Chapter 23

1

ELECTRIC FIELDS

1

Lecture 01

2

Electric Charge

2

Electric Charges

3

Electric charge is an intrinsic property of the fundamental particles that make up objects such as: the rods, silk, and fur.

Electric charge is a **scalar** quantity.

The SI unit of charge is the **Coulomb**; it is derived from the SI unit Ampere:

$$(1\ C) = (1\ A)(1\ s)$$

The **fundamental charge** has the magnitude of:

$$e = 1.6 \times 10^{-19}\ C$$

3

Electric Charges

4

- There are two kinds of electric charges
  - Called **positive** and **negative**
    - Negative charges are the type possessed by electrons.

$$e = -1.6 \times 10^{-19}\ C$$

    - Positive charges are the type possessed by protons.

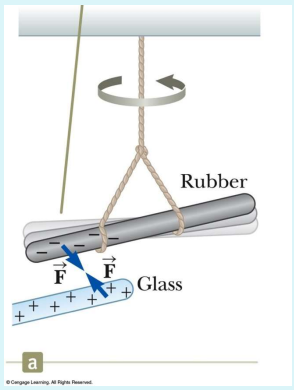
$$p = +1.6 \times 10^{-19}\ C$$

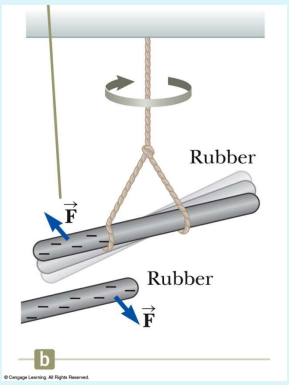
4

Electric Charges

Charges with opposite signs attract one another.

Charges of the same sign repel one another.

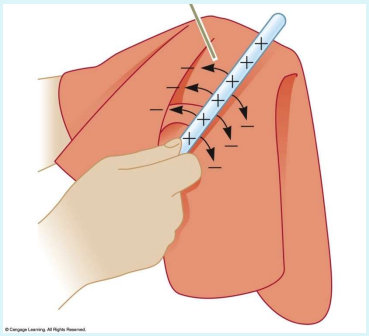




5

Conservation of charge

- **Neutral objects**: there are equal numbers of negative charges and positive charges, and so the net charge is zero.
- During a charging process, **charge isn't created**, but it is transferred from one object to another; electrons are transferred from the glass to the silk.
  - Object that **gained** negative charge becomes negatively charged.
  - Object that **lost** negative charge becomes positively charged.



6

Quantization of Electric Charges

7

- The electric charge is said to be quantized.
  - Charge on any object is a **multiple of the fundamental charge**.

$$q = \pm ne$$

  - q is the standard symbol used for charge as a variable.
  - n is an integer = 1, 2, 3, ….
  - e is the fundamental unit of charge

$$|e| = 1.6 \times 10^{-19} \text{ C}$$

7

Conductors

8

- Electrical conductors are materials in which some of the electrons are **free electrons**.
  - Free electrons are not bound to the atoms.
  - These electrons can move relatively freely through the material.
  - Examples of good conductors include copper, aluminum and silver.
  - When a good conductor is charged in a small region, the charge readily distributes itself over the entire surface of the material.

8

Insulators

9

- Electrical insulators are materials in which all of the **electrons are bound** to atoms.
  - These electrons can not move relatively freely through the material.
  - Examples of good insulators include glass, rubber and wood.
  - When a good insulator is charged in a small region, the charge is unable to move to other regions of the material.

9

Semiconductors

10

- The electrical properties of semiconductors are somewhere between those of insulators and conductors.
- Examples of semiconductor materials include silicon and germanium.
  - Semiconductors made from these materials are commonly used in making electronic chips.

10

Charge is quantized

Friday, 29 January, 2021 19:53

Lecturer: Mustafa Al-Zyout, Philadelphia University, Jordan.

R. A. Serway and J. W. Jewett, Jr., *Physics for Scientists and Engineers*, 9th Ed., CENGAGE Learning, 2014.
J. Walker, D. Halliday and R. Resnick, *Fundamentals of Physics*, 10th ed., WILEY,2014.
H. D. Young and R. A. Freedman, *University Physics with Modern Physics*, 14th ed., PEARSON, 2016.
H. A. Radi and J. O. Rasmussen, *Principles of Physics For Scientists and Engineers*, 1st ed., SPRINGER, 2013.

How many electrons would have to be removed from a coin to leave it with a charge of $1 \times 10^{-7}\ C$?

Solution:

From the fundamental charge (e) and the total charge q on each coin, we can find the number of removed electrons n as follows:

$$Q = Ne$$

$$\Rightarrow +1 \times 10^{-7} = N \times 1.6 \times 10^{-19}$$

$$\Rightarrow N = 6.25 \times 10^{11}$$