

ELECTROSTATICS

EXAMPLE 1.1

Calculate the number of electrons in one coulomb of negative charge.

EXAMPLE 1.11

A sample of HCl gas is placed in a uniform electric field of magnitude $3 \times 10^4 \text{ N C}^{-1}$. The dipole moment of each HCl molecule is $3.4 \times 10^{-30} \text{ Cm}$. Calculate the maximum torque experienced by each HCl molecule.

EXAMPLE 1.16

A water molecule has an electric dipole moment of $6.3 \times 10^{-30} \text{ Cm}$. A sample contains 10^{22} water molecules, with all the dipole moments aligned parallel to the external electric field of magnitude $3 \times 10^5 \text{ N C}^{-1}$. How much work is required to rotate all the water molecules from $\theta = 0^\circ$ to 90° ?

EXAMPLE 1.17

Calculate the electric flux through the rectangle of sides 5 cm and 10 cm kept in the region of a uniform electric field 100 NC^{-1} . The angle θ is 60° . If θ becomes zero, what is the electric flux?

EXAMPLE 1.20

A parallel plate capacitor has square plates of side 5 cm and separated by a distance of 1 mm. (a) Calculate the capacitance of this capacitor. (b) If a 10 V battery is connected to the capacitor, what is the charge stored in any one of the plates? (The value of $\epsilon_0 = 8.85 \times 10^{-12} \text{ N}^{-1}\text{m}^{-2} \text{ C}^2$)

EXAMPLE 1.21

A parallel plate capacitor filled with mica having $\epsilon_r = 5$ is connected to a 10 V battery. The area of each parallel plate is 6 cm^2 and separation distance is 6 mm. (a) Find the capacitance and stored charge.

(b) After the capacitor is fully charged, the battery is disconnected and the dielectric is removed carefully.

Calculate the new values of capacitance, stored energy and charge.

EXAMPLE 1.24

Dielectric strength of air is $3 \times 10^6 \text{ V m}^{-1}$. Suppose the radius of a hollow sphere in the Van de Graff generator is $R = 0.5 \text{ m}$, calculate the maximum potential difference created by this Van de Graff generator.

Exercises

- 1.** When two objects are rubbed with each other, approximately a charge of 50 nC can be produced in each object. Calculate the number of electrons that must be transferred to produce this charge.
- 4.** Suppose a charge $+q$ on Earth's surface and another $+q$ charge is placed on the surface of the Moon. (a) Calculate the value of q required to balance the gravitational attraction between Earth and Moon (b) Suppose the distance between the Moon and Earth is halved, would the charge q change?
- 13.** During a thunder storm, the movement of water molecules within the clouds creates friction, partially causing the bottom part of the clouds to become negatively charged. This implies that the bottom of the cloud and the ground act as a parallel plate capacitor. If the electric field between the cloud and ground exceeds the dielectric breakdown of the air ($3 \times 10^6 \text{ Vm}^{-1}$), lightning will occur.

