Exercises

1. A particle \((m = 50 \text{ g}, q = 5.0 \mu \text{C})\) is released from rest when it is 50 cm from a second particle \((Q = -20 \mu \text{C})\). Determine the magnitude of the initial acceleration of the 50-g particle.

   \[ A. \ 54 \text{ m/s}^2 \quad B. \ 90 \text{ m/s}^2 \quad C. \ 72 \text{ m/s}^2 \quad D. \ 65 \text{ m/s}^2 \quad E. \ 36 \text{ m/s}^2 \]

2. Three point charges, two positive and one negative, each having a magnitude of 20 \(\mu \text{C}\) are placed at the vertices of an equilateral triangle (30 cm on a side). What is the magnitude of the electrostatic force on the negative charge?

   \[ A. \ 80 \text{ N} \quad B. \ 40 \text{ N} \quad C. \ 69 \text{ N} \quad D. \ 57 \text{ N} \quad E. \ 75 \text{ N} \]

3. A charge \(Q\) is placed on the \(x\) axis at \(x = +4.0\) m. A second charge \(q\) is located at the origin. If \(Q = +75\) nC and \(q = -8.0\) nC, what is the magnitude of the electric field on the \(y\) axis at \(y = +3.0\) m?

   \[ A. \ 19 \text{ N/C} \quad B. \ 23 \text{ N/C} \quad C. \ 32 \text{ N/C} \quad D. \ 35 \text{ N/C} \quad E. \ 21 \text{ N/C} \]

4. A uniformly charged rod (length = 2.0 m, charge per unit length = 3.0 nC/m) is bent to form a semicircle. What is the magnitude of the electric field at the center of the circle?

   \[ A. \ 64 \text{ N/C} \quad B. \ 133 \text{ N/C} \quad C. \ 48 \text{ N/C} \quad D. \ 85 \text{ N/C} \quad E. \ 34 \text{ N/C} \]

5. A uniform linear charge of 2.0 nC/m is distributed along the \(x\) axis from \(x = 0\) to \(x = 3\) m. What is the \(x\) component of the electric field at \(y = 2\) m on the \(y\) axis?

   \[ A. \ -5.0 \text{ N/C} \quad B. \ -4.0 \text{ N/C} \quad C. \ -5.7 \text{ N/C} \quad D. \ -6.2 \text{ N/C} \quad E. \ -9.0 \text{ N/C} \]

6. A particle (mass = 5.0 g, charge = 40 mC) moves in a region of space where the electric field is uniform and is given by \(E_x = -5.5 \text{ N/C}, E_y = E_z = 0\). If the position and velocity of the particle at \(t = 0\) are given by \(x = y = z = 0\) and \(v_x = 50 \text{ m/s}, v_y = v_z = 0\), what is the distance from the origin to the particle at \(t = 2.0\) s?

   \[ A. \ 60 \text{ m} \quad B. \ 28 \text{ m} \quad C. \ 44 \text{ m} \quad D. \ 12 \text{ m} \quad E. \ 88 \text{ m} \]

7. A particle \((m = 20 \text{ mg}, q = -5.0 \mu \text{C})\) moves in a uniform electric field of 60 N/C in the positive \(x\) direction. At \(t = 0\), the particle is moving 25 m/s in the positive \(x\) direction and is passing through the origin. How far is the particle from the origin at \(t = 2.0\) s?

   \[ A. \ 80 \text{ m} \quad B. \ 20 \text{ m} \quad C. \ 58 \text{ m} \quad D. \ 10 \text{ m} \quad E. \ 30 \text{ m} \]

8. A uniform charge density of 500 nC/m\(^3\) is distributed throughout a spherical volume (radius = 16 cm). Consider a cubical (4.0 cm along the edge) surface completely inside the sphere. Determine the electric flux through this surface.

   \[ A. \ 7.1 \text{ N} \cdot \text{m}^2/\text{C} \quad B. \ 3.6 \text{ N} \cdot \text{m}^2/\text{C} \quad C. \ 12 \text{ N} \cdot \text{m}^2/\text{C} \quad D. \ 19 \text{ N} \cdot \text{m}^2/\text{C} \quad E. \ 970 \text{ N} \cdot \text{m}^2/\text{C} \]

9. A long nonconducting cylinder (radius = 12 cm) has a charge of uniform density (5.0 nC/m\(^3\)) distributed throughout its column. Determine the magnitude of the electric field 5.0 cm from the axis of the cylinder.

   \[ A. \ 25 \text{ N/C} \quad B. \ 20 \text{ N/C} \quad C. \ 14 \text{ N/C} \quad D. \ 31 \text{ N/C} \quad E. \ 34 \text{ N/C} \]
10. Charge of uniform density (40 pC/m²) is distributed on a spherical surface (radius = 1.0 cm), and a second concentric spherical surface (radius = 3.0 cm) carries a uniform charge density of 60 pC/m². What is the magnitude of the electric field at a point 4.0 cm from the center of the two surfaces?
A. 3.8 N/C  B. 4.1 N/C  C. 3.5 N/C  D. 3.2 N/C  E. 0.28 N/C

11. A solid nonconducting sphere (radius = 12 cm) has a charge of uniform density (30 nC/m³) distributed throughout its volume. Determine the magnitude of the electric field 15 cm from the center of the sphere.
A. 22 N/C  B. 49 N/C  C. 31 N/C  D. 87 N/C  E. 26 N/C

12. A point charge of 6.0 nC is placed at the center of a hollow spherical conductor (inner radius = 1.0 cm, outer radius = 2.0 cm) which has a net charge of −4.0 nC. Determine the resulting charge density on the inner surface of the conducting sphere.
A. +4.8 μC/m²  B. −4.8 μC/m²  C. −9.5 μC/m²  D. +9.5 μC/m²  E. −8.0 μC/m²