ADVANCED PHYSICS CLUB

APRIL 21, 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 almost finished solving the problems on electrostatic potential. The remaining problem is reassigned. There are few new problems about capacitors and energy density of electric field.

REASSIGNED HOMEWORK

*1. A point charge Q is located at distance h from an infinite metal plane. With what force does the plane act on the charge? What is the density of the surface charge induced on the plane?

NEW HOMEWORK

1. a) Find the capacity of a parallel plate capacitor consisting of two plates of area A at a distance d from each other.
b) How will this capacity change if a metal slab of thickness $\frac{d}{3}$ and the same area A is inserted in between the plates? Does the answer change if this slab is in contact with one of the plates?

2. Find the capacity of a capacitor made out of two concentric spheres of radii R_1 and R_2 (spherical capacitor).

3. a) A parallel plate capacitor has charge Q. Area of the plates is A, the distance between them is d. What work has to be performed in order to increase the distance between the plates by Δ?
b) What work has to be performed to change the distance in the same way if the voltage between the plates of the capacitor is kept constant by a battery? Why is work different in this case?

4. a) Find the surface charge density on a plane separating two regions if these regions have different electric field E_1 and E_2 perpendicular to this separating plate. Find the force acting on unit area of the plate (this is also known as electric pressure). Consider the cases $E_1 = E, E_2 = 2E$ and $E_1 = E, E_2 = -2E$. Is the electric pressure different in these two cases? Why?
*b) Will the answer change if E_1 and E_2 can point in any direction, not necessarily perpendicular to the plate?

5. What is the energy stored in a parallel plate capacitor charged to a certain charge Q? Express it in terms of the electric field inside and the volume of the capacitor. What quantity would you call energy density of the electric field? Compare to the results of the previous problem.

6. a) Geometric size of a capacitor is increased n times in all directions while keeping the voltage between the plates the same. How will the energy stored in the capacitor change? If the size is kept the same but the charge of plates is increased k times how many times will the energy change?
*b) Understand the above result using the notion of energy density of electric field (the expression you derived in the previous problem holds in general).

FOR THE NEXT MEETING

IMPORTANT: The next club's meeting is at 3:30pm, via Zoom, on Sunday, **May 5**.