THE UNIVERSITY OF MISSISSIPPI

PHYS 212, Honors Section – Review Material

Chapter 24: Gauss' Law

- General concept: The flux of a constant vector field **v** through a flat surface of area A is

$$\Phi = (v \cos\theta)\, A = \mathbf{v} \cdot \mathbf{A}\ .$$

  (Recall the concept of flow rate through a surface for a fluid.)

- Electric field flux: For a constant field through a flat surface, $\Phi = (E \cos\theta)\, A = \mathbf{E} \cdot \mathbf{A}$. It can be interpreted as (proportional to) the number of field lines crossing the surface. For a non-constant field and/or a non-flat surface, apply the equation to each infinitesimal surface element and integrate,

$$\Phi = \int \mathbf{E} \cdot \mathrm{d}\mathbf{A}\ .$$

- Gauss' law: Concept of Gaussian surface; The electric flux through a closed Gaussian surface is

$$\Phi = q_{\mathrm{in}}/\varepsilon_0.$$

- Charged conductors: Inside a conductor, the electric field is always zero in electrostatic equilibrium (conduction charges are not moving). Any excess charge on a conductor will be found entirely on its surface. What happens when there are cavities. Electric field at the surface of a conductor: It has to be perpendicular to the surface, and its magnitude is $E = \sigma/\varepsilon_0$.

- Applications of Gauss' law: Be able to apply it to situations with charged lines, planes, and volumes.

- Results: For a large non-conducting sheet, $E = \sigma/2\varepsilon_0$ on both sides; Outside a conducting plate, $E = \sigma/\varepsilon_0$; Between two plates with opposite-sign charges, $E = \sigma/\varepsilon_0$. (Recall the distinctions in the meanings of σ).

Note: You are not required to know the topics and equations inside square brackets.

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