# ADVANCED PHYSICS CLUB

MARCH 24, 2024

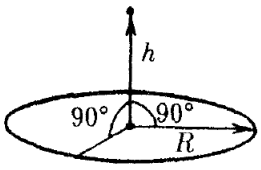
The updates, homework assignments, and useful links for APC can be found on SchoolNova's web page:
`http://schoolnova.org/nova/classinfo?class_id=adv_phy_club&sem_id=ay2023`
The practical information about the club and contacts can be found on the same web page.

## Today's meeting

Today we started solving the problems on Coulomb law. The remaining problems are reassigned, there are also new problems on our next topic - Gauss's law.

## Reassigned Homework

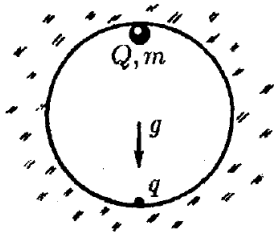
**1.** What is the electric field at the center of a uniformly charged thin ring of radius $R$? What is the electric field on the axis of the ring at distance $h$ from its center? The charge of the ring is $Q$.




**2.** a) A metal ring with more and more electric charge steadily put onto it was torn by the Coulomb force when its charge reached $Q$. Another ring with exactly the same dimensions was made out of a material 10 times more durable than the first one. What charge would tear the new ring?

b) If the first material is used to make a ring with all dimensions three times larger than the first one, what charge would tear such a ring?

***3.** A charge $q$ is attached to the bottom point of a spherical cavity of radius $R$. A small bead of mass $M$ is placed at the top point of the cavity. What charge should the bead have in order to be in stable equilibrium at the top of the cavity? Free fall acceleration is $g$.




## New Homework

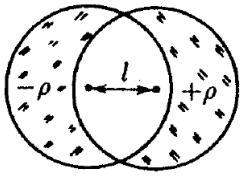
**1.** Prove that in a conducting material the electric charge is concentrated on the surface in a static situation (without electric current).

**2.** Using Gauss's law find the electric field
(a) of a uniformly charged sphere of radius $R$ with charge $Q$ both inside and outside of the sphere;
(b) of a uniformly charged straight infinite thread with linear charge density $\lambda$;
(c) of a uniformly charged infinite plane with surface charge density $\sigma$;
(d) of a uniformly charged ball of radius $R$ with volume charge density $\rho$ both inside and outside of the ball.

**3.** There is a point charge $Q$ and a surface (of any shape) which subtends a solid angle $\Omega$ from the location of the charge. Prove that the electric flux created by this charge through this surface is $kQ\Omega$ ($k$ is the Coulomb constant).

**4.** A point charge $q$ is placed at the center of a uniformly charged tetrahedron with surface charge density $\sigma$. With what force does the charge act on each face of the tetrahedron?

***5.** a) When two balls of radius $R$ are located at the distance between the centers $l < 2R$ they form two "crescents" (see figure). The "crescents" have uniform volume charge densities $-\rho$ on the left and $\rho$ on the right. Prove that electric field in the intersection region (which is empty) is uniform and find this electric field.
b) By considering a limit such that $l \to 0$, $\rho \to \infty$, $l\rho = const$ find a distribution of charge on the surface of a sphere that produces a uniform electric field inside the sphere.




***6.** What force is pushing apart the faces of a uniformly charged hollow cube? How about a tetrahedron? Surface charge density is $\sigma$, the edge length is $l$.

## For the next meeting

**IMPORTANT:** The next club's meeting is at 3:30pm, via Zoom, on Sunday, **April 7**.