# 1 | Electrostatics

## 1.1 | Conduction vs Insulation

- Charge can flow through or over the surface of conductors:
  - Metals, graphite, plasma
- Insulators do not allow charge to flow along or through them.

## 1.2 | Transferred and Induced Charges

- Charge can jump from a charged object to an uncharged object, sometimes through insulators depending on voltage.
- A charged object can induce a temporary charge **migration** in an uncharged object, but the entire object is still neutral.

## 1.3 | Coulomb's Law

$F\vec{F} = \frac{1}{4\pi\epsilon_0}\left(\frac{q_1 q_2}{r^2}\right) = k\frac{q_1 q_2}{r^2}$

$k = 8.99_{x10^5}\frac{Nm^2}{C^2}$

| Variable | Units | Description |
|---|---|---|
| $q_1$, $q_2$ | Coulomb ($C$) | The charge of each particle |
| $r$ | Meters ($m$) | Distance between centers of charges |

$\epsilon_0$ and $k$ are different ways of representing the constant.

### 1.3.1 | Signs

**Be very careful with signs:**

If $\vec{F} < 0$, charges repel each other.

If $\vec{F} > 0$, charges attract each other.

### 1.3.2 | Multiple Charges

You have to calculate each pairwise charge, and then add them up for each particle. This is normal (vector) addition, so you can actually add them (to get a vector field) and then apply it to a test particle directly.

### 1.3.3 | Fields

$F_{elec} = k\frac{Q_1 Q_2}{R^2}$

$F_{grav} = G\frac{M_1 M_2}{R^2}$

$F_{elec} =$ **EQ$_1$**

You can add fields together component-wise to get a combined field from multiple charged particles.

---