# physics 222 lecture 1 notes

mguiney

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# 1 Electric Charge

## 1.1 Properties of electric charge

- Electric charge is a coherent physical property of certain subatomic particles that is responsible for electrical and magnetic properties
- Subatomic particles can be charged or uncharged

### 1.1.1 Particle charge examples

**Positively Charged Particles:**

- proton
- atomic nuclei
- positrons

**Negatively Charged Particles:**

- electron
- muons

**Particles without charge:**

- neutrons

## 1.2 Fundamental Unit of electric charge

The fundamental unit of electrical charge is the Colomb.
**charge of an electron:** e = 1.6 * $10^{-19}$

# 2 Conductors, insulators, and charge

**Conductors:** Electrons move freely through the medium. More likely to transfer electrons to other objects.

**Insulators:** Electrons do not move freely through the medium. Less likely to transfer electrons to other objects.

## 2.1 Charging by Direct contact

One way to charge an object is two rub two objects made of materials with different conductivity. The more conductive object will transfer electrons to the more conductive one, thus changing the object's total charge. The drier the climate, the more likely the charge is to transfer.

### 2.1.1 Charge Polarization

No charges are being transferred, but the charged particles are repelled by/attracted to one another within the object(s) themselves.

### 2.1.2 Charge simulator

For an example of charging by direct contact in action, check out:
https://phet.colorado.edu/en/simulation/balloons

## 2.2 Charging by induction

When we charge an object by induction, we transfer charged particles between two objects with different charge *without ever touching them together*.

## 2.3 Coulomb's Law

The force on a charge due to another charge is proportional to the product of the charge in each, divided by the square of the distance between them.

### 2.3.1 Definition

$$F \propto \frac{q_1 q_2}{r^2}$$

Where:

- F = the force on the charge
- $q_1$ and $q_2$ = the charges on objects the two objects
- r = the distance between the two objects

**NOTE:** don't forget that we are not setting these equal, we are stating that they are *proportional* to one another.

### 2.3.2 Practical Equation

In order to apply coulomb's law as an equation, we need to use the constant $k$, which is columb's constant.

**Coulomb's constant:** = 8.987551 * $10^9$ $N * m^2/C^2$ (or m/F)

$$F = \frac{q_1 q_2}{r^2}$$

### 2.3.3 Vector form of Columb's law

$$F_{1,2} = \frac{q_1 q_2}{4\pi\epsilon_0} * \frac{r_1 - r_2}{|r_1 - r_2|^3}$$

### 2.3.4 Superposition

If there are more than two charges present, the total force on any given charge in the group is just the vector sum of the forces created by each of the vector charges.