

ROZWIAZANIE WYGENEROWANE PRZEZ CHAT GPT

6. a) Nieskończona płaszczyzna jest naładowana ze stałą gęstością powierzchniową σ . Korzystając z prawa Gaussa obliczyć wektor natężenia $\mathbf{E}(d)$ pola elektrostatycznego wytwarzanego przez tę płaszczyznę w odległości d od niej.
b) Korzystając z prawa Gaussa obliczyć natężenie pola elektrostatycznego w odległości l od nieskończonej długiej prostoliniowej nici, naładowanej jednorodnie z gęstością liniową λ .

To solve this problem using Gauss's Law, we need to employ some symmetry arguments for each situation.

a) Infinite Plane with Surface Charge Density σ Gauss's Law states:

$$\Phi = \oint \mathbf{E} \cdot d\mathbf{A} = \frac{Q_{\text{enc}}}{\epsilon_0}$$

1. **Symmetry**: For an infinite plane, the electric field \mathbf{E} is perpendicular to the surface and has the same magnitude at all points equidistant from the plane. 2. **Gaussian Surface**: Consider a cylindrical Gaussian surface (a "pillbox") that straddles the plane. The flux only passes through the two flat faces of the cylinder.

3. **Flux Calculation**: The electric field through each face is E , and the area of each face is A . Thus, the total flux is:

$$\Phi = E \cdot A + E \cdot A = 2EA$$

4. **Charge Enclosed**: The charge enclosed by the Gaussian surface is σA .

5. **Apply Gauss's Law**:

$$2EA = \frac{\sigma A}{\epsilon_0}$$

6. **Solve for E** :

$$E = \frac{\sigma}{2\epsilon_0}$$

Thus, the electric field $E(d)$ at a distance d from the plane is $\frac{\sigma}{2\epsilon_0}$ and is directed perpendicularly away from the plane.

b) Infinite Line Charge with Linear Charge Density λ

1. **Symmetry**: For an infinite line charge, the electric field \mathbf{E} is radial and has the same magnitude at any point equidistant from the line.

2. **Gaussian Surface**: Use a cylindrical Gaussian surface with radius l and length L , coaxial with the line charge.

3. **Flux Calculation**: The electric field is perpendicular to the curved surface of the cylinder, and the field lines are radial. Thus, the flux through the lateral surface is:

$$\Phi = E \cdot (2\pi lL)$$

4. **Charge Enclosed**: The charge enclosed is λL .

5. **Apply Gauss's Law**:

$$E \cdot (2\pi lL) = \frac{\lambda L}{\epsilon_0}$$

6. **Solve for E** :

$$E = \frac{\lambda}{2\pi\epsilon_0 l}$$

Thus, the electric field $E(l)$ at a distance l from the line is $\frac{\lambda}{2\pi\epsilon_0 l}$ and is directed radially outward from the line.