HW8 Concepts

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1 24.38 Dielectric

This problem leads through an example of Capacitance in the form of a parallel plate. In particular you are told to calculate the *capacity* the plates have for charge at a particular potential. Then a dielectric is inserted and you are told to calculate the capacity again. It changes. Try to think about why. In particular use the model we discussed for dielectrics to try and reason why the capacity for charge goes up.

2 24.49 Gauss' Law and Dielectrics

Here again we calculate the capacity for charge (i.e. capacitance) of a parallel plate at a fixed potential with a dielectric inside. Then you are told to use Gauss' Law to calculate the Electric field between the plates. Does this calculated value agree with what you expect? Then if you disconnect the capacitor from the potential source and remove the teflon, what is the electric field between the plates now? Does it go up or down? Can you explain how and why it changed?

3 24.59 Capacitor Network

You are told to solve a circuit consisting of a number of capacitors. This will serve as a change to practice the method of equivalent capacitance. In part (b) you are told to calculate the charge on each of the capacitors and the potential difference across the plates. How do these charges compare? Can you reason out the values they have independent of the circuit equations? Do the potential differences across the capacitors agree with your intuition? Why or why not?

4 24.60 Throw the Switch

Here again you are told to solve a circuit involving capacitors. After computing part (a), see if you can reason out why it has the value it does given the circuit. Would the answer be substantially different if we replaced the North east capacitor with one with a capacitance of 8.00 μF? After the switch is thrown, what is the potential difference, and can you reason this result out? Finally you are told to compute the charge that flows through the switch when it is thrown. Where does this charge come from/ go to?

5 26.39 Discharging Capacitor

You are given some data from a circuit involving a discharging capacitor. You are told to compute the capacitance and the time constant of the circuit. Try to think about how your data would change if the time constant was increased/decreased? How would the data change if the capacitance was increased/decreased?

6 26.79 Wheatstone Bridge

You are given the Wheatstone bridge to solve. This is the circuit we saw in section earlier this week, except our ideal voltmeter has been replaced by a more realistic Galvinometer. Make sure you understand how the circuit actually allows you to determine the unknown resistance. What do they mean that the bridge is *balanced*? Why does this circuit provide particularly high precision results? Finally they give you data from a sample data run and you are told to compute the unknown resistance. Compare the order of magnitudes of the four resistances (N, P, M, and X). Can you think of a general rule for how the orders of magnitude of these resistors should compare? Can you think of any exceptions?

7 26.87 Energy and Capacitors

You are told to look to the equation for current in a charging capacitor

$$i = I_0 e^{-t/RC}$$

Do you understand where this equation comes from? Think about the shape of the curve. Can you picture how the circuit evolves in time?

You are then told to integrate the power supplied by the battery to find the total energy supplied by the battery. Where does this energy come from? Then the energy dissipated in the resistor. Where does this energy go? Then you are told to calculate the energy stored in the capacitor. Is energy conserved? How does a capacitor store energy? Then you are told to calculate the fraction of energy stored in the capacitor. Think about how this depends on R. If we aim at maximizing how much energy we store, how should we go about it?

8 Energy in the Electric Field

Having worked the previous problem, you may have some questions about how energy relates to electric fields. You are told to imagine a parallel plate capacitor, but now we will tie in some mechanics. You are told the mass densities of the plates and told to compute the force between them. What will happen as a result of this force? Then you are told to calculate the kinetic energy right before they collide. Try to think about where this energy could have come from. Is Energy conserved? So, does this change the way you think of the electric field? Does it seem more or less real now?

9 Charging a capacitor

In this problem you are led through the solution to the charging capacitor circuit we saw in problem 26.87. You are told to plot the voltage as a function of time. What happens at $t = 0$? Can you explain this? What is the current as a function of time? What happens at $t = 0$? Can you explain this? What is the *final charge* of the capacitor? How long does it take for this charge to be realized? Now how long it would take for the charge to be within a single electron charge of this value? At what t is the voltage across the battery equal to that across the capacitor? Does this quantity make sense? Check the units. Could we have expected this?