Worksheet: Electric Field in a Dielectric

Question Video

Q1: A parallel-plate capacitor has charge of magnitude 9.00 μC on each plate and capacitance 3.00 μF when there is air between the plates. The plates are separated by 2.00 mm. With the charge on the plates kept constant, a dielectric with $\kappa = 5.00$ is inserted between the plates, completely filling the volume between the plates.

What is the potential difference between the plates of the capacitor before the dielectric has been inserted?

A 3.33 V

B 4.21 V

C 3.00 V

D 3.86 V

E 4.00 V

What is the potential difference between the plates of the capacitor after the dielectric has been inserted?

A 0.761 V

B 1.12 V

C 0.600 V

D 0.900 V

E 1.07 V

Before the dielectric is inserted, what is the electric field magnitude at the point midway between the plates?

A 1 000 V/m

B 3 000 V/m

C 1 500 V/m

D 2 250 V/m

E 2 670 V/m

After the dielectric is inserted, what is the electric field magnitude at the point midway between the plates?

A 100 V/m

B 1 000 V/m

C 300 V/m

D 560 V/m

E 634 V/m

Q2: The dielectric to be used in a parallel-plate capacitor has a dielectric constant of 3.60 and a dielectric strength of 1.60×10^7 V/m. The capacitor has to have a capacitance of 1.25 nF and must be able to withstand a maximum potential difference 5.5 kV. What is the minimum area the plates of the capacitor may have?

A $0.014\ m^2$

B $0.022\ m^2$

C $0.020\ m^2$

D $0.016\ m^2$

E $0.011\ m^2$

Q3: A capacitor has parallel plates of area $9.0\ cm^2$ separated by 1.5 mm. The space between the plates is filled with nylon with a dielectric constant of 3.4 and a dielectric strength of 14×10^6 V/m.

- What is the maximum permissible voltage across the capacitor to avoid dielectric breakdown?

A 53 kV

B 80 kV

C 66 kV

D 21 kV

E 74 kV

What is the surface charge density on the surface of the dielectric when the capacitor is at the maximum voltage at which it avoids dielectric breakdown?

A $0.18\ \text{mC/m}^2$

B $0.17\ \text{mC/m}^2$

C $0.80\ \text{mC/m}^2$

D $0.12\ \text{mC/m}^2$

E $0.11\ \text{mC/m}^2$

Q4: Some cell walls in the human body have a layer of negative charge on the inside surface. The wall's surface charge densities are $\pm 0.30 \times 10^{-3}\ \text{C/m}^2$, the cell wall is 2.6×10^{-9} m thick, and the cell wall material has a dielectric constant $\kappa = 7.1$.

What is the magnitude of the electric field in the wall between two charge layers?

A 4.8 MV/m

B 7.2 MV/m

C 10 MV/m

D 2.1 MV/m

E 1.7 MV/m

What is the potential difference between the inside and the outside of the cell?

A 13 mV

B 12 mV

C 16 mV

D 63 mV

E 40 mV

Q5: When a 140 nF vacuum capacitor is connected to a power supply, the energy stored in the capacitor is 6.7 μJ. While the capacitor is connected to the power supply, a slab of dielectric that completely fills the space between the plates is inserted. This decreases the stored energy by 3.2 μJ.

What is the potential difference between the capacitor plates with the dielectric?

A 96 V

B 8.9 V

C 2.6 V

D 9.8 V

E 50 V

What is the dielectric constant of the slab?

A 2.1

B 0.45

C 1.3

D 0.52

E 1.5