PHYS 212, Honors Section – Review Material

Chapter 23: Electric Fields

- Electric charge: Concept, types, attraction/repulsion; Units for charge (C); Charge conservation.
- Types of materials: Conductors vs insulators, and microscopic interpretation; Charging and grounding.
- Coulomb's law: Electric force between two point charges,

$$F = k\, q_1 q_2/r^2, \text{ with electrostatic constant } k = 8.99 \cdot 10^9 \text{ N·m}^2/\text{C}^2 = 1/(4\pi\varepsilon_0)\ .$$

- Results: Shell theorems for spherical charge distributions.
- Fundamental charge: Charge quantization; Value of the charge of an electron or proton,

$$e = 1.60 \times 10^{-19} \text{ C}\ .$$

- Definition of electric field: If a charge q feels an electric force **F** at a point P, the electric field there is

$$\mathbf{E} = \mathbf{F}/q\ .$$

  Interpretation as force that a 1-C charge would feel there. Units for electric fields (N/C).

- Electric field lines: The general concept; How to draw them for simple charge arrangements; How they provide information on the direction and magnitude of the electric field. Other properties: No crossings; They start at positive charges and end at negative ones, if charges are present.
- Electric field due to point charges: From Coulomb's law, each charge produces an electric field,

$$E = k\, q/r^2 = 1/(4\pi\varepsilon_0)\; q/r^2 \text{ , with electric permittivity of vacuum } \varepsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N·m}^2\ .$$

- [Electric field due to an electric dipole: Concept of dipole, electric dipole moment **p**, with $p = qd$, and

$$E = 1/(2\pi\varepsilon_0)\; p/z^3 \text{ on the axis of the dipole .]}$$

- Electric field due to a line or surface charge distribution: How to set up the appropriate integral

$$\mathbf{E} = k \int (\mathrm{d}q/r^3)\, \mathbf{r}\ .$$

- Electric charges in electric fields: If the field **E** is known at a place, then the force felt by a charge q placed there is $\mathbf{F} = q\mathbf{E}$. The normal values of electric field near the surface of the Earth are around 100 N/C, and in most practical situations the gravitational forces felt by particles such as electrons and protons can be ignored if there are electric forces acting on them.
- [Electric dipoles in electric fields: Torque $\boldsymbol{\tau} = \mathbf{p} \times \mathbf{E}$, and what happens to the dipole, qualitatively.]

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

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