ADVANCED PHYSICS CLUB

MARCH 29, 2026

Useful resources

The updates, homework assignments, and useful links for APC can be found on SchoolNova's web page:
`https://schoolnova.org/classinfo?class_id=2252&sem_id=74`
The practical information about the club and contacts can be found on the same web page.

Today's meeting

Today we solved some problems about capacitors and energy density of electric field, the remaining problems are reassigned, along with new problems on electric circuits.

Reassigned Homework

1. A parallel plate capacitor is connected to a battery of voltage V. 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? Why is this work different compared to the case when the charge of the capacitor is constant, not the voltage?

2. 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?

3. 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.

4. 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).

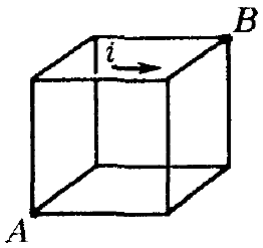
New Homework

1. (a) N identical resistors, each of resistance R, are connected *in series*. An electric current I enters the first resistor. What is the current through each resistor? What is the voltage across each resistor? What is the equivalent resistance of the entire series?
(b) N identical resistors, each of resistance R, are connected *in parallel*. Voltage across the first resistor is V. What is the voltage across each resistor? What is the current through each resistor? What is the equivalent resistance of the entire parallel network?

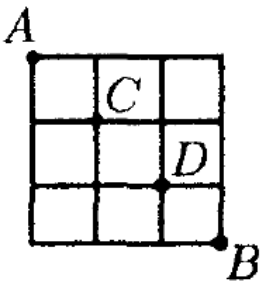
2. A wire is bent into a perfect circle and has a total resistance of 10 ohms. At which two points on the circle should an ohmmeter be connected so that it measures a resistance of exactly 1 ohm between those points?

3. A cube is constructed from wire, with each of its 12 edges having the same resistance r. A battery is connected across two vertices A and B, as shown on the figure. It is known that the current through one specific edge (marked in the figure) is i. Determine the following:

(a) The potential difference between points A and B
(b) The equivalent resistance between points A and B
(c) The total current flowing from A to B.



4. In the circuit shown in the figure, each side has the same resistance r. Determine the equivalent resistance a) between points A and B; b) between points C and D.



FOR THE NEXT MEETING

IMPORTANT: The next club's meeting is at 3:00pm, online via Zoom, on Sunday, **April 12**.