Physics Unit

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Contents

1 Static Electricity (pg. 465)

Atomic Structure and Electric Charge

- All matter is made up of **atoms**
- Atoms contain **protons** (+), **neutrons** (0), **electrons** (-)
- Atoms have no charge, while ions have positive charges (**cation**) or negative charges (**anion**)

Positive, Negative, and Neutral Objects

Everyday items are made up of millions of billions of atoms, so it is impossible to show all individual atoms and their charges. We use + and - signs to represent an equally large group of protons and neutrons respectively. *The overall charge of an object can be determined by comparing the number of + and - signs drawn on the object.*

The **transfer of electrons** between objects can both charge neutral objects and neutralize charged objects. Most of the objects we interact with on a daily basis are neutral.

Note: Only elecrons can transfer, not protons or neutrons.

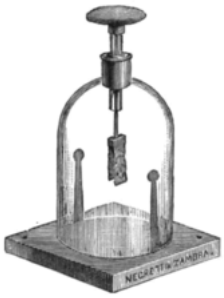
Static Electricity

Static electricity is an imbalance of electric charges on the surface of a material or between materials. This produces a **static chrage**, as the charges stay at rest on the surface of the object.

2 Detecting Static Charges and the Law of Electric Charges (pg. 467)

Detecting Static Electric Charges

Scientists use a device called an **electroscope** to detect the presence of electric charges.



A pith ball electroscope consists of a ball of bith (plant material) suspended from a strand by a thread. To test for the presence of an electrical charnge on an object, it is brought near the neutral bith ball. If the object is charged, the pith ball will be attracted to it.

The Law of Electric Charges

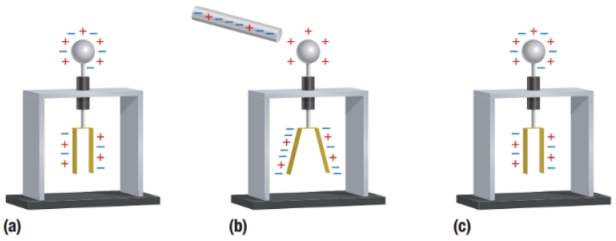
- A charged object exerts an electric force, which can be either an attractive force or a repulsive force
- Objects with **like charges repel each other**
- Objects with **opposite charges attract each other**
- The strength of the electric force increases with increasing electrical charges and decreases with increasing distance

Attraction of Neutral Objects to Charged Objects

- A neutral object has no charge (if two netural objects are brought near each other, nothing happens)
- According to the **Law of Electric Charges**, when a charged object is brought near a neutral object, it induces the electrons *to shift in position*, which is called **induced charge separation**
- No electrons are gained or lost in this process; the electrons return to their original positions once the charged object is moved away from the neutral object

Using a Metal Leaf Electroscope to Detect Electric Charge

A **metal leaf electroscope** is more sensitive to electric charge than a pith ball electroscope. It consists of a vertical rod with two thin pieces of metal foil called "the leaves". The object is brought near the metal terminal attached to the top of the rod to test for a charge. If the object is charged, electrons are transferred to (or from) the leaves of the electroscope, which charges the leaves, causing them to repel each other.



Using Static Charges

- Properties of static charges are useful in a brach of science called **electrostatics**, which deals with static charges and static electricity
- **Electrostatic paint sprayers** are used by many industries to reduce the amount of wasted paint and more efficiently paint objects. The paint is given a charge as it leaves the nozzle of the sprayer, and the object to be painted is given the opposite charge. When sprayed, the charged paint particles are attracted to the object, minimizing the amount of wasted paint.

3 Charging by Contact (pg. 273)

Over 2500 years ago, the Greeks discovered that amber attracted objects, such as feather and straw, after it came in contact with fur.

Two common methods of charging by contact are **charging by friction** and **charging by conduction**.

Charging Objects by Friction

Occurs when two different neutral materials are rubbed together or come in contact.

One object is more likely to become negatively charged while the other is more likely to become positively charged (some atoms are more strongly attracted to electrons than others).

Objects become charged more easily in the winter than in the summer since the air is more humid in the summer (water molecules in the water vapor collide with nearby objects, tranferring the electrons from the charged object to the water molecules, thus causing the object to lose its charge).

The Electrostatic Series

This is a list of materials in order of increasing tendency to gain electrons. The lower the material is in the list, the greater the tendency to gain electrons. This is used to predict the charge that will be gained by two objects or materials that are rubbed together; the one higher on the list will lose electrons and become positively charged while the one lower on the list will gain electrons and become negatively charged.

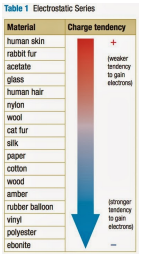


Table 1 Electrostatic Series

Material	Charge tendency
human skin	+ (weaker tendency to gain electrons)
rabbit fur	
acetate	
glass	
human hair	
nylon	
wool	
cat fur	
silk	
paper	
cotton	
wood	
amber	
rubber balloon	
vinyl	
polyester	
ebonite	− (stronger tendency to gain electrons)

Charging Objects by Conduction

Occurs when two objects with different amounts of electric charge come in contact and electrons move from one object to the other. The objects are either both charged or one is charged and one is neutral, as long as they have different charges.

Electrons move from the object with a larger negative charge to the object with a smaller negative charge so that both objects will have an equal charge;

essentially, the charges are averaged.

Example

If a piece of metal has a charge of +3 and other peice of metal has a charge of + 1, they will both end up with a charge of + 2 after coming in contact.

The charge is NOT neutralized, rather, both objects have the same type and amount of charge.

Grounding

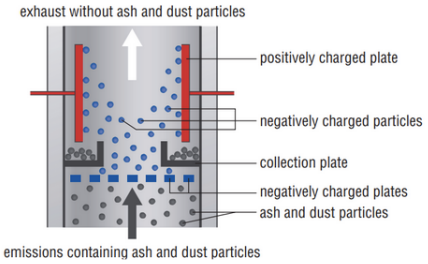
A process which involves removing an object's excess charge by transferring **electrons between the object and a large neutral object** such as Earth (the ground).

Any object that serves as a seemingly infinite reserrvoir of electrons can be used as a "ground" for electric charges; Earth effectively neutralizes any excess charge since it spreads out over a huge area.

When grounded, electrons travel from the ground to the object if it is positively charrged, and vice versa if it is negatively charged.

Putting Charged Objects to Work

- **Electrostatic dusters** depend on charging by friction to operate. Charge builds up as the duster is swept across an object, causing the dust to become attracted to the duster and move off of the dusty surface to the duster.
- Ostrich feathers have a natural tendency to become charged when rubbed
- **Electrostatic precipitators** are used in large power plants, manufacturing plants, and incinerators to remove particles from the air. The particles in the smoke become negatively charged by conduction as the smoke passes through the negatively charged plates. The particles then stick to positively charged plates as they pass through them and fall onto the collection plate, allowing them to be removed.



4 Conductors and Insulators (pg. 480)

Conductors are materials that allow the movement of electrons.
Insulators are materials that prevent the movement of electrons.

Conductors

- **Good conductors** allow electrons to move through them with easy
- **Fair conductors** allow electrons to move through them with a small amount of difficulty
- Graphite and silicon are **semiconductors** because they allow electrons to move through them, although not as easily as in a good conductor
- It is not possible to place a charge on a conductor if it is in your hand since it would immediately pass through the conductor into your hand
- Water is generarlly conductive and should therefore not be near electrical appliances when you are handling them, as you are at risk of injury from the movement of large amount of electric charge through your body
- Pure water, which has no ions, is not conductive

5 **Charging by Induction (pg. 286)**

6 **Electric Circuits (pg. 509)**

7 **Forms of Current Electricity (pg. 515, 551)**

8 **Electric Current and Potential Difference (pg. 556)**

9 **Ohm's Law (pg. 568)**

10 **Current and Voltage in Series and Parallel Circuits (pg. 571)**

11 **Electrical Power and Efficiency (pg. 530)**

12 **Power and Efficiency**

13 **Generating Current Electricity (pg. 518)**