

Source: [\[KB20200824163718\]](#)

## 1 | Electrostatics

### 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.

### 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.

### Coulomb's Law

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

$$k = 8.99 \times 10^5 \frac{Nm^2}{C^2}$$

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.

### Signs

**Be very careful with signs:**

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

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

### 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.

### Fields

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

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

$$F_{elec} = \mathbf{E} Q_1$$

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

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