4.3 Q_1 and Q_2 are point charges located at (0, −4, 3) and (0, 1, 1). If Q_1 is 2 nC, find Q_2 such that

(a) The force on a test charge at (0, −3, 4) has no z-component.

(b) The **E** at (0, −3, 4) has no y-component.

4.4 Charges $+Q$ and $+3Q$ are separated by a distance 2 m. A third charge is located such that the electrostatic system is in equilibrium. Find the location and the value of the third charge in terms of Q.

4.5 Determine the total charge

(a) On line $0 < x < 5$ m if $\rho_L = 12x^2$ mC/m

(b) On the cylinder $\rho = 3$, $0 < z < 4$ m if $\rho_S = \rho z^2$ nC/m^2

(c) Within the sphere $r = 4$ m if $\rho_v = \dfrac{10}{r \sin \theta}$ C/m^3

4.7 A ring placed along $y^2 + z^2 = 9$, $x = 0$ carries a uniform charge of 5 nC/m.

(a) Find **E** at $P(4, 0, 0)$.

(b) If two identical point charges Q are placed at (0, −4, 0) and (0, 4, 0) in addition to the ring, find the value of Q such that $\mathbf{E} = 0$ at P.

4.9 Find **E** at (0, 0, 4) due to a charge of 2 nC distributed uniformly on

(a) The line $0 \le x \le 3$

(b) The arc $\rho = 3$, $\pi/4 \le \phi \le \pi/2$, $z = 0$

4.11 A point charge 100 pC is located at (4, 1, −3) while the x-axis carries charge 2 nC/m. If the plane $z = 3$ also carries charge 5 nC/m^2, find **E** at (1, 1, 1).

4.15 A line charge with uniform charge ρ_L C/m lies along the x-axis. The electric flux density at (−3, 6, 8) is 3 nC/m^2.

(a) Find ρ_L.

(b) Determine **D** at (0, 0, 4).

4.21 Point charges 5 μC, −3 μC, 2 μC, and 10 μC are located at (−12, 0, 5), (0, 3, −4), (2, −6, 3), and (3, 0, 0) respectively. Calculate the flux through the spherical surfaces at

(a) $r = 1$

(b) $r = 10$

(c) $r = 15$

4.25 If the electric flux density is $\mathbf{D} = \frac{10}{r}\mathbf{a}_r$ nC/m^2, find the total charge within $0 \leq r \leq 2$ m.

4.26 Find the work done in carrying a 5-C charge from $P(1, 2, -4)$ to $R(3, -5, 6)$ in an electric field

$$\mathbf{E} = \mathbf{a}_x + z^2\mathbf{a}_y + 2yz\mathbf{a}_z \text{ V/m}$$

4.29 Two point charges $Q_1 = 3$ nC and $Q_2 = -2$ nC are placed at (0, 0, 0) and (0, 0, -1) respectively. Assuming zero potential at infinity, find the potential at

(a) (0, 1, 0)

(b) (1, 1, 1)

***4.39** A spherical charge distribution is given by

$$\rho_v = \begin{cases} \rho_0\left(1 - \dfrac{r^2}{a^2}\right), & r \leq a \\ 0, & r > a \end{cases}$$

(a) Find $\mathbf{E}$ and V for $r \geq a$.

(b) Find $\mathbf{E}$ and V for $r \leq a$.

(c) Show that the maximum value of $\mathbf{E}$ is at $r = 0.745a$.

(d) Find where V is maximum and calculate that maximum value.

4.44 A point charge Q is placed at the origin. Calculate the energy stored in region $r > a$.