8.6 Gauss's Law

Name: ______________ Class: __________ Date: ____________ **Total: 10 marks**

KEY WORDS gauss's law 高斯定律 • gaussian surface 高斯面 • electric field 电场 • electric flux 电通量 • conductor 导体

Objective

Build the skills to answer exam questions on **Gauss's law**.

You must be able to:

- state **Gauss's law** 高斯定律, $\oint \vec{E} \cdot d\vec{A} = \dfrac{Q_{\text{enc}}}{\varepsilon_0}$
- choose a **Gaussian surface** 高斯面 whose symmetry makes $\vec{E}$ constant and perpendicular
- apply Gauss's law to spherical, cylindrical, and planar distributions
- explain why $\vec{E} = 0$ inside a conductor in electrostatic equilibrium

1 Worked examples

Study these first. Each one shows the method for a question type used later.

■ Gauss's law

$\oint \vec{E} \cdot d\vec{A} = \dfrac{Q_{\text{enc}}}{\varepsilon_0}$: the net flux through a closed surface equals the enclosed charge divided by ε_0.

■ Choose the symmetry

Pick a Gaussian surface (sphere, cylinder, box) on which E is constant and either perpendicular or parallel to the surface, so the integral becomes $E \times A$.

■ A point charge

For a sphere of radius r around charge q: $E(4\pi r^2) = \dfrac{q}{\varepsilon_0}$, giving $E = \dfrac{kq}{r^2}$. Inside a conductor at equilibrium, no charge is enclosed, so $E = 0$.

2 Practice

2.1 State Gauss's law. [1]

2.2 State the electric field inside a conductor in electrostatic equilibrium. [1]

2.3 A charge of 5.0×10^{-9} C is enclosed by a closed surface ($\varepsilon_0 = 8.85 \times 10^{-12}$). Find the flux through it. [2]

3 Exam-style questions

3.1 Gauss's law relates the flux through a closed surface to the [1]

A total field everywhere
B charge enclosed
C surface area
D current

3.2 Inside a charged conducting sphere in equilibrium, the electric field is [1]

A kq/r^2
B zero
C at its maximum
D infinite

3.3 A point charge $+8.0 \times 10^{-9}$ C sits at the centre of a spherical surface of radius 0.20 m ($\varepsilon_0 = 8.85 \times 10^{-12}$, $k = 8.99 \times 10^9$).

(a) Find the flux through the sphere. [2]

(b) Find the field at the surface. [2]