Zero Doubts

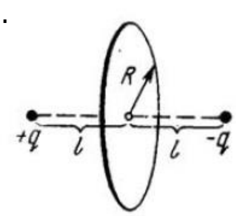
Practice Questions

1. A thin wire ring of radius r carries a charge q. Find the magnitude of the electric field strength on the axis of the ring as a function of distance l from its centre. Investigate the obtained function at $l >> r$. Find the maximum strength magnitude and the corresponding distance l. Draw the approximate plot of the function $E(l)$.
2. A point charge q is located at the centre of a thin ring of radius R with uniformly distributed charge $-q$. Find the magnitude of the electric field strength vector at the point lying on the axis of the ring at a distance x from its centre, if $x >> R$.
3. A system consists of a thin charged wire ring of radius R and a very long uniformly charged thread oriented along the axis of the ring, with one of its ends coinciding with the centre of the ring. The total charge of the ring is equal to q. The charge of the thread (per unit length) is equal to λ. Find the interaction force between the ring and the thread.
4. A thin non-conducting ring of radius R has a linear charge density $\lambda = \lambda_0 \cos \phi$, where λ_0 is a constant, ϕ is the azimuthal angle. Find the magnitude of the electric field strength

   (a) at the centre of the ring;

   (b) on the axis of the ring as a function of the distance x from its centre. Investigate the obtained function at $x >> R$.
5. A very long straight uniformly charged thread carries a charge λ per unit length. Find the magnitude and direction of the electric field strength at a point which is at a distance y from the thread and lies on the perpendicular passing through one of the thread's ends.
6. A thread carrying a uniform charge λ per unit length has the configuration shown in fig. Assuming a curvature radius R to be considerably less that the length of the thread, find the magnitude of the electric field strength at the point O.

(a) (b)



7. A sphere of radius r carries a surface charge of density $\sigma = \boldsymbol{ar}$, where a is a constant vector, and r is the radius vector of a point of the sphere relative to its centre. Find the electric field strength vector at the centre of the sphere.
8. Suppose the surface charge density over a sphere of radius R depend on a polar angle θ as $\sigma = \sigma_0 \cos \theta$, where σ_0 is a positive constant. Show that such a charge distribution can be represented as a result of a small relative shift of two uniformly charged balls of radius R whose charge are equal in magnitude and opposite in sign. Resorting to the representation, find the electric field strength vector inside the given sphere.
9. Find the electric field strength vector at the centre of a ball of radius with volume charge density $\rho = \boldsymbol{ar}$, where $\boldsymbol{a}$ is a constant vector, and is a radius vector drawn from the ball's centre.
10. A very long uniformly charged thread oriented along the axis circle of radius R rests on its centre with one of the ends. The charge of the thread per unit length is equal to λ. Find the flux of the vector across the circle area.
11. Two point charges q and $-q$ are separated by the distance $2l$. Find the flux of the electric field strength vector across a circle of radius R.
12. A ball of radius R is uniformly charged with the volume density ρ. Find the flux of the electric field strength vector across the ball's section formed by the plane located at a distance $r_0 < R$ from the centre of the ball.
13. Each of the two long parallel threads, carries a uniform charge λ per unit length. The threads are separated by a distance l. Find the maximum magnitude of the electric field strength in the symmetry plane of this system located between the threads.
14. An infinitely long cylindrical surface of circular cross-section is uniformly charged lengthwise with the surface density $\sigma = \sigma_0 \cos \phi$, where ϕ is the polar angle of the cylindrical coordinate system whose z axis coincides with the axis of the given surface. Find the magnitude and direction of the electric field strength vector on the z axis.

15. The electric field strength depends only on the x and y coordinates according to the law $\mathbf{E} = a(x\boldsymbol{i} + y\boldsymbol{j})/(x^2 + y^2)$, where a is a constant. $\boldsymbol{i}$ and $\boldsymbol{j}$ are the unit vectors of x and y axis. Find the flux of the vector $\mathbf{E}$ through a sphere of radius R with its centre at the origin of coordinates.
16. A ball of radius R carries a positive charge whose volume density depends only on a separation r from the ball's centre as $\rho = \rho_0(1 - r/R)$. where ρ_0 is a constant. Assuming the permittivities of the ball and the environment to be equal to unity, find:

    (a) the magnitude of the electric field strength as a function of the distance r both inside the outside the ball;

    (b) the maximum intensity E_{max} and the corresponding distance r
17. A system consists of a ball of radius R carrying a spherically symmetric charge and the surrounding space filled with a charge of volume density $\rho = \alpha/r$, where α is a constant, r is the distance from the centre of the ball. Find the ball's charge at which the magnitude of the electric field strength vector is independent of r outside the ball. How high is this strength? The permittivities of the ball and the surrounding space are assumed to be equal to unity.
18. A space is filled up with a charge with volume density $\rho = \rho_0 e^{-\alpha r^3}$ where ρ_0 and α are positive constants, r is the distance from the centre of this system. Find the magnitude of the electric field strength vector as a function of r. Investigate the obtained expression for the small and large values of r, i.e, at $\alpha r^3 << 1$ and $\alpha r^3 >> 1$.
19. Inside a ball charged uniformly with volume density ρ there is a spherical cavity. The centre of the cavity is displaced with respect to the centre of the ball by a distance $\boldsymbol{a}$. Find the field strength $\mathbf{E}$ inside the cavity, assuming the permittivity equal to unity.
20. Inside an infinitely long circular cylinder charged uniformly with volume density ρ there is a circular cylindrical cavity. The distance between the axes of the cylinder and the cavity is equal to a. Find the electric field strength $\mathbf{E}$ inside the cavity. The permittivity is assumed to be equal to unity.