Electric Charge (Q or q)

- Conservation of Charge: Net charge cannot be created or destroyed
- SI Unit of charge: Coulomb (C)
  - 1 C is a HUGE charge; usually have μC or nC
- Charge quantum: $e = 1.602 \times 10^{-19}$ C
  - Proton charge = e
  - Electron charge = -e
- Can transfer electrons from one material to another by rubbing, etc., to get net charge
- Electrons can move through materials
  - Conductors: Some electrons move easily
  - Insulator: Limited or no electron motion

Electric Force - Coulomb's Law

- Charge creates electric field; second charge placed in field feels electric force

$\Rightarrow$Charges exert electric force on each other

  - Charges of opposite sign attract each other
  - Charles of like sign repel each other

- Strength of force depends on amount of each charge and the distance between them
- Force exerted ON point charge Q_2 BY point charge Q_2 given by **Coulomb's Law**:

Coulomb's Law

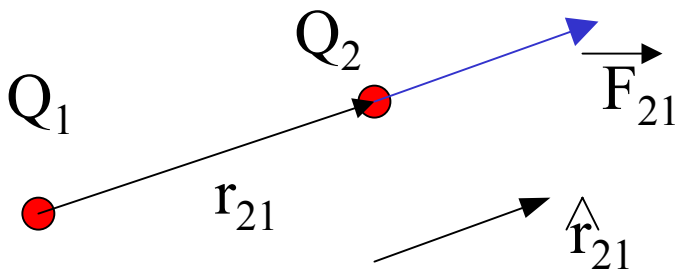
$$\vec{F}_{21} = k\frac{Q_1 Q_2}{r_{21}^2}\hat{r}_{21}$$

Force ON Q_2 FROM Q_1

Coulomb constant k =
$8.99 \times 10^9\ N \cdot m^2/C^2$

$\approx 9 \times 10^9\ N \cdot m^2/C^2$

Unit vector along direction toward Q_2 from Q_1



Coulomb's Law Notes

- Constant k can be written as $k = \frac{1}{4\pi\varepsilon_0}$
  - $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/(N \cdot m^2)$
  - "Permittivity of vacuum"
- Note that if Q_1 & Q_2 have same sign, <u>direction</u> of $\vec{F}_{21}$ is same as $\hat{r}_{21}$: repulsive force
  - If Q_1 & Q_2 have opposite signs, <u>direction</u> of $\vec{F}_{21}$ is opposite to $\hat{r}_{21}$: attractive force

Example

- What force does $Q_1 = -20\ \mu C$ at the origin exert on $Q_2 = 1\ \mu C$ at position $\vec{r}_2 = 2m\,\hat{i} + 2m\,\hat{j}$?