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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

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

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

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

ϵ_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

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

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

$F_{elec} = \mathbf{EQ_1}$

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