ADVANCED PHYSICS CLUB

MARCH 20, 2022

USEFUL RESOURCES

The updates, homework assignments, and useful links for APC can be found on SchoolNova's web page:
`https://schoolnova.org/nova/classinfo?class_id=adv_phy_club&sem_id=ay2021`
The practical information about the club and contacts can be found on the same web page.

TODAY'S MEETING

We continue with electricity and magnetism. This assignment is about Gauss's law.

HOMEWORK

1. Prove that in the metal the charge is concentrated on the surface.

2. Prove that a system of electric charges cannot be in stable static equilibrium if the only acting forces are Coulomb ones (this statement is known as Earnshaw theorem).

3. 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 λ;
   (c) of a uniformly charged infinite plane with surface charge density σ;
   (d) of a uniformly charged ball of radius R with volume charge density ρ both inside and outside of the ball.

4. Two infinite planes intersect at an angle α and divide the space into four parts. The planes are oppositely charged with uniform surface charge densities $\pm\sigma$. What is the electric field in regions 1 and 2 (see figure)?
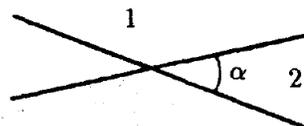
5. There is a point charge Q and a surface (of any shape) which subtends a solid angle Ω from the location of the charge. Prove that the electric flux created by this charge through this surface is $kQ\Omega$ (k is the Coulomb constant).

6. A point charge q is placed at the center of a uniformly charged tetrahedron with surface charge density σ. With what force does the charge act on each face of the tetrahedron?

*7. 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 ρ 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.
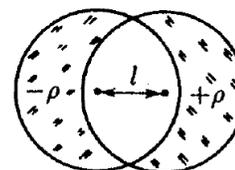
*8. What force is pushing apart the faces of a uniformly charged hollow cube? How about a tetrahedron? Surface charge density is σ, the edge length is l.

FOR THE NEXT MEETING

IMPORTANT: The next club's meeting is at 3:00pm, via Zoom, on Sunday, **March 27**.