Chapter 22
Electric Fields

The Electric field Due to a Point Charge

Q1. A point charge of 4.0 nano-C is located at a point having coordinates (30.0 cm, 40.0 cm). At what point will the electric field be 72 N/C and pointing in the negative y-direction?Ans:(30.0, -30.7) cm
Q2. A 40 micro-C charge is positioned on the x axis at x = 4.0 cm. In order to produce a net electric field of zero at the origin, where, on the x-axis, should a -60 micro-C charge be placed?Ans:4.9 cm
Q3. Four charges are placed on the circumference of a circle of radius 1.0 m and centered at the origin as shown in Figure 2. What is the magnitude and direction of the electric field at the origin (0,0)? Ans:54000 N/C along the negative y-axis

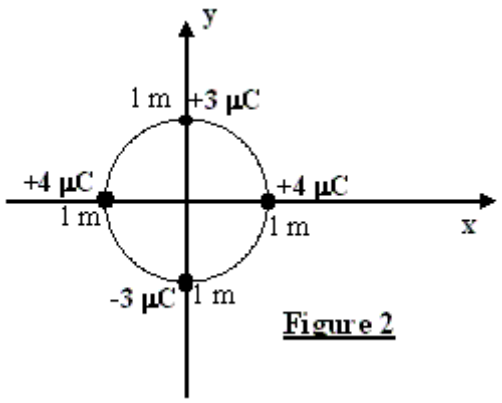

Figure 2

Q4. A charged particle has a mass of 2.0×10^{-4} kg. If it is held stationary by a downward 300 N/C electric field, the charge of the particle is:Ans:- 6.5×10^{-6} C.
Q5. Two uniformly charged, concentric and hollow, spheres have radii r and 1.5r. The charge of the inner sphere is q/2 and that on the outer sphere is 3q/2. Find the electric field at a distance 2.0r from the center of the spheres.Ans:$0.5kq/(r^2)$.
Q6. For the arrangement of charges shown in figure (1), the electric field at the point P is:Ans:kq/d^2 in the negative y-direction.

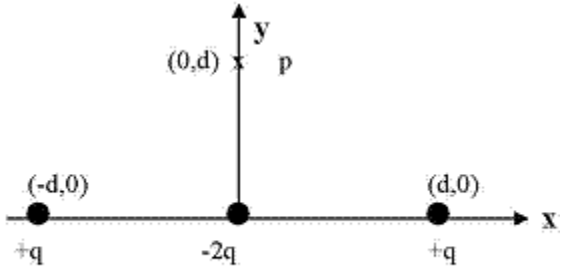

Figure 1

Q7. In figure (4), what is the magnitude of the electric field at point P due to the four point charges shown? Ans:zero

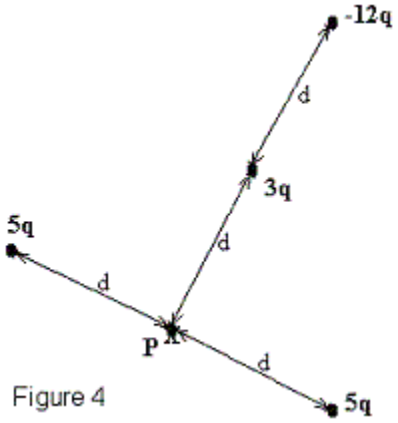

Figure 4

Q8. Four point charges are placed at the corners of a square as shown in figure 2. What is the magnitude of the electric field at the center of the square? Ans:$5.66kq/a^2$

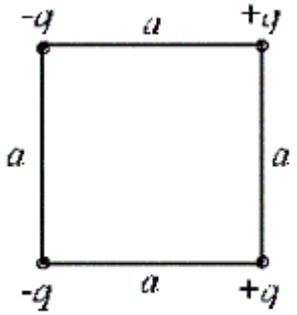

Figure 2

Q9. In figure 4, a 0.3 g metallic ball hangs from an insulating string in a vertical electric field of 4000 N/C directed upward as shown. If the tension in the string is 0.005 N, then the charge on the ball is: Ans:-0.52 micro-C

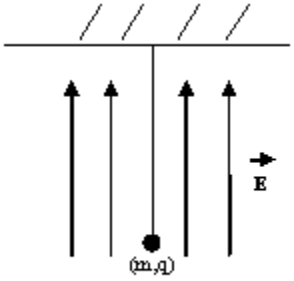

Figure 4

Q10. In figure 9, a small ball of mass m=2.0 g is hanging from a fixed point by a non-conducting string of length 1.00 m. The ball carries a charge $q=25.0\times10^{-9}$ C. The mass of the string is negligible. An electric field E with magnitude $E=2.0\times10^{5}$ N/C, in the positive x-direction, causes the ball to be in an equilibrium position with an angle Theta. Find the angle Theta. [Take g = 9.80 m/s^2]. Ans:14.3 degrees

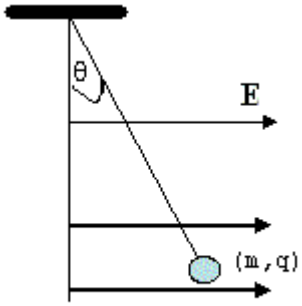

Figure 9

A Point Charge in an Electric Field

Q11. A particle (m =1.0×10^{-2} g, q = -4.0 micro C) is moving with a velocity of 20 m/s in the positive x-direction. If the particle enters a uniform electric field of 20 N/C in the positive x-direction, what is the particle's speed after 5.0 s?Ans:20 m/s , in negative x-direction.

Q12. An electron starts from point P (at t = 0) with an initial velocity vo =(8.6×10^{5})i m/s in an electric field E =(4.1×10^{3})i N/C. Find the time it takes the electron to return to point P. (i is the unit vector along the positive x-axis.)Ans:2.4×10^{-9} sec

Q13. An electron, traveling with initial velocity 10^{5} i m/s, enters a region of a uniform electric field given by E = 4.0×10^{3} i N/C. Determine the time it takes for the electron to come to rest momentarily. (i is a unit vector in the positive x-direction)Ans:1.4×10^{-10} s.

Q14. A uniform electric field exists in a region between two oppositely charged plates. An electron, released from rest from the negative plate, strikes the other plate with a speed of 1.2×10^{6} m/s, 15 nanoseconds after its release. What is the distance between the plates? Ans:0.90 cm

Q15. Two particles of the same mass carrying charges +3Q and -2Q are shot into a region that contains a uniform electric field as in figure 2. The particles have the same initial velocities in the + x direction. The direction of the electric field is as shown. What will be the resulting paths for the particles? Ans:path 5 for +3Q and path 2 for -2Q

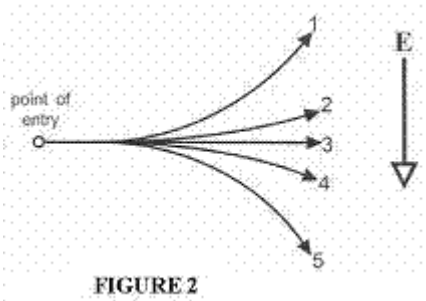

FIGURE 2

Q16. Two 1.0 g spheres are charged equally and placed 2.0 cm apart. When released, each one begins to accelerate at 225 m/s^2. What is the magnitude of the charge on each sphere?Ans:1.0×10^{-7} C.
Q17. A uniform electric field is set up between two large charged plates, see Figure 3. An electron is released from the negatively charged plate, and at the same time, a proton is released from the positively charged plate. They cross each other at a distance of 5.00×10^{-6} m from the positively charged plate. If only the field due to the charged plates is considered, find the distance between the two plates. [Take the ratio mass of the electron : mass of the proton = 1 : 1833] Ans:9.19 mm.

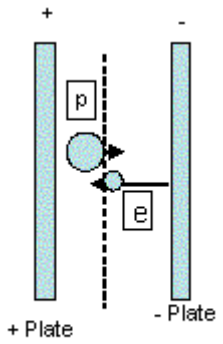

Figure 3

A Dipole in an Electric field

Q18. An electric dipole consists of a positive charge of magnitude 6.0×10^{-6} C at the origin and a negative charge of magnitude 6.0×10^{-6} C on the x-axis at x = 3.0×10^{-3} m. Its dipole moment is:Ans:1.8×10^{-8} C.m, in the negative x direction.
Q19. An electric dipole consists of charges +2e and -2e separated by 0.78×10^{-9} m. It is in an electric field of strength 3.0*10**6 N/C. Calculate the magnitude of the torque on the dipole when the dipole is perpendicular to the field. [e is the magnitude of the charge on the electron.]Ans:7.5×10^{-22} N.m.
Q20. An electric dipole consists of two opposite charges, each of magnitude 5.0×10^{-19} C, separated by a distance of 1.00×10^{-9} m. The dipole is placed in an electric field of strength 2.45×10^{5} N/C. Calculate the magnitude of the torque exerted on the dipole when the dipole moment is perpendicular to the electric field. Ans:1.2×10^{-22} Nm.
Q21. An electric dipole has a dipole moment of magnitude 2.0×10^{-9} C.m. The dipole is placed in an external electric field whose strength is 300 N/C, with its dipole moment initially perpendicular to the field. The electric field rotates the dipole until it is aligned parallel to the field. How much work is done by the electric field?Ans:$+6.0\times10^{-7}$ J

Chapter 22
Electric Fields

Q1. Which one of the following statements is CORRECT?

(a) Electric charge is not quantized.
(b) Electric field lines are closer together when the electric field is weak, and are far apart when the electric field is strong.
(c) Halfway between two point charges of equal magnitude and opposite sign, the net electric field is zero.
(d) In a solid conductor, electrons do not move freely.
(e) The direction of an electric field does not change whether a positive or negative test charge is used in calculating the electric field.

Q2. The strength of the electric field shown in Figure 3

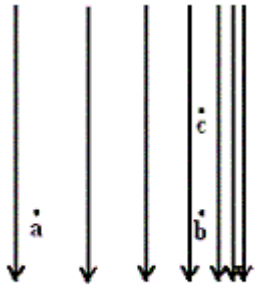

Figure 3

(a) increases as we go from point a to point b.
(b) increases as we go from point c to point b.
(c) increases as we go from point b to point a.
(d) is the same at points a, b and c.
(e) increases as we go from point b to point c.

Q3. Which of the following statements is WRONG:

(a) A shell of uniform charge density exerts a constant force on a charge inside it.
(b) Electric field lines extend away from a positive charge.
(c) Electric field can exert a torque on an electric dipole.
(d) A shell of uniform charge density exerts a constant force on a charge outside it.
(e) The magnitude of the charge on a positive ion is an integer multiple of the electron charge.

Q4. Which statement is false:

(a) The electric dipole consists of two charges of the same magnitude but opposite sign.
(b) Electric field lines extend away from negative charge and toward positive charge.
(c) The principle of superposition applies to electric fields as well as to electrostatic forces.
(d) When an electric dipole is placed in a uniform electric field, the net force on the dipole is zero.
(e) Electric fields are vector fields.

Q5. Which one of the following statements is WRONG?

(a) Electric field lines form a vector field.
(b) The principle of superposition applies to electric fields as well as electrostatic forces.
(c) Electric field lines extend away from negative charges and toward positive charges.
(d) The electric dipole consists of two charges having the same magnitude but opposite sign.
(e) When an electric dipole is placed in a uniform external electric field, the net force on it is zero.