## *1. Introduction :( History of electricity)*

*The history of electricity traces back to ancient times, notably with the observations of the Greek philosopher Thales. While experimenting with amber and fur, Thales noticed lightweight objects being attracted to the charged amber. He proposed that a force he termed "electricity" was responsible for this phenomenon, deriving the term from the Greek word for amber, "ēlektron." Thales's insights laid the foundation for the study of static electricity and sparked centuries of scientific inquiry into electricity, shaping our modern understanding and applications of this fundamental force.*

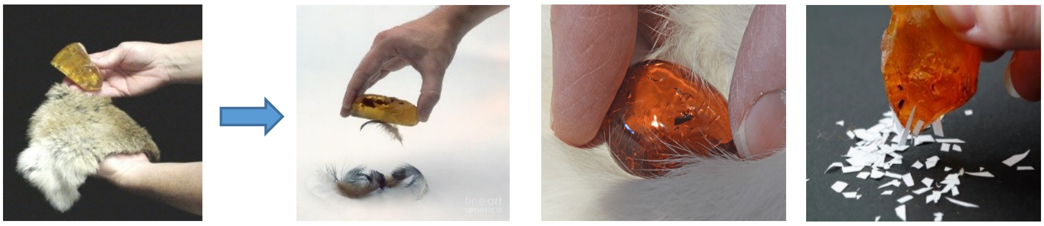

***Figure 01: Attracting lightweight objects towards charged amber***

## *2. The evolution of the concept of electrification in materials*

*Electricity is a fundamental aspect of nature, often explained by the presence of electric charges within materials. When materials become electrified, they possess an amount of electricity, known as electrical charge. This charge is carried by tiny particles called electrons, which were discovered by physicist Joseph John Thomson in 1897. Thomson's groundbreaking work revolutionized our understanding of atomic structure, revealing that atoms contain negatively charged electrons orbiting a positively charged nucleus.*

*Further advancements in atomic theory came with the discoveries of the proton and neutron. Physicist Ernest Rutherford identified the proton in 1919, elucidating its role as a positively charged particle within the atomic nucleus. This discovery provided crucial insights into the composition of atomic nuclei and their interactions.*

*In 1932, scientists James Chadwick and John Colcock discovered the neutron, a neutral particle found within atomic nuclei. The existence of neutrons helped reconcile discrepancies in atomic mass and contributed to the development of nuclear physics.*

*These discoveries collectively expanded our understanding of electricity and paved the way for advancements in fields such as particle physics, nuclear energy, and electronics. By* *unraveling the mysteries of atomic structure and subatomic particles, scientists have unlocked the potential for countless technological innovations and scientific breakthroughs.*

### 2.1 Millikan Oil Drop Experiment (for quantization of charge):

*The Millikan Oil Drop Experiment, conducted by physicist Robert A. Millikan in 1909, aimed to quantify the charge of an electron. In this experiment, tiny oil droplets suspended in a chamber were observed under the influence of an electric field. By carefully measuring the motion of these droplets and analyzing their behavior, Millikan determined that electric charge is quantized, meaning it exists in discrete units. His precise measurements led to the determination of the charge of a single electron, providing fundamental insights into the nature of atomic and subatomic particles.*

*As a result of Millikan's experiment, any positive or negative charge q that can be detected is expressed as:*

$$q = n\varepsilon$$

*Where n is an integer (positive or negative), representing the number of elementary charges, and $\epsilon$ is the smallest unit charge in nature. This smallest unit charge, denoted as ε, has a value of approximately $1.60219\times10^{-19}$ coulombs.*

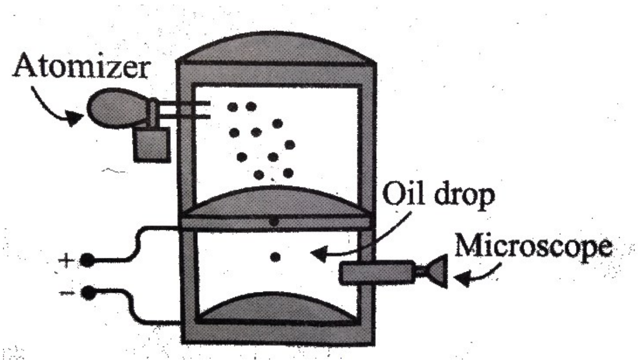


**Figure 02: Millikan Oil Drop Experiment**

### 2.2 Electrification Mechanism Explained

*The figure below illustrates the mechanism of electrification. Initially, the material is uncharged. However, when we rub a piece of amber with a cloth, a transfer of charges occurs from the surface of one body to the surface of the other. This transfer causes a redistribution of charges, resulting in one surface becoming positively charged and the other becoming negatively charged.*

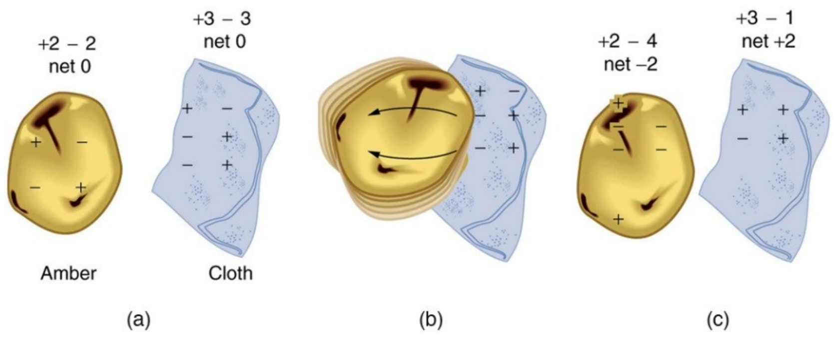


***Figure 03: Electrification Mechanism***

### *2.3 methods of electrification*

*As depicted in the figure below, there are various methods of electrification:*

#### *2.3.1 Rubbing Charging:*

*This occurs when two objects are rubbed together, resulting in the transfer of electrons from one object to the other. The object that gains electrons becomes negatively charged, while the other becomes positively charged. An illustrative example is the act of rubbing a plastic rod with a piece of cloth.*

#### *2.3.2 Contact Charging*

*Contact charging takes place when two objects make physical contact, leading to the exchange of electrons between them. If a negatively charged object touches a neutral object, the charge is redistributed between them. This phenomenon occurs frequently in everyday scenarios when different objects come into contact with each other.*

#### *2.3.3 Induction Charging*

*Induction charging occurs when a charged object influences the charge distribution in another object without direct contact. The presence of the charged object alters the distribution of charges in the nearby object. A classic demonstration of this is bringing a charged rod close to a piece of paper and observing how the charge distribution in the paper is affected by the proximity of the charged rod.*

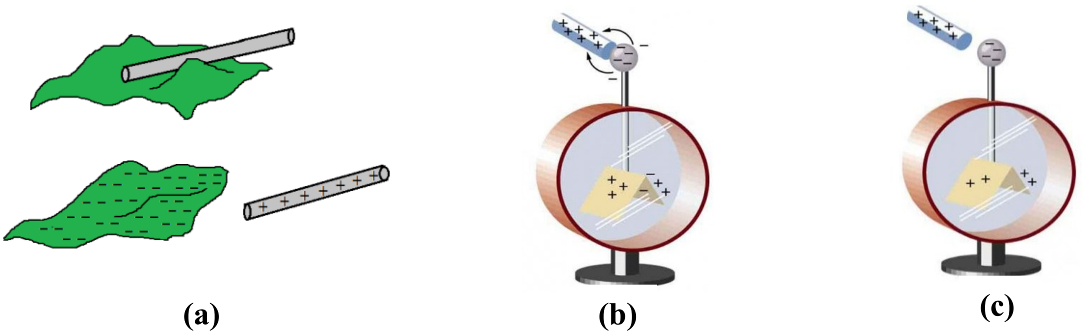


**Figure 04: Electrification (charging) methods**

## 3. Electrostatic forces

*The physicist Coulomb was able to measure the electric force exchanged between two charged balls using the following experimental setup.*

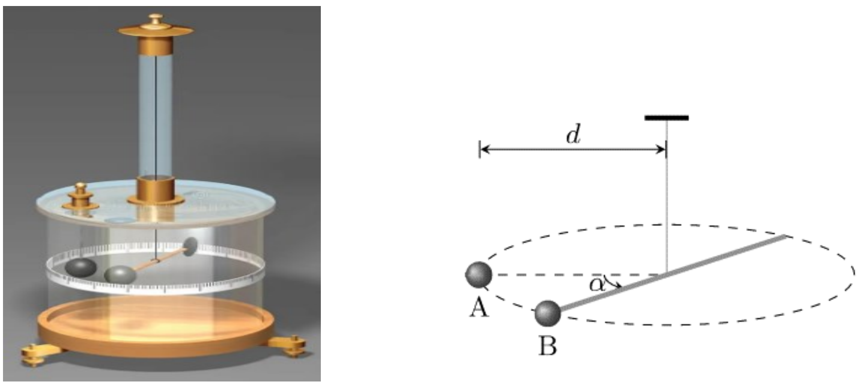


**Figure 05: Coulomb's experimental**

*Coulomb's law describes the electrostatic force between two charged objects. It states that the force between two point charges is directly proportional to the product of their charges and inversely proportional to the square of the distance between them. Mathematically, Coulomb's law is expressed as:*

$$\overrightarrow{F_{A/B}} = \frac{1}{4\pi\varepsilon_0}\frac{q_A q_B}{r^2}\overrightarrow{u_{AB}} = k\,\frac{q_A q_B}{\left\|\overrightarrow{AB}\right\|^3}\overrightarrow{AB}$$

*Where* $k$ *is Coulomb's constant (*$k \approx 8.9875\times10^9\ N.m^2/C = 9\times10^9\ N.m^2/C$*, in vacuum).*

$r = \left\|\overrightarrow{AB}\right\|$ *is the distance between the two charges A and B.*

$\varepsilon_0$ *denotes the vacuum permittivity (*$\varepsilon_0 \approx 8.854\times10^{-12}\ C^2N^{-1}m^{-2}$ *)*

- *The electric force applied by charge A to the point charge B is represented by a vector characterized by:*

***Magnitude:*** *The magnitude of the electric force between two charges $q_A$ and $q_B$ separated by a distance r is indeed given by Coulomb's law as* $\left\|\overrightarrow{F_{A/B}}\right\| = k\ \frac{q_A q_B}{r^2}$

***Support:*** *refers to the line connecting the centers of the two point charges A and B*

***Direction:*** *The direction of the electric force depends on the types of charges involved. The force vector points along the line connecting the charges. If the charges are of opposite signs, the force is attractive, pulling the charges together. If the charges are of the same sign, the force is repulsive, pushing the charges apart.*

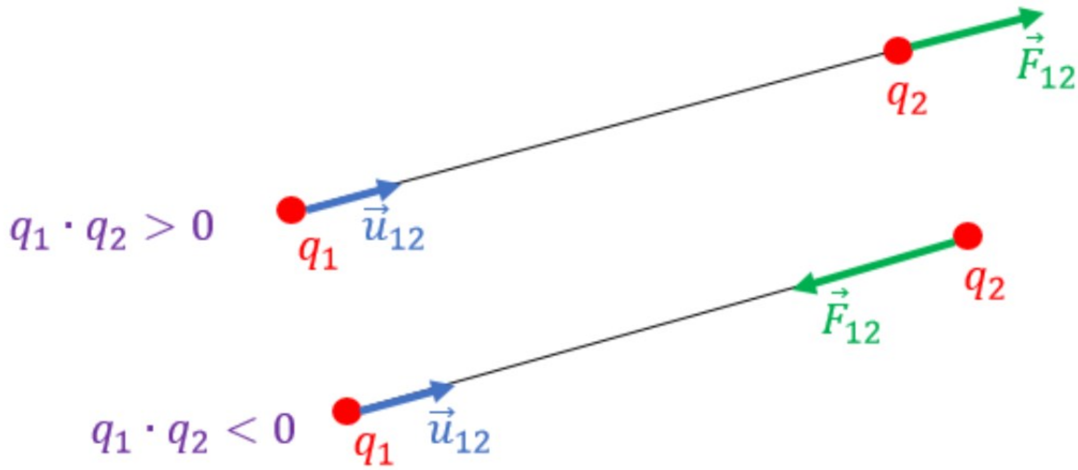


***Figure 06: attractive (between Opposite Charges (One Positive, One Negative)) and repulsive forces (between the same Charges (Both Positive or Both Negative))***