Reading

Required Reading

- Chapter 4, pp. 110-140.

Point Charges

Problem 1 – Single Charge

A single point charge of 7.2 nC resides at position $(0,0,0)$ within a silicon medium with relative permittivity $\varepsilon_r = 3.5$. Calculate the electric field intensity $\vec{E}$ at position $(10\text{ mm}, -20\text{ mm}, 5.0\text{ mm})$.

Problem 2 – Two Charges

A first point charge of – 2.4 nC is at position $(1.0\ \mu\text{m}, 2.0\ \mu\text{m}, -3.0\ \mu\text{m})$. A second point charge of 5.6 nC is at position $(-2.0\ \mu\text{m}, 1.1\ \mu\text{m}, 2.7\ \mu\text{m})$. Both point charges reside in a ceramic medium with dielectric constant $\varepsilon_r = 6.2$.

a) Calculate the electric field intensity $\vec{E}$ at position $(-0.5\ \mu\text{m}, 0.5\ \mu\text{m}, 0.5\ \mu\text{m})$.

b) Calculate the force $\vec{F}$ on the second charge.

Problem 2 – Multiple Charges

The table below lists four different point charges that reside in a plastic medium with dielectric constant $\varepsilon_r = 2.5$.

#	Charge	Position
1	2.0 nC	$(0.5\text{ mm}, -1.4\text{ mm}, 2.5\text{ mm})$
2	-4.3 nC	$(2.7\text{ mm}, 6.1\text{ mm}, -0.2\text{ mm})$
3	-9.3 nC	$(-8.5\text{ mm}, -3.7\text{ mm}, 1.8\text{ mm})$
4	7.9 nC	$(-2.4\text{ mm}, 5.3\text{ mm}, 8.2\text{ mm})$

Part a

Calculate the force $\vec{F}_2$ on the second charge.

Part b

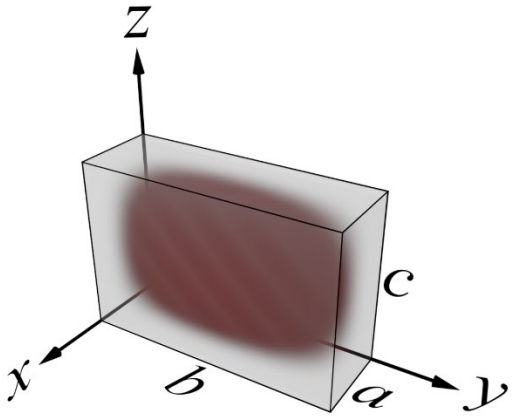
When measured experimentally, the force was actually $(-0.5\text{ mN}, -0.5\text{ mN}, 1.5\text{ mN})$. It was discovered that the error was due to a fifth mystery charge of 1.0 nC at an unknown location. Calculate the location of the fifth mystery charge that would lead to the stated force on the second charge.

Charge Distributions

Problem 1 – Cuboid Charge

The figure below shows a cuboid with charge distribution throughout its volume described by

$$\rho_v(x,y,z) = \rho_0 \sin\left(\frac{\pi x}{a}\right) \sin\left(\frac{\pi y}{b}\right) \sin\left(\frac{\pi z}{c}\right)$$



Derive an expression for the total charge Q.