Name: _____ Period: ____Date: _____

AP Physics 2

Lab #3-4: Capacitor Simulation

In this activity, we'll use the PhET Capacitor Lab simulation at ***phet.colorado.edu/sims/cheerpj/capacitor-lab/latest/capacitor-lab.html*** *to examine the properties of capacitors. Follow the directions for each situation below and answer the questions as completely as possible.* ***IMPORTANT:*** *This simulation uses browser-based Java, so it will take a little while to load on Chromebooks and will not work on iPads/iPhones/etc.*

I. *To complete the first part of this activity, click on the blue "Introduction" tab at the top of the window. On the right, make sure the boxes for "Plate Charges", "Electric Field Lines", "Capacitance", "Plate Charge" and "Stored Energy" are all checked.*

1. Before making any adjustments, describe the setup for the simulation. What is the capacitance on the plates? How is this possible if the battery is at 0 V?

2. On the left, slide the battery's potential up to 1.5 V.
   a. What change(s) happened to the plates? Why do you think this happened?

   b. What value(s) changed at the top of the simulation? Why do you think this happened?

   c. What value(s) did NOT change at the top of the simulation? Why do you think so?

   d. Use calculations to confirm the changed values – show your work!

3. Use the green double arrow above the plates to change the plate separation, first to 10.0 mm and then to 5.0 mm.
   a. What change(s) happened to the plates? Why do you think this happened?

   b. What value(s) changed at the top of the simulation? Why do you think this happened?

   c. What value(s) did NOT change at the top of the simulation? Why do you think so?

d. Use calculations to confirm the changed values – show your work!

4. Reset the simulation. Use the green double arrow to the left of the plates to change the plate area from 100.0 mm^2 to 400.0 mm^2.
   a. What change(s) happened to the charges on the plates and the electric field between them? Why do you think these changes happened?

   b. What value(s) changed at the top of the simulation? Why do you think this happened?

   c. What value(s) did NOT change at the top of the simulation? Why do you think so?

   d. Use calculations to confirm the changed values – show your work!

5. Click the "Disconnect Battery" button below the plates.
   a. What change(s) happened to the plates? Why do you think this happened?

   b. Change the separation between the plates. What value(s) changed at the top of the simulation? How could this happen while the plates are disconnected from the battery?

   c. What would happen to the values (C, Q and U_C) if you changed the plate area? Confirm your prediction.

   d. Check the "Voltmeter" box to the right and drag the red probe so that it's touching the top plate and then drag the black probe so that it's touching the bottom plate. What is the reading on the voltmeter? Change the plate separation but make sure the probe ends are still touching the plates. What is the reading now? Explain how this change matches the relationship between potential, charge and capacitance.

II. *To complete the second part of this activity, click on the blue "Dielectric" tab at the top of the window. On the right, make sure the boxes for "Plate Charges", "Electric Field Lines", "Capacitance", "Plate Charge" and "Stored Energy" are all checked.*

6. On the right under "Dielectric", use the dropdown menu to change the dielectric material to "teflon (2.1)". Use the green double arrow to the right of the material to slide the dielectric all the way to the left in between the plates.

    a. What change(s) happened in the simulation as you slid the dielectric between the plates? Why do you think this happened?

    b. What value(s) changed at the top of the simulation? Why do you think this happened?

    c. What value(s) did NOT change at the top of the simulation? Why do you think so?

    d. Use calculations to confirm the changed values – show your work!

7. On the left, slide the battery's potential up to 1.5 V.

    a. What value(s) changed at the top of the simulation? How do these compare to the values from before, when there wasn't a dielectric medium in between the plates? (You can slide the material back out for comparison.) In terms of the charges, explain why you think this happened.

    b. What value(s) did NOT change at the top of the simulation? Why do you think so?

    c. Use calculations to confirm the changed values – show your work!

8. On the right under "Dielectric", use the dropdown menu to change the dielectric material to "paper (3.5)". Use the green double arrow to the right of the material to slide the dielectric all the way to the left in between the plates.

    a. How much larger is the dielectric constant (κ) for paper than it was for teflon? How does it compare to the changes in capacitance, plate charge and stored energy?

b. Use calculations to confirm the changed values – show your work!

III. *To complete the last part of this activity, click on the blue "Multiple Capacitors" tab at the top of the window. On the right, make sure the boxes for "Plate Charges", "Electric Field Lines", "Total Capacitance", "Stored Charge" and "Stored Energy" are all checked.*

9. On the left, slide the battery's potential up to 1.5 V. Make note of the values in the bar graphs at the top of the window. On the right under "Circuits", click on the radio button next to "2 in Parallel".

   a. What change(s) happened to the plates? What value(s) changed at the top of the simulation? Why do you think this happened?

   b. What do you think would happen to the values (C, Q and U_C) if you added a third plate? Why do you think so?

10. On the right under "Circuits", click on the radio button next to "3 in Parallel".

    a. Did your prediction in #9b match the changes to the values in the simulation? Why do you think this happened?

    b. Use calculations to predict what would happen if you added a fourth plate in parallel.