Answer on Question 82846, Physics, Other

Question:

A parallel plate capacitor has plates with dimensions 3 cm by 4 cm separated by 2 mm. The plates are connected across a 60 V battery. Find:

i) The capacitance of the capacitor

ii) The charge stored on each plate

iii) The number of electrons transferred in the process

iv) The stored energy in the capacitor

Solution:

i) We can find the capacitance of the capacitor from the formula:

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

here, ε_0 is the permittivity of free space, A is the area of overlap of the conducting surfaces, d is the plate separation.

Then, we get:

$$C = \varepsilon_0 \frac{A}{d} = 8.854 \cdot 10^{-12} \frac{F}{m} \cdot \frac{3 \cdot 10^{-2}\, m \cdot 4 \cdot 10^{-2}\, m}{2 \cdot 10^{-3}\, m} = 5.31 \cdot 10^{-12}\, F.$$

ii) We can find the charge stored on each plate from the formula:

$$Q = C\Delta V,$$

here, C is the capacitance of the capacitor, ΔV is the voltage across the plates of the capacitor.

Then, we get:

$$Q = C\Delta V = 5.31 \cdot 10^{-12}\, F \cdot 60\, V = 3.2 \cdot 10^{-10}\, C.$$

iii) We can find the number of electrons transferred in the process from the formula:

$$Q = Ne,$$

here, Q is the charge stored on each plate of the capacitor, N is the number of electrons transferred in the process, $e = 1.6 \cdot 10^{-19}\, C$ is the charge of the electron.

Then, we get:

$$N = \frac{Q}{e} = \frac{3.2 \cdot 10^{-10}\ C}{1.6 \cdot 10^{-19}\ C} = 2 \cdot 10^{9}\ electrons.$$

iv) We can find the stored energy in the capacitor from the formula:

$$E = \frac{1}{2} C(\Delta V)^2 = \frac{1}{2} \cdot 5.31 \cdot 10^{-12}\ F \cdot (60\ V)^2 = 9.55 \cdot 10^{-9}\ J.$$

Answer:

i) $C = 5.31 \cdot 10^{-12}\ F.$

ii) $Q = 3.2 \cdot 10^{-10}\ C.$

iii) $N = 2 \cdot 10^{9}\ electrons.$

iv) $E = 9.55 \cdot 10^{-9}\ J.$