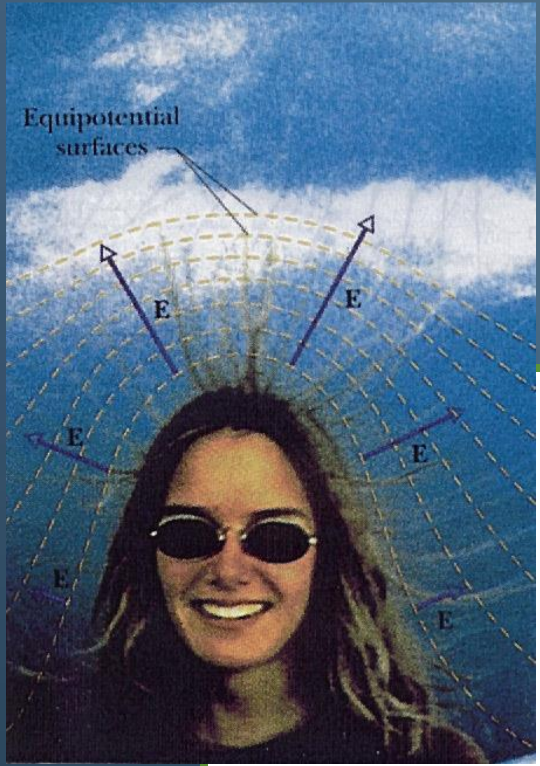
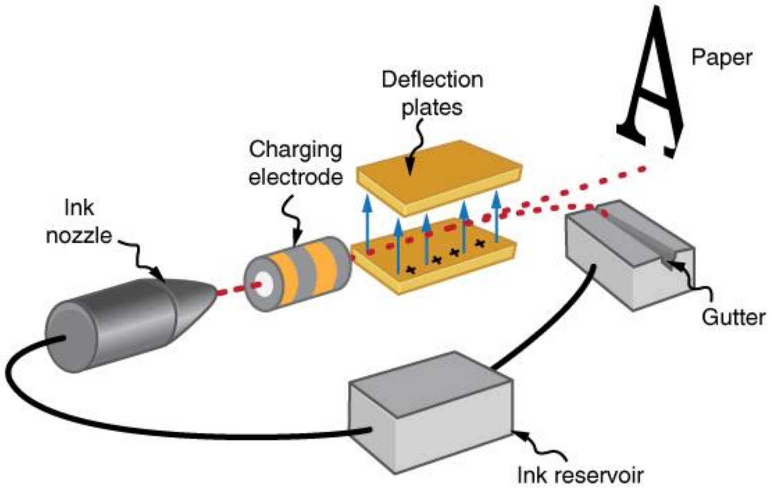
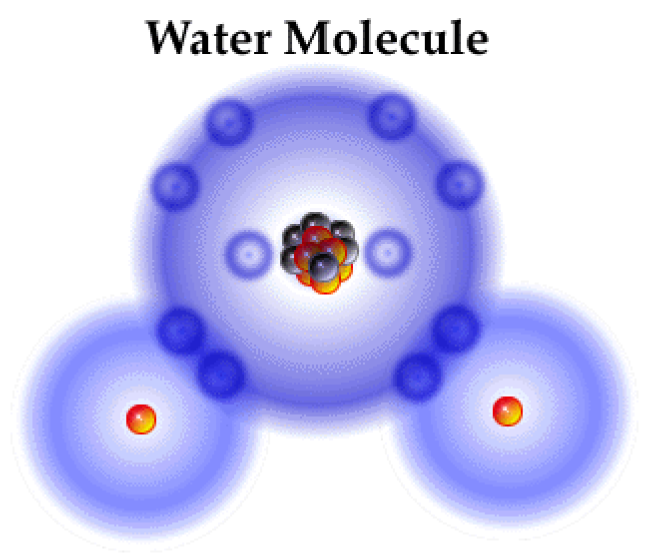




Chapter 22

Electric Fields



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22-2-3 The Electric Field & Lines

Learning Objectives

22.01 Identify that at every point in the space surrounding a charged particle, the particle sets up an electric field ***E***, which is a vector quantity and thus has both magnitude and direction.

22.02 Identify how an electric field ***E***: can be used to explain how a charged particle can exert an electrostatic force ***F*** on a second charged particle even though there is no contact between the particles.

22.03 Explain how a small positive test charge is used (in principle) to measure the electric field at any given point.

22.04 Explain electric field lines, including where they originate and terminate and what their spacing represents.

22-4 The Electric Field Due to a Charged Particle

Learning Objectives

22.05 In a sketch, draw a charged particle, indicate its sign, pick a nearby point, and then draw the electric field vector ***E***: at that point, with its tail anchored on the point.

22.06 For a given point in the electric field of a charged particle, identify the direction of the field vector ***E***: when the particle is positively charged and when it is negatively charged.

22.07 For a given point in the electric field of a charged particle, apply the relationship between the field magnitude ***E***, the charge magnitude |*q*|, and the distance ***r*** between the point and the particle.

22.08 Identify that the equation given here for the magnitude of an electric field applies only to a particle, not an extended object.

22.09 If more than one electric field is set up at a point, draw each electric field vector and then find the net electric field by adding the individual electric fields as vectors (not as scalars).

22-5 The Electric Field Due to a Dipole

Learning Objectives

22.10 Draw an electric dipole, identifying the charges (sizes and signs), dipole axis, and direction of the electric dipole moment.

22.11 Identify the direction of the electric field at any given point along the dipole axis, including between the charges.

22.12 Outline how the equation for the electric field due to an electric dipole is derived from the equations for the electric field due to the individual charged particles that form the dipole.

2.13 For a single charged particle and an electric dipole, compare the rate at which the electric field magnitude decreases with increase in distance. That is, identify which drops off faster.

22-5 The Electric Field Due to a Dipole

Learning Objectives (Contd.)

22.14 For an electric dipole, apply the relationship between the magnitude *p* of the dipole moment, the separation *d* between the charges, and the magnitude *q* of either of the charges.

22.15 For any distant point along a dipole axis, apply the relationship between the electric field magnitude ***E***, the distance *z* from the center of the dipole, and either the dipole moment magnitude *p* or the product of charge magnitude *q* and charge separation *d*.

22-6 The Electric Field Due to a Line of Charge

Learning Objectives

22.16 For a uniform distribution of charge, find the linear charge density λ for charge along a line, the surface charge density σ for charge on a surface, and the volume charge density ρ for charge in a volume.

22.17 For charge that is distributed uniformly along a line, find the net electric field at a given point near the line by splitting the distribution up into charge elements dq and then summing (by integration) the electric field vectors $d\mathbf{E}$ set up at the point by each element.

22.18 Explain how symmetry can be used to simplify the calculation of the electric field at a point near a line of uniformly distributed charge.

22-7 The Electric Field Due to a Charged Disk

Learning Objectives

22.19 Sketch a disk with uniform charge and indicate the direction of the electric field at a point on the central axis if the charge is positive and if it is negative.

22.20 Explain how the equation for the electric field on the central axis of a uniformly charged ring can be used to find the equation for the electric field on the central axis of a uniformly charged disk.

22.21 For a point on the central axis of a uniformly charged disk, apply the relationship between the surface charge density σ, the disk radius R, and the distance z to that point.

22-8 A Point Charge in an Electric Field

Learning Objectives

22.22 For a charged particle placed in an external electric field (a field due to other charged objects), apply the relationship between the electric field ***E*** at that point, the particle's charge *q*, and the electrostatic force ***F*** that acts on the particle, and identify the relative directions of the force and the field when the particle is positively charged and negatively charged.

22.23 Explain Millikan's procedure of measuring the elementary charge.

22.24 Explain the general mechanism of ink-jet printing.

22-7 A Dipole in an Electric Field

Learning Objectives

22.25 On a sketch of an electric dipole in an external electric field, indicate the direction of the field, the direction of the dipole moment, the direction of the electrostatic forces on the two ends of the dipole, and the direction in which those forces tend to rotate the dipole, and identify the value of the net force on the dipole.

22.26 Calculate the torque on an electric dipole in an external electric field by evaluating a cross product of the dipole moment vector and the electric field vector, in magnitude-angle notation and unit-vector notation.

22.27 For an electric dipole in an external electric field, relate the potential energy of the dipole to the work done by a torque as the dipole rotates in the electric field.

22-7 A Dipole in an Electric Field

Learning Objectives (Contd.)

22.28 For an electric dipole in an external electric field, calculate the potential energy by taking a dot product of the dipole moment vector and the electric field vector, in magnitude-angle notation and unit-vector notation.

22.29 For an electric dipole in an external electric field, identify the angles for the minimum and maximum potential energies and the angles for the minimum and maximum torque magnitudes.