Physics Notes (Electric Charge)

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5. Electric Charges

5.1 Production of Charges (Triboelectric Effect)

- **Principle:** Electric charge is typically produced by the **transfer of electrons** between materials. An object becomes charged when it gains or loses electrons.
- **Fundamental Law:** Charge is always conserved. It is neither created nor destroyed, only transferred.
- **Process:** When two suitable insulating materials are rubbed together (friction), electrons from one material are stripped away and transferred to the other material.
    - The material that **loses electrons** becomes **positively charged**.
    - The material that **gains electrons** becomes **negatively charged**.

5.2 Types of Charges

- **Positive Charge (+):** Occurs when a body has a **deficiency** of electrons.
- **Negative Charge (-):** Occurs when a body has an **excess** of electrons.
- **Neutral Body:** Has an equal number of positive charges (protons) and negative charges (electrons), resulting in a net charge of zero.
- **Fundamental Rule:**
    - **Like charges** repel each other (e.g., + and +, or - and -).
    - **Unlike charges** attract each other (e.g., + and -).

5.3 Ways of Producing Charges

- **1. Charging by Friction (Triboelectric Effect):**
    - Involves rubbing two different insulating materials together (e.g., rubbing a plastic rod with fur). This causes electron transfer, resulting in both objects becoming oppositely charged.
- **2. Charging by Contact (Conduction):**
    - Involves touching a charged object to a neutral conductor.
    - Electrons transfer directly from the charged object to the neutral object (or vice versa) until the charge is distributed between them. Both objects end up with the **same type of charge**.
- **3. Charging by Induction:**
    - Involves bringing a charged object **near** a neutral conductor **without touching it**.
    - The presence of the charged object causes charges in the neutral conductor to separate (polarization).

    - While the charged object is held near, the conductor is temporarily grounded to allow one type of charge to escape or be acquired.
    - The ground connection is removed, and then the inducing charged object is removed. The conductor is left with a charge **opposite** to the inducing charge.

5.4 Distribution of Charges

- **Conductors:** Excess electric charge on an isolated conductor will reside entirely on its **outer surface**. The charge will be distributed such that the concentration is **greatest where the surface is most curved** (e.g., on sharp points).
- **Insulators:** Excess charge placed on an insulator usually remains where it was placed, as charges are not free to move throughout the material.
- **Faraday Cage Effect:** A hollow conductor shields its interior from external electric fields because charges distribute on the outer surface to cancel out the external field inside.

5.5 Storage of Charges

- **Gold-leaf Electroscope:** A simple device used to detect the presence and sign of an electric charge. A charge is indicated by the divergence (separation) of the two gold leaves.
- **Capacitors:** The primary device used in electrical circuits to **store electrical potential energy and electric charge** on its conductive plates, separated by a dielectric (insulator). (See **Electric Field I** notes for details on capacitance).

5.6 Summary

- Charge is produced by the transfer of electrons, often through friction.
- Charges are positive (electron deficiency) or negative (electron excess), with like charges repelling and unlike charges attracting.
- Methods of charging: friction (insulators), conduction (same charge), and induction (opposite charge).
- Charge resides on the outer surface of conductors, concentrating at sharp points.
- Capacitors are used for practical charge storage.