Al-Mustaqbal University

college of sciences

Department of Biology

Bio Physics

fourth lecture

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First Stage

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1. Material and charge

The physics of electromagnetism was first studied by the early **Greek philosophers**, who discovered that if a piece of amber is rubbed(دلك) and then brought near bits of straw (قطع القش), the straw will jump to the amber. We now know that the attraction between amber and straw is due to an **electric force**.

From these modest origins with the Greek philosophers, the sciences of electricity and magnetism developed separately for centuries—until 1820, in fact, when **Hans Christian Oersted** found a connection between them: an electric current in a wire can deflect a magnetic compass needle.

2. Electric Charge

After rubbing a glass rodعمود زجاج with a silk clothقطعة حرير, we hang the rod by means of a thread tied around its center. Then we rubندلك a second glass rod with the silk cloth and bring it near the hanging rod. The hanging rod magicallyسحري moves away. We can see that a force repels it from the second rod, but how?

In the second demonstrationالعرض الثاني we replace the second rod with a plastic rod that has been rubbed with furالفرو . This time, the hanging rod moves toward the nearby rod.

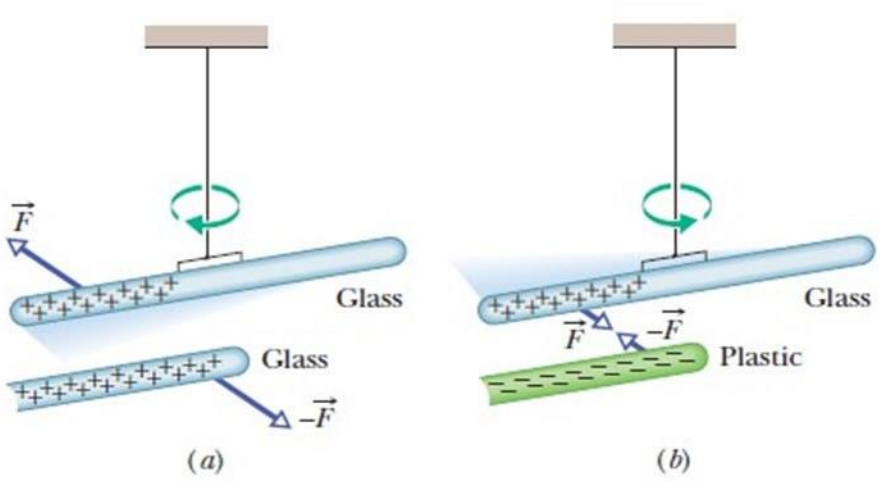

Figure. 1: (*a*) The two glass rods were each rubbed with a silk cloth and one was suspended by thread. When they are close to each other, they repel each other. (*b*) The plastic rod was rubbed with fur. When brought close to the glass rod, the rods attract each other.

In the first demonstration, the force on the hanging rod was ***repulsive***, and in the second, ***attractive***. After a great many investigations, scientists figured out that the forces in these types of demonstrations are due to the **electric charge** that we set up on the rods when they are in contact with silk or fur.

3. **Two Types of charge**: There are two types of electric charge, named by the American scientist and statesman Benjamin Franklin as positive charge and negative charge. In most everyday objects, such as a mug, there are about equal numbers of negatively charged particles and positively charged particles, and so the net charge is zero, the charge is said to be balanced, and the object is said to be **electrically neutral** ***متعادل کہربائیا***.

Note: Particles with the same signs of electrical charge repel each other, and particles with opposite signs attract each other.

4. Charge is Conserved

If you rub a glass rod with silk, a positive charge appears on the rod. Measurement shows that a negative charge of equal magnitude appears on the silk. This suggests that rubbing does not create charge but only transfers it from one body to another. This hypothesis of **conservation of charge,** first put forward by **Benjamin Franklin**, has stood up under close examination, both for large-scale charged bodies and for atoms, nuclei.

5. Charge is Quantized

Any positive or negative charge q that can be detected can be written as:

$$q = ne, \qquad n = \pm 1, \pm 2, \pm 3, \ldots,$$

in which e, the **elementary charge,** has the approximate value:

$$e = 1.602 \times 10^{-19}\,\text{C}.$$

The electron and proton both have a charge of magnitude e.

Quarks, the constituent particles of protons and neutrons, have charges of $e/3$ or $2e/3$.

6. Electric Charge and the Structure of Matter

All matter is composed of **atoms**, each of which has a central **nucleus** and one or more electrons that travel in orbits around the nucleus, like satellites around the earth. The nucleus contains one or more **positively** charged particles called **protons**. The positive charge of a proton is 'opposite' to the

negative charge of an electron, in the sense that the total, or net, charge of the combination is zero. Thus, an atom that has the same number of electrons in orbit as it has protons in its nucleus is **electrically neutral**.

Summary of Subatomic Particles		
Proton	**Neutron**	**Electron**
In nucleus Tightly Bound Positive Charge Massive	In nucleus Tightly Bound مرتبط بشدة No Charge Massive ضخم	Outside nucleus Weakly Bound ارتباط ضعيف Negative Charge Not very massive