Chapter 24
Electric Potential

Electric Potential Energy

Q1. A particle, of mass m and charge q, is released from rest at point A in a uniform electric field, see figure (2). The kinetic energy, due to the electric field, it attains after moving a distance y is: Ans:qEy.

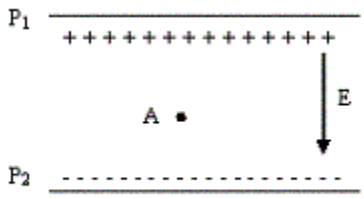

Figure (2)

Q2. Two oppositely charged parallel plates, 0.02 m apart, produce a uniform electric field between the plates. The potential energy U(J) of an electron in the field varies with displacement x(m) from one of the plates as shown in figure 5. What is the magnitude of the force on the electron? Ans:7.5×10^{-15} N.

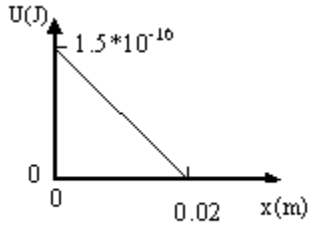

Figure 5

Electric Potential

Q3. A particle (m = 2.0 micro-g, q = - 5.0 micro-C) has a speed of 30 m/s at point A and moves, under the influence of a parallel and uniform electric field, to point B where its speed became 80 m/s. What is the potential difference [V(B)-V(A)].Ans:1.1 V.

Q4. Two equal point charges (Q = 20 micro-C) are located at the vertices of an equilateral triangle of side a = 2 m as shown in Figure 3. What is the work done to bring a 5 micro-C point charge from infinity to the point P? Ans:0.9 J

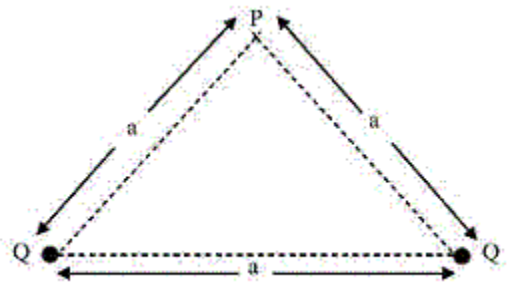

Figure 3

EquIpotential Surfaces

Q5. A 2 meters conducting rod is fixed perpendicularly to a uniform 200 N/C electric field. The potential difference between its ends is:Ans:Zero.

Calculating the Potential from the Field

Q6. Consider an insulating infinite plane sheet of uniform charge density sigma. The electric potential at point A is 200 V and at point B is 350 V as shown in Figure 4. What is the charge density on the plane sheet? Ans:-1.33 nano-C/m^2

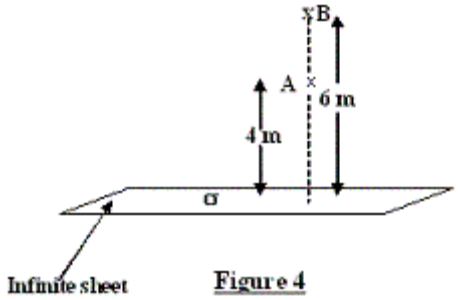

Figure 4

Q7. Figure 6 shows three points X, Y and Z forming an equilateral triangle of side S in a uniform electric field of strength E. A unit positive test charge is moved from X to Y, then from Y to Z, and from Z back to X. Which one of the following correctly gives the work done by an external agent in moving the charge along the various parts of the path?
Ans:0, -ESSin(60 degrees) , + ESSin(60 degrees).

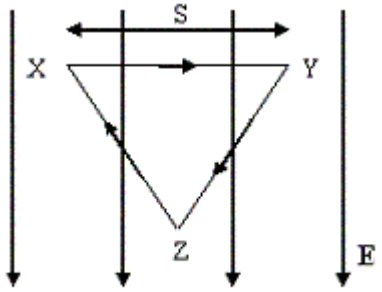

Figure 6

Potential Due to a Point Charge

Q8. A 4.0 nano-C point charge is located at the origin, and a second point charge (-5.0 nano-C) is placed on the y axis at y = 60 cm. If point A is at (45 cm, 0) and point B is at (80 cm, 0), what is the potential difference between points A and B (VA - VB)?Ans:20 V

Q9. Consider a metallic sphere carrying a charge of 4.0×10^{-8} C and having a potential of 400 V. Find the diameter of the sphere.Ans:1.8 m.

Q10. If an isolated metal sphere of radius r = 10 cm has a net charge of 4.0 micro-C. What is the potential on the surface of the sphere? [Consider V = 0 at infinity]Ans:3.6×10^{5} V.

Potential Due to a Group of Point Charges

Q11. In Figure (2), if $Q=4.0\times10^{-9}$ C, what is the potential difference V_A-V_B? Ans:18 V.

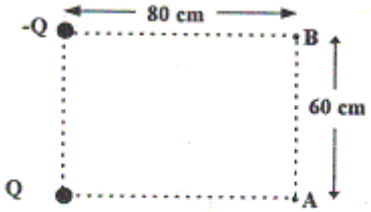

Figure # 2

Q12. Two point charges Q1 and Q2 are positioned as shown in Figure(2). If Q1 = 2.0×10^{-9} C, Q2 = - 2.0×10^{-9} C, a = 3.0 m, and b = 4.0 m, what is the electric potential difference, VA - VB? Ans:4.8 V

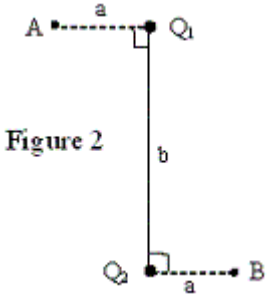

Figure 2

Calculating the Field from the Potential

Q13. An infinite nonconducting sheet has a surface charge density 0.10×10^{-6} C/m^2 on one side. How far apart are equipotential surfaces whose potentials differ by 90 V?Ans:1.6 cm.

Q14. The electric potential at points in an xy-plane is given by

$$V = 4.0(x^2) - 5.0(y^2),$$

where V is in volts, and x and y are in meters. What is the magnitude of the electric field at point (2.0 m, 3.0 m)? Ans:34 V/m

Q15. The electric potential at point A in an electric field is 15 V smaller than at point B. If a charge q = -2.0 C is moved from A to B, then the electric potential energy of this charge will:Ans:decrease by 30 J.

Electric Potential Energy of a System of Point Charges

Q16. Two charged parallel plates are separated by a distance of 3 mm. If an electron starts from rest at one plate and reaches the

other plate with a final speed of 3.7×10^{6} m/s, what is the change in electric potential between the initial position and the final position of the electron?Ans:+39 V

Q17. Consider the four charges shown in Figure 5. How much work is required, by an external agent, to move the charge q to infinity. (Take q = 1.0 micro-C.) Ans:0.95 J

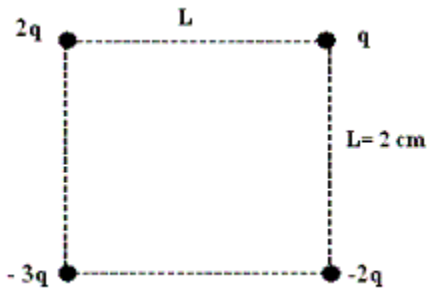

Figure 5

Potential of a Charged Isolated Conductor

Q18. Two conducting spheres are very far apart. The smaller sphere carries a total charge of 6 micro-C. The larger sphere has a radius twice that of the smaller sphere and is neutral (Q = 0). After the two spheres are connected by a thin conducting wire, the charges on the smaller and the larger spheres, respectively are:Ans:2 micro-C and 4 micro-C

Q19. Consider two concentric (thin and conducting) spherical shells. The inner has a radius a = 15 cm and a charge of 10 nano-C. The outer shell has a radius b = 30 cm and a charge of -15 nano-C. Find the electric potential on the surface of the inner shell.Ans:150 V

Q20. A solid conducting sphere of radius R = 5.0 cm has a charge density of 2.0×10^{-6} C/m^2 on its surface. What is the electric potential at the center of the sphere? (Take V = 0 at infinity.)Ans:1.1×10^{4} V