PreAP Electrostatics 14

$$C = \varepsilon_0 \frac{A}{d}$$

$$\varepsilon_0 = 8.85 \times 10^{-12}$$

$$C = \frac{|Q|}{\Delta V}$$

1. Units: Electric field is in ____; Electric force is in ____; Voltage is in ____; Charge is in ____; Capacitance is in ____ or ____.

2. You find a parallel plate capacitor. Its capacitance is not written on it. So you decide to find out what it can do. You pull out your handy volt/charge meter and a variable voltage supply.

    A. You discharge the capacitor. How?

    B. What is the voltage of the discharged capacitor?

    C. What is the charge on one of the plates when discharged?

    D. You then hook up the voltage supply, set to 6 volts. You connect it to the capacitor for only 2 seconds. What is the voltage of the capacitor, approximately?

    E. You reattach the 6V supply. When will the capacitor stop charging?

    F. When it is fully charged to 6V you read that −3C of charge has been pushed to the negative plate. What is the charge on the positive plate?

    G. What is the capacitance of the capacitor?

    H. You then up the power supply to 10 volts. What is the final voltage across the plates of the capacitor?

    I. When fully charged the negative plate then read −5C. What is the capacitance of the capacitor?

    J. How did the increase of voltage change the capacitance of the capacitor?

    K. What does an increase of voltage change for a capacitor?

    L. You up the power supply to its maximum voltage. You read −7.5C. What is the capacitance of the capacitor?

    M. What is the maximum voltage of your power supply?

    > A. Connect with a wire (a conductor)
    >
    > B: 0V
    > C: 0C
    >
    > 2D: less than 6V
    >
    > 2E: when $V_{cap} = 6V$
    >
    > 2F: |Q+| = |Q−| (always)
    >
    > G: 3C/6V = 0.5 F
    >
    > H: 10 volts
    >
    > I: 5C/10V = 0.5 F
    >
    > J. Didn't change it. (Like a bigger battery doesn't change a resistor)
    >
    > K. Amount of Q
    >
    > L. You already have C (capacitance) from part I

3. On another day you find a different parallel plate capacitor, but you don't have your voltage/charge meter. Instead you have a micrometer (reads very small distances) and a ruler.

    A. You measure one side of one of the square plates at 25 cm. What is the area of the plate?

    B. The micrometer reads 12 μm between the plates. What will you use for d?

    C. Now that you have measured the physical dimensions of the capacitor, what is its capacitance?

    D. If the distance between the plates of the capacitor was half as much, what is its new capacitance?

    E. By halving the plate distance you _____ the capacitance.

    OK—now you should see the difference between the two equations.

    > A. $A = \ell \times w = (.25)^2$
    > $= .0625 m^2$
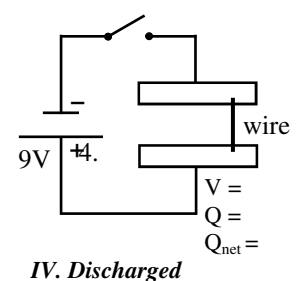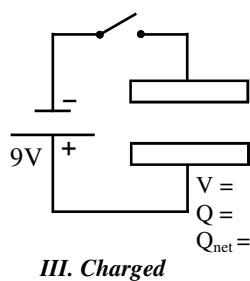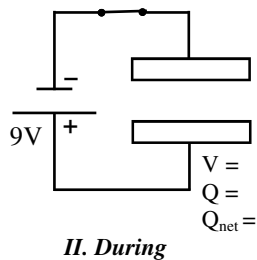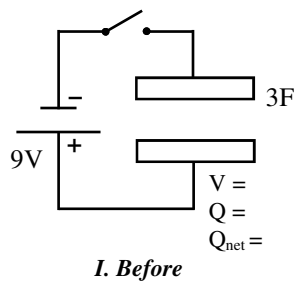   >
    > B. 12×10^{-6} m
    >
    > C. $C = \varepsilon_0 \frac{A}{d} = \varepsilon_0 \frac{.0625}{12 \times 10^{-6}}$
    > $C = 4.61 \times 10^{-8} F$
    >
    > D. 2 times

4. A 9 V battery is hooked up to a 1 F capacitor.
    A. How much charge can it hold?

    B. How much charge can a 2 F capacitor hold for the same potential (voltage)?

    C. So, a bigger capacitor can hold _____ charge for the same voltage.

    > 4A: 1F = 1C per volt OR
    > 1F = 1C/V mult by volts

5. A. On the diagrams below draw what occurs on the capacitor plates. Be correct as for which plate is positive.
    B. For each of the stages, give V, Q, and Qnet. If you can't completely calculate, give < or >.

I. Before	II. During	III. Charged	IV. Discharged
9V 3F V = Q = Qnet =	9V V = Q = Qnet =	9V V = Q = Qnet =	9V wire +4. V = Q = Qnet =

6. A neutral 3 pF (pico farad) capacitor (pico = $\times 10^{-12}$) is placed in a circuit, but the switch is not closed.

    A. What is the charge on one of the plates beforehand (*before being charged*)?

    A 12 V battery is then connected and charges the capacitor.
    B. What is the total charge on the capacitor when it is fully charged?

    C. What is the final voltage across the capacitor?

    D. What charge will be gained by the positive plate?

    E. What charge will be gained by the negative plate?

    F. How much potential energy is stored?

    G. If the voltage were doubled, how much charge could it hold?

    H. How would the capacitance change if the voltage were doubled?

    I. When the capacitor is discharged, what happens (talk + and − charges and voltage).

    B. 36pC

    D. 3.6E−11C
    E. Same, just neg.

7. Solve the capacitance equation for Q.
8. Write the PE for a capacitor without Q in it.
9. Solve the capacitance equation for V.
10. Write the PE for a capacitor without V in it.
11. A 3F capacitor is charged to 2 V. Calculate the potential energy stored.

7. C = Q/V so Q = CV
8. PE = ½CV(V) = ½CV^2
9. V = Q/C
10. PE = ½Q^2/C
11. Use one of the above equations.

12. A 6F capacitor has 15C of charge on one plate. Calculate its potential energy.