# Static Electricity

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Static electricity refers to the imbalance of electric charge on the surface of an object. It occurs when electrons are transferred between objects through contact or friction, resulting in a buildup of static charge. This buildup can lead to various phenomena, such as sparks, shocks, and the attraction or repulsion of objects.

Material	Rubbed with	Charge acquired	Behavior
Polythene rod	Woolen cloth	Negative	attract each other
Perspex or cellulose acetate	Woolen cloth	Positive	attract each other
Ebonite	Fur	Negative	attract each other
Glass	Silk cloth	Positive	attract each other
Glass	Flannel cloth	Negative	

Electrostatic induction:
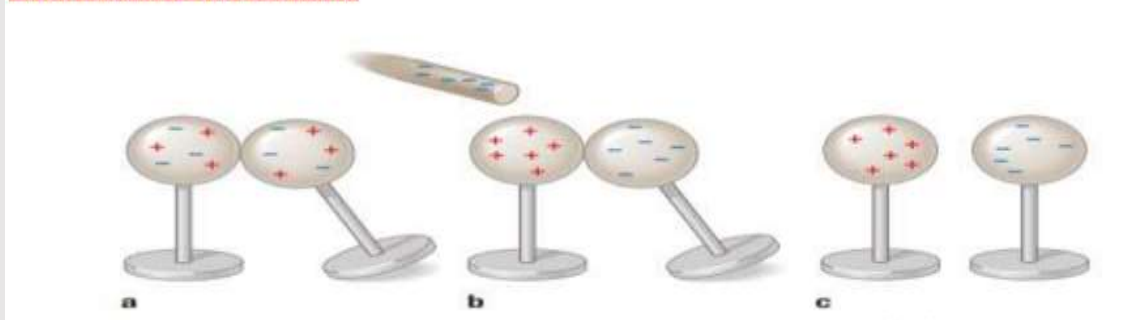
➤ Electrostatic induction happens when a charged object gets close to a neutral object. The charged object creates an electric field around it. This electric field affects the charges in the neutral object, causing them to redistribute. As a result, one side of the neutral object becomes more positive while the other side becomes more negative.

➤ This happens because the charges in the neutral object are attracted or repelled by the charged object's electric field. However, there is no physical contact between the two objects.

➤ Electrostatic induction is used in various practical applications. For example, it's the principle behind how some air purifiers work. They use charged plates to attract and collect particles from the air.

Some Uses of static electricity

1. Static electricity is used to paint cars.
2. It is used in computer printers to distribute toner or ink to go at the right place.
3. Static electricity is also used to remove pollution from smoke-chimneys.

Dangers of static electricity:

1. Lightning is static electricity due to charges in clouds, and it can damage buildings and harm people.
2. Static electricity can damage sensitive electrical components.
3. Static electricity can be responsible for the ignition of flammable gases.
4. Dusts and germs are attracted by charged.
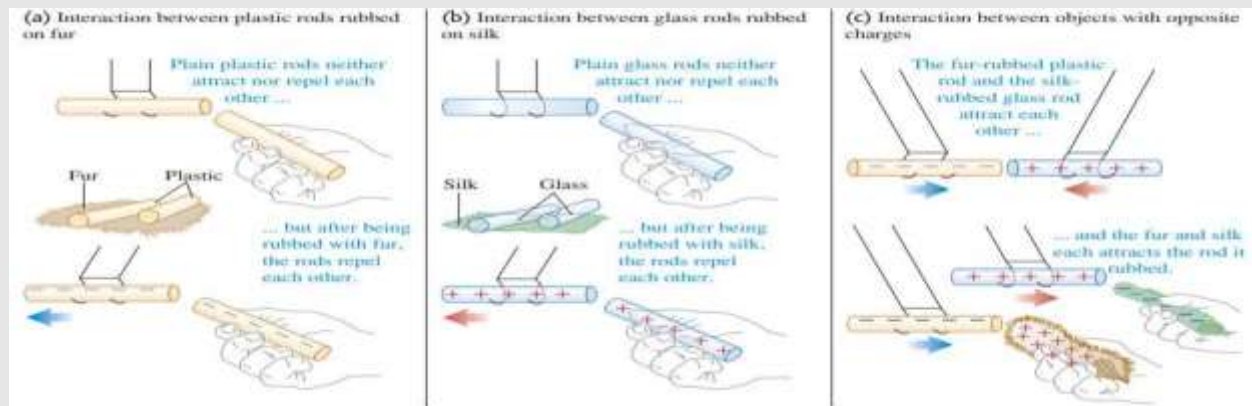
Coulomb's Law

Coulomb's Law describes the electrostatic interaction between charged objects. It states that the force between two charged objects is directly proportional to the product of their charges and inversely proportional to the square of the distance between them. Coulomb's Law provides a mathematical understanding of the strength and behavior of electric forces.

$$F = K \frac{q_1 \, q_2}{d^2}$$
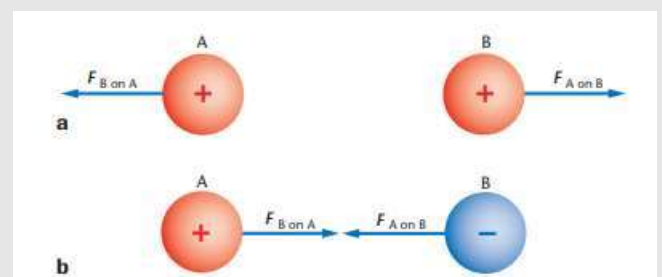
Repulsive and Attractive Forces

Repulsive and attractive forces are fundamental to the interaction between charged objects. Like charges repel each other, causing objects to push away from each other. On the other hand, opposite charges attract each other, resulting in objects being pulled towards each other. These forces play a crucial role in determining the behavior of charged particles and the stability of atomic and molecular structures.

(a) Interaction between plastic rods rubbed on fur
(b) Interaction between glass rods rubbed on silk
(c) Interaction between objects with opposite charges

Electric Field

An electric field is a region around a charged object or group of objects where electric forces can be felt. It is a vector field that describes the strength and direction of the electric force experienced by a charged particle placed in the field. Electric fields are created by charged objects and can be used to explain the behavior of charged particles and the transmission of electric forces through space.

Electric field intensity = Force/Charge

$$E = \frac{F}{q} = \frac{K\,q}{d^2}$$
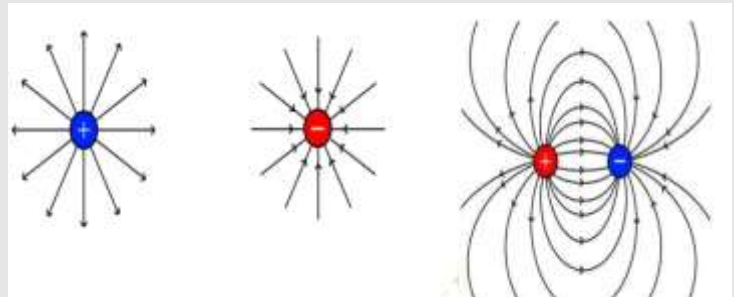
MCQ Questions:

1. **What is static electricity?**
   a) The flow of electric current
   b) The buildup of electric charge on an object
   c) The generation of magnetic fields
   d) The conversion of mechanical energy to electrical energy

2. **Which subatomic particle is responsible for carrying electric charge?**
   a) Proton
   b) Neutron
   c) Electron
   d) Photon

3. **True or False: Like charges attract each other, while opposite charges repel each other.**

4. **What is the unit of electric charge?**
   a) Volt
   b) Ampere
   c) Coulomb
   d) Ohm

5. **What happens when two objects with different electric charges come into contact with each other?**
   a) The charges are destroyed
   b) The charges are transferred from one object to another
   c) The charges cancel each other out
   d) The charges remain on their respective objects

6. **What is an insulator?**
   a) A material that easily conducts electricity
   b) A material that prevents the flow of electric charge
   c) A device that stores electric energy
   d) A device that measures electric current

7. **True or False: Lightning is an example of static electricity.**

8. How does static electricity affect the behavior of objects?
   a) It increases their mass
   b) It changes their color
   c) It causes them to repel each other
   d) It can make them attract or repel other charged objects

9. What is the process of removing excess charge from an object called?
   a) Charging
   b) Neutralization
   c) Discharge
   d) Conduction

10. What is the purpose of a grounding wire in electrical systems?
    a) To increase the flow of electric current
    b) To prevent electric shocks
    c) To generate static electricity
    d) To store electrical energy

11. When two neutral objects are rubbed together, what happens to their charges?

a) The charges on both objects become negative.
b) The charges on both objects become positive.
c) One object becomes positively charged, and the other becomes negatively charged.
d) The charges on both objects remain neutral.

12. What is the process called when charges move from one object to another without direct contact?
    a) Conduction
    b) Induction
    c) Charging
    d) Discharging

13. True or False: The movement of electrons is necessary for the transfer of static electricity.

14. Which of the following materials is an example of a good conductor of electricity?
    a. Rubber
    b. Glass

    c. Copper

    d. Plastic

15. **What is the purpose of an antistatic wrist strap?**
   - e) To protect against electric shocks
   - f) To generate static electricity
   - g) To measure electric charge
   - h) To increase electrical resistance

16. **True or False: The buildup of static electricity is a result of an imbalance of electric charges on an object.**

The answers as follows:

1. b

2. c

3. False

4. c

5. b

6. b

7. True

8. d

9. c

10. b

11. c

12. b

13. True

14. c

15. a

16 True

Solved problems

Two charges are separated by 3 cm. Object A has a charge of +6 µC, while object B has a charge of -3µ C. What is the force on object A?

The solution

$$F_{B\ on\ A} = K\frac{q_A q_B}{d_{AB}^2}$$

$$F_{B\ on\ A} = (9 \times 10^9 \quad N{\cdot}m^2/C^2)\frac{(6.0\ \mu C)(3.0\ \mu C)}{(3.0 \times 10^{-2}\ m)^2}$$

$$\boldsymbol{F_{B\ on\ A}} = 1.8 \times 10^2\ N,$$

What must be the distance between point charge $q_1 = 26\ \mu C$ and point charge $q_2 = -47\ \mu C$ for the electrostatic force between them to have a magnitude of 5.7 N?

$$F = K\frac{q_1\ q_2}{d^2}$$

$$5.7 = 9 \times 10^9 \times \frac{26 \times 10^{-6} \times 47 \times 10^{-6}}{d^2}$$

$$d^2 = 1.93\ m^2$$

$$d = 1.39\ m$$

Solved problem

A force of 2 N is acting on the charge 4 µ C at any point. Calculate the electric field intensity at that point.

Solution:

$$E = \frac{F}{q}$$

$$E = \frac{2}{4 \times 10^{-6}} = 5 \times 10^5\ N/C$$

1.A negative charge of - 2.0 C and a positive charge of 3.0 C are separated by 80 m. What is the force between the two charges?

2. A negative charge of - 0.0005 C exerts an attractive force of 9.0 N on a second charge that is 10 m away. What is the magnitude of the second charge?

3. Two negative charges that are both - 3.0 C push each other apart with a force of 19.2 N. How far apart are the two charges?

4. A negative charge of - 4.0×10^{-5} C and a positive charge of 7.0×10^{-5} C are separated by 0.15 m. What is the force between the two charges?

5. A negative charge of - 8.0×10^{-6} C exerts an attractive force of 12 N on a second charge that is 0.050 m away. What is the magnitude of the second charge?

6. Two negative charges that are both - 5.0×10^{-5} C push each other apart with a force of 15 N. How far apart are the two charges?

With My Best Wishes

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