A capacitor is made of two flat parallel plates 1.50 mm apart. The magnitude of charge on each of the plates is 0.0180 μC with the potential difference of 200 V.

a. What is the capacitance?

\[ C = \frac{Q}{\Delta V} \]

\[ C = \frac{(0.0180 \times 10^{-6} \text{ C})}{(200 \text{ V})} = 0.900 \times 10^{-10} \text{ F} \]

b. What is the area of each plate?

\[ C = \frac{\varepsilon_0 A}{d} \]

\[ A = \frac{C d}{\varepsilon_0} \]

\[ A = \frac{(0.900 \times 10^{-10} \text{ F}) (1.50 \times 10^{-3} \text{ m})}{(8.854 \times 10^{-12} \text{ C/N m}^2)} = 0.0152 \text{ m} \]

c. What is the total energy stored?

\[ E_{\text{ST}} = \frac{1}{2} Q \Delta V \]

\[ E_{\text{ST}} = \frac{1}{2} (0.0180 \times 10^{-6} \text{ C}) (200 \text{ V}) = 1.80 \times 10^{-6} \text{ J} \]
\[ C = \left( 8.85 \times 10^{-12} \text{ C}^2/(\text{N-m}^2) \right) \left( \frac{0.100 \text{ m}}{0.001 \text{ m}} \right)^2 = 8.85 \times 10^{-11} \text{ F} = 88.5 \text{ pF} \]

b. If the capacitor is charged by 12.0-V battery, how much charge is transferred from one plate to the other?

\[ C = \frac{Q}{\Delta V} \]

\[ Q = \Delta V \cdot C = (12.0 \text{ V})(88.5 \text{ pF}) = 1062 \text{ pC} = 1.06 \text{ nC} \]

2. A 2.00 \( \mu \text{F} \) and 4.00 \( \mu \text{F} \) capacitors are connected in parallel across an 18.0-V battery. Find

a. The equivalent capacitance.

\[ C_{eq} = C_1 + C_2 = (2.00 \ \mu \text{F}) + (4.00 \ \mu \text{F}) = 6.00 \ \mu \text{F} \]

b. The charge on the capacitors and the potential difference across each.

\[ \Delta V_1 = \Delta V_2 = \Delta V = 18.0 \text{ V} \]

\[ Q_1 = \Delta V_1 \cdot C_1 \]

\[ Q_1 = (18.0 \text{ V})(2.00 \ \mu \text{F}) = 36.0 \ \mu \text{C} \]

\[ Q_2 = \Delta V_2 \cdot C_2 \]

\[ Q_2 = (18.0 \text{ V})(4.00 \ \mu \text{F}) = 72.0 \ \mu \text{C} \]
\[ \Delta V = E d = (8.50 \times 10^5 \text{ V/m})(0.00245 \text{ m}) = 2083 \text{ V} \]

b. What is the capacitance of the capacitor?

\[ C = \varepsilon_0 \frac{A}{d} = (8.85 \times 10^{-12} \text{ C}^2/\text{N-m}^2)(35.0 \times 10^{-4} \text{ m}^2)/(0.00245 \text{ m}) = 12.6 \times 10^{-12} \text{ F} = 12.6 \text{ pF} \]

c. What charge must be on each plate?

\[ C = \frac{Q}{\Delta V} \]

\[ Q = C \Delta V = (12.6 \text{ pF})(2083 \text{ V}) = 26246 \text{ pC} = 26.2 \text{ nC} \]

The plates of a parallel-plate capacitor in vacuum are 5.00 mm apart and 2.00 m² in area. A potential difference of 10,000 V is applied across the capacitor.

a. What is the capacitance of the capacitor?

\[ C = \varepsilon_0 \frac{A}{d} \]

\[ C = (8.85 \times 10^{-12} \text{ C}^2/\text{N-m}^2)(2.00 \text{ m}^2)/(0.00500 \text{ m}) = 3.54 \times 10^{-9} \text{ F} = 3.54 \text{ nF} \]

b. What is the charge on each plate?

\[ C = \frac{Q}{\Delta V} \]

\[ Q = \Delta V C = (10,000 \text{ V})(3.54 \times 10^{-9} \text{ F}) = 3.54 \times 10^{-5} \text{ C} = 35.4 \text{ \mu C} \]
c. What is the magnitude of the electric field between the plates?

\[ \Delta V = E d \]

\[ E = \Delta V/d = (10,000 \text{ V})/(0.00500 \text{ m}) = 2.00 \times 10^6 \text{ V/m} \]

Name ______SOLUTION__________________________

1. The two plates of a capacitor hold \( +2500 \mu \text{C} \) and \( -2500 \mu \text{C} \) of charge, respectively, when the potential difference is 850 V. What is the capacitance?

\[ C = Q/\Delta V \]

\[ C = (2500 \times 10^{-6} \text{ C})/(850 \text{ V}) = 2.94 \times 10^{-6} \text{ F} \]

2. A 9500-pF capacitor holds plus and minus charges of \( 16.5 \times 10^{-8} \text{ C} \). What is the voltage across the capacitor?

\[ \Delta V = Q / C \]

\[ \Delta V = (16.5 \times 10^{-8} \text{ C})/(9500 \times 10^{-12} \text{ C}) = 17.4 \text{ V} \]

3. How much charge flows from each terminal of a 12.0-V battery when it is connected to a \( 7.00-\mu \text{F} \) capacitor?

\[ C = Q/\Delta V \]

\[ Q = C \Delta V \]

\[ Q = (7.00 \times 10^{-6} \text{ F})(12.0 \text{ V}) = 84.0 \times 10^{-6} \text{ C} \]
4. A 0.20-F capacitor is desired. What area must the plates have if they are to be separated by a 2.2-mm air gap?

\[ C = \varepsilon_0 \frac{A}{d} \]

\[ A = d \frac{C}{\varepsilon_0} = (2.20 \times 10^{-3} \text{ m}) (0.200 \text{ F}) / (0.00 \times 10^{-6} \text{ F}) = \]

Clayton State University
Department of Natural Sciences

June 10, 2008

Physics 1112 – Quiz 4

Name ___SOLUTION__________________________________

One of several 100 \( \mu \text{F} \) capacitors in defibrillator has a potential difference of 220 V between its plates.

a. What is the magnitude of charge on each plate of the capacitor?

\[ Q = C \Delta V = (100 \times 10^{-6} \text{ F})(220 \text{ V}) = 2.20 \times 10^{-2} \text{ C} = 0.0220 \text{ C} \]

b. What is the energy stored in the capacitor?

\[ E_{st} = \frac{1}{2} C (\Delta V)^2 = \frac{1}{2} (100 \times 10^{-6} \text{ F})(220 \text{ V})^2 = 2.42 \text{ J} \]

c. If this energy were fully utilized to lift a 100 g doughnut with no change in its kinetic energy, how high could the doughnut be raised?

\[ \Delta y = \frac{E_{st}}{mg} \]

\[ \Delta y = (4.84 \text{ J})/[(0.100 \text{ kg})(9.81 \text{ m/s}^2 \text{ g})] = 2.47 \text{ m} \]

Clayton State University
Department of Natural Sciences

September 15, 2010

Physics 1112 – Quiz 4
1. How much charge is on each plate of a 4.00 – μF capacitor when it is connected to a 12.0 – V battery?

\[ C = \frac{Q}{\Delta V} \]

\[ Q = C\Delta V = (4.00 \ \mu F)(12.0 \ V) = 48.0 \ \mu C \]

2. Two conductors having net charges of +10.0 μC and -10.0 μC have a potential difference of 10.0 V between them.

a. Determine the capacitance of the system.

\[ C = \frac{Q}{\Delta V} = \frac{10.0 \ \mu C}{10.0 \ V} = 1.00 \ \mu F \]

b. What is the potential difference between the two conductors if the charges on each are increased to +100 μC and -100 μC?

\[ \Delta V = \frac{Q}{C} = \frac{100 \ \mu F}{1.00 \ \mu F} = 100 \ V \]