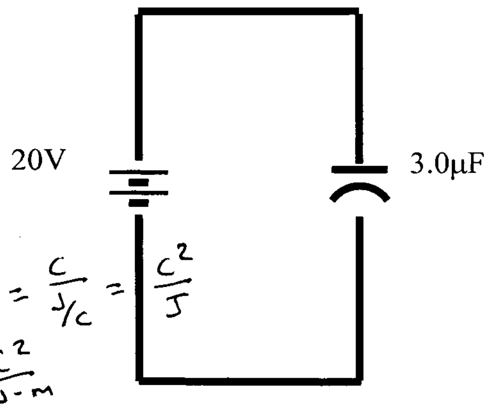
Name____________________ SP222 Quiz

The 3.0μF capacitor in the circuit below is connected to the 20.0 V battery. It is at equilibrium and is fully charged. The capacitor is a parallel plate type, with air separating the plates by 0.10 mm.



$F = \frac{C}{V} = \frac{C}{J/C} = \frac{C^2}{J} = \frac{C^2}{N\text{-}m}$

What is the potential across the capacitor?

$20\,V$

What is the current in the wires connecting the capacitor to the battery when the capacitor is at equilibrium?

$0\,A$

What is the magnitude of the uniform electric field inside the capacitor?

$V = Ed \Rightarrow E = \frac{20\,V}{.1\,mm} = 2\times10^5 \frac{V}{m}$

What is the area of the plates?

$C = \frac{\epsilon_0 A}{d} \Rightarrow A = \frac{Cd}{\epsilon_0} = \frac{3\mu F\,(.1\,mm)}{8.85\times10^{-12}\frac{C^2}{N\text{-}m^2}} = 33.9\,m^2$ $\left[\frac{C^2}{N\text{-}m}\,m \Big/ \frac{C^2}{N\text{-}m^2}\right]$

How much charge is stored on one plate of the capacitor?

$Q = CV = (3\mu F)(20\,V) = 60\,\mu C$

How much energy is stored in the capacitor?

$U = \frac{1}{2}CV^2 = \frac{1}{2}(3\mu F)(20\,V)^2 = 6\times10^{-4}\,J$

What is the energy density in the capacitor?

$u = \frac{U}{Vol} = \frac{6\times10^{-4}\,J}{(33.9\,m^2)(.1\,mm)} = .177\,\frac{J}{m^3}$ OR $u = \frac{1}{2}\epsilon E^2 = \frac{1}{2}\left(8.85\times10^{-12}\frac{C^2}{N\text{-}m^2}\right)\left(2\times10^5\frac{V}{m}\right)^2 = .177\,\frac{J}{m^3}$

$\left[\frac{C^2}{N\text{-}m^2}\,\frac{J^2}{m\,C^2\,m^2}\right] = \left[\frac{J}{m^3}\right]$

The capacitor is disconnected from the battery and discharged. A 0.10 mm dielectric (mica) with a dielectric constant of 7.0 is placed between the parallel plates of the capacitor above. What is the new capacitance of the capacitor?

$C_D = K C_0 = 7(3\mu F) = 21\,\mu F$

The capacitor with the mica is reconnected to the battery. What is the charge stored in the capacitor when the system returns to equilibrium?

$Q = CV = (21\,\mu F)(20\,V) = 420\,\mu C$

How much energy is stored in the new capacitor?

$U = \frac{1}{2}CV^2 = \frac{1}{2}(21\mu F)(20\,V)^2 = 42\times10^{-4}\,J$

$\varepsilon_o = 8.85\text{x}10^{-12}\frac{C^2}{N-m^2}$ $V_{ba} = -\int_a^b \vec{E}\cdot d\vec{\ell}$ $Q = CV$ $C = \frac{\kappa\varepsilon_o A}{d}$ $U = \frac{1}{2}CV^2$ $u = \frac{1}{2}\kappa\varepsilon_o E^2$

Extra Credit: (1 point) Bancroft Hall used to have a bowling alley. Where was it?

MIDSTORE – "NAVY" CLOTHING SECTION