is parallel to four of the faces of the cube. If the electric flux through any one of the remaining two faces is  $m\sqrt{n}$  volt-meter, then find (mn).

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27. The below figure shows a closed Gaussian surface in the shape of a cube of edge length 3.0(-m). There exists an electric field given by  $\vec{E} = \left[ (2.0x + 4.0)\hat{i} + 8.0\hat{j} + 3.0\hat{k} \right] \frac{N}{C}$ , where x is in metres, in the region in which it lies. The net ebarge (in coulombs) enclosed by the cube is equal to  $\alpha \varepsilon_0$ . Find  $\alpha$ .

'(##CEN\_KSR\_PHY\_JEE\_C18\_E01\_027\_Q13##)'

28. A small sphere of mass m=0.5 kg cariying a positive charge  $q = 110 \mu C$ is connected with a light, flexible and inextensible string of length r=60 cm

and  $whir \leq d \in avertical \circ \leq .$  If  $avertically upwarde \leq ctrie field of states E=10^{(5)}$  N C^(-1)  $\exists \in the space, then the min i \mu m velocity ( <math>\in \frac{m}{s}$ ) of the sphere required att (g=10 ms^(-2))`

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**29.** A solid spherical region having a spherical cavity. whose diameter R is equal to the radius of the spherical region, has a total charge Q. The

electric field at a point 
$$P$$
 as shown is  $\frac{Q}{28\pi\varepsilon_0}\left[\frac{A}{x^2} - \frac{B}{\left(x - \frac{R}{2}\right)^2}\right]$ . Find  $(A - B)$ .

'(##CEN\_KSR\_PHY\_JEE\_C18\_E01\_029\_Q14##)'

30. A non-conducting disc of mass = 2kg , total charge = +1 C

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'(##CEN\_KSR\_PHY\_JEE\_C18\_E01\_030\_Q15##)'

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**31.** In the figure shown, S is a large non-conducting sheet of uniform charge density  $\sigma$ . A rod R of length I and mass m is parallel to the sheet and hinged at its midpoint. The linear charge densities on the upper and lower half of the rod are shown in the figure. The angular acceleration of the rod just after it is released is  $\frac{p\sigma\lambda}{qm\epsilon_o}$ . Find pq. '(##CEN KSR PHY JEE C18 E01 031 Q16##)'

**32.** A square loop of side l having uniform linear charge density  $\lambda$  is placed in an x - y plane as shown in the figure. There is a non-uniform electric field  $E = \frac{a}{l}(x + l) \overrightarrow{i}$ , where a and l are constants. The resultant electric force on the loop is having the value  $2na\lambda$ . Find the value of n. '(##CEN\_KSR\_PHY\_JEE\_C18\_E01\_032\_Q17##)'

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**33.** A semi-circular wire is charged with linear charge density dependent on the angle  $\theta$  from +y-axis as  $\lambda = \lambda_0 |\sin \theta|$ , where  $\lambda_0$  is a constant. The electric field intensity at the center of the arc is  $\overline{E} = \frac{mK\lambda_0}{4R} \left(-\hat{j}\right)$ . Find m. (R is the radius of semi-circle and  $K = \frac{1}{4\pi\varepsilon_0}$ )

'(##CEN\_KSR\_PHY\_JEE\_C18\_E01\_033\_Q18##)'

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34. A problem of practical interest is to make a beam of electrons turn through  $90^{\circ}$ . This can be done with the parallel plates shown in the

figure. An electron with kinetic energy  $8.0 \times 10^{-17} J$  center through a small hole in the bottom plate. The strength of electric field that is needed if the electron is to emerge from an exit hole 1.0cm away from the entrance hole, traveling at right angle to its original direction is  $\times 10^5$  N/C.

'(##CEN\_KSR\_PHY\_JEE\_C18\_E01\_034\_Q19##)'

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**35.** An infinitely long string uniformly charged with a linear charge density  $\lambda_1 = 1\mu$ C/m and a segment of length I uniformly charged with linear charge density  $\lambda_2 = \frac{1}{\ln 4}\mu$  C/M lie in a plane at right angle to each other and separated by a distance  $l_{assbown \in the figure.Determinethef}$  or ce (in mN) with which these two intertct.

'(##CEN\_KSR\_PHY\_JEE\_C18\_E01\_035\_Q20##)'

**36.** A long uniformly charged wire with lineär charge density  $\lambda = \varepsilon_0 \frac{C}{m}$  is placed in the form of a spiral of outer radius R = 1m and having a total N = 160 turns as shown in the figure. A dipole of dipole moment  $\left| \overrightarrow{p} \right| = 0.1 Cmisplacedalongthex - a\xi sata. p \oint (a, 0,0), wherea=sqrt(3)m'$ . Find the magnitude of force (in N) experienced by the dipole. '(##CEN KSR PHY JEE C18 E01 036 Q21##)'

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**37.** A non-conducting infinite rod is placed along the 2 -axis, the upper half of the rod (lying along  $z \ge 0$ ) is charged positively with a uniform linear charge density  $+\lambda$  while the lower half ( $z \le 0$ ) is charged negatively with a uniform linear charge density  $-\lambda$ . The origin is located at the junction of the positive and negative halves of the rod. A uniformly charged annular disc (surface charge density:  $\sigma_0$ ) of inner radius R and outer radius 2R is placed in the x - y plane with its center at the origin. The force on the rod due to the disc is  $\frac{y\sigma_0\lambda R}{8\varepsilon_0}$ , Find the value of y. '(##CEN\_KSR\_PHY\_JEE\_C18\_E01\_037\_Q22##)'

**38.** An electric field  $\overrightarrow{E} = E_0 \hat{i} + E_0 \hat{j}$  exists in space. The flux through triangular loop with vertices at  $\left(\frac{a}{2}, 0, 0\right)$ ,  $\left(\frac{a}{2}, 0, a\right)$  and  $\left(\frac{a}{2}, a, \frac{a}{2}\right)$  is  $\frac{E_0 a^2}{b}$ . Find b.

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**39.** A uniformly charged sphere is placed inside a charged hollow sphere as shown in the figure, O is the center of hollow sphere and C is the center of solid sphere. The magnitude of charge on both the spheres is  $4\left(\sqrt{\frac{3}{7}}\right)\mu(C)$ . The electric field at point P which lies just outside the hollow sphere is given by  $3\alpha K$ N/C. Find the value of  $\alpha$ . (Here,  $K = \frac{1}{4\pi\epsilon_0}$ ).

'(##CEN\_KSR\_PHY\_JEE\_C18\_E01\_039\_Q23##)'

**40.** An infinitely long solid cylinder of radius R has a uniform volume charge density  $\rho$ . It has a spherical cavity of radius  $\frac{R}{2}$  with its center on the axis of the cylinder, as shown in the figure. The magnitude of the electric field at the point P, which at a distance 2 R (from the axis of the cylinder, is given by the expression  $\frac{23\rho R}{16n\varepsilon_0}$ , The value of n is '(##CEN\_KSR\_PHY\_JEE\_C18\_E01\_040\_Q24##)'