Electricity and Magnetism

- Physics 259 – L02
- Lecture 5

Section 21.1-3

Last time

- Charges and Force Between Charges
- Conductors and Insulators
- Van De Graaff Generator Experiment 
- Solve Class Activity Question
- Coulomb's Law

This time

- Examples for Coulomb's law

Coulomb's Law

$$\boxed{F_{1\,on\,2} = F_{2\,on\,1} = K\frac{|q_1||q_2|}{r^2}}$$

K = electrostatic constant

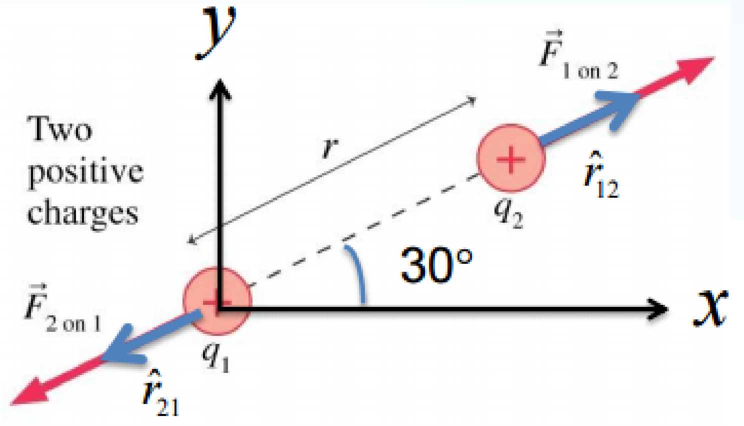
$$K = 8.99\times10^{9}\,\frac{N\cdot m^2}{C^2}$$

$$\boxed{F_{1\,on\,2} = F_{2\,on\,1} = \frac{1}{4\pi\varepsilon_0}\frac{|q_1||q_2|}{r^2}}$$

ε_0 = permittivity of free space

$$\varepsilon_0 = \frac{1}{4\pi K} = 8.85\times10^{12}\,\frac{C^2}{N\cdot m^2}$$

Example #1: Two point charges



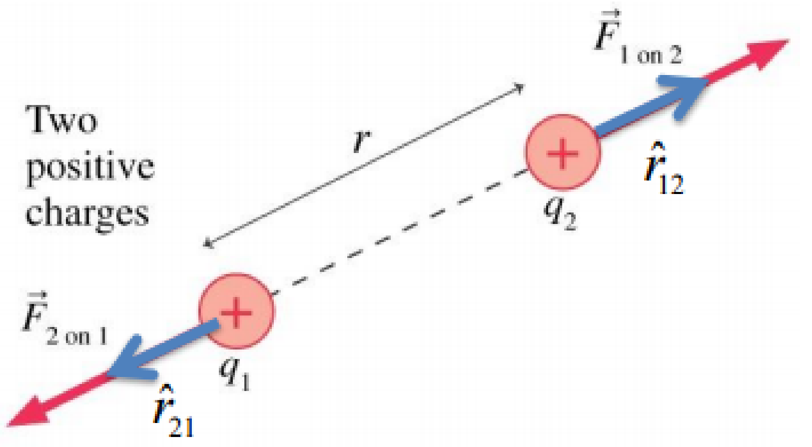
$$q_1 = +2\text{ C},\ q_2 = +5\text{ C},\ r = 10\text{ m}$$

$$\vec{F}_{1\ on\ 2} = k_e \frac{|q_1||q_2|}{r^2}\hat{r}_{12}$$

$$= \left(8.99\times10^9\ \text{Nm}^2/\text{C}^2\right)\frac{(2\text{C})(5\text{C})}{(10\text{ m})^2}\hat{r}_{12}$$

$$= \left(8.99\times10^8\,\text{N}\right)\hat{r}_{12}$$

$$= 8.99\times10^8\left(\cos 30\ \hat{i} + \sin 30\ \hat{j}\right)\text{N}$$



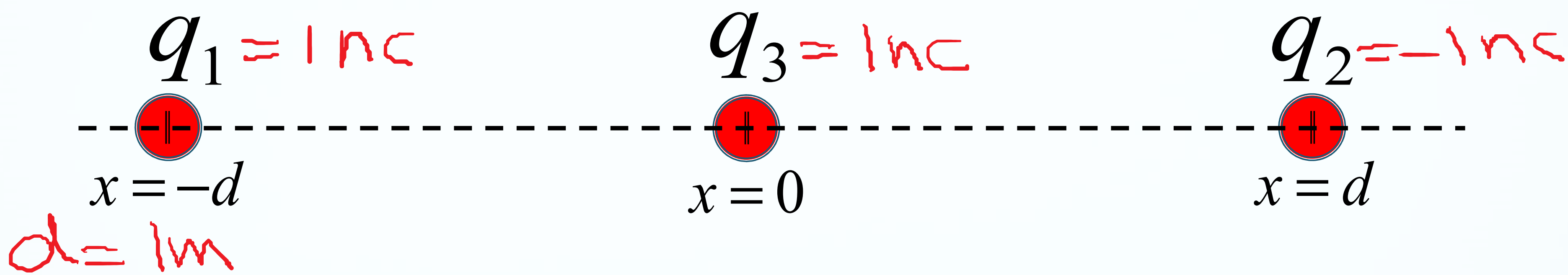
$$\vec{F}_{2\ on\ 1} = k_e \frac{|q_1||q_2|}{r^2}\hat{r}_{21}$$

$$= \left(8.99\times10^8\,\text{N}\right)\hat{r}_{21}$$

$$= 8.99\times10^8\left(-\cos 30\ \hat{i} - \sin 30\ \hat{j}\right)\text{N}$$

Force is fully defined.

Example #2 (last section's homework): Three point Charges



Total electric force on q_1?

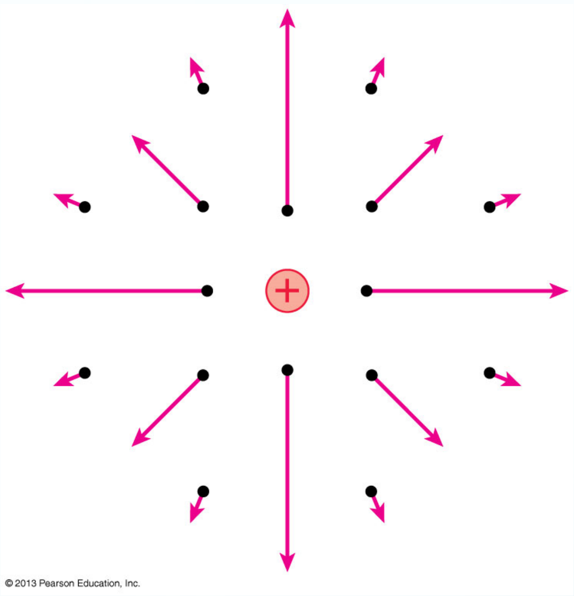
$$\left|\vec{F}_{31}\right| = 8.99 \times 10^{-9}\ \mathrm{N} \qquad \left|\vec{F}_{21}\right| = 2.25 \times 10^{-9}\ \mathrm{N} \qquad \boxed{\vec{F}_{net} = \left(-6.74 \times 10^{-9}\ \mathrm{N}\right)\hat{i}}$$

Example #3: Building blocks of electric force

$$\vec{F} = \frac{KQq}{r^2}\hat{r}$$

$\hat{r}$

$+Q$



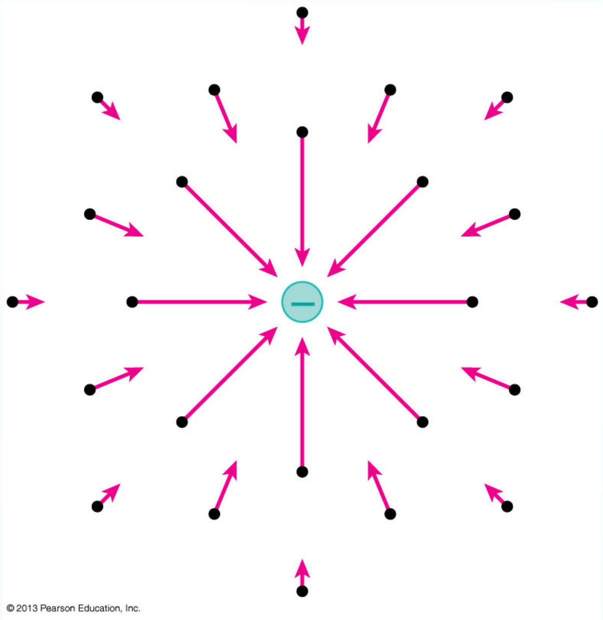
● = positive charge q at the position indicated

Example #3: Building blocks of electric force

$$\vec{F} = \frac{-KQq}{r^2}\hat{r}$$

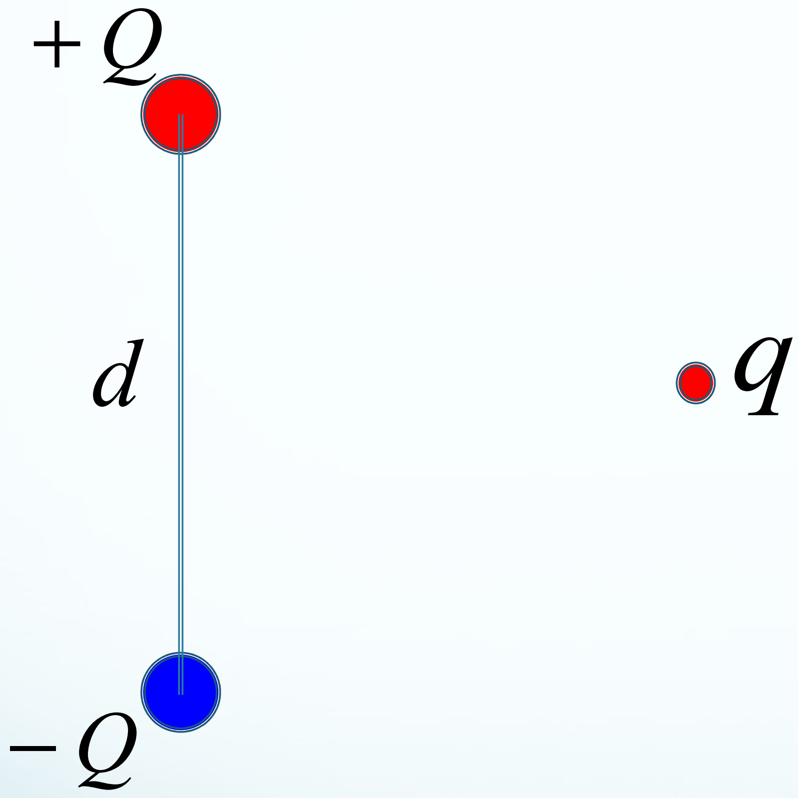
$\hat{r}$

$-Q$



● = positive charge *q* at the position indicated

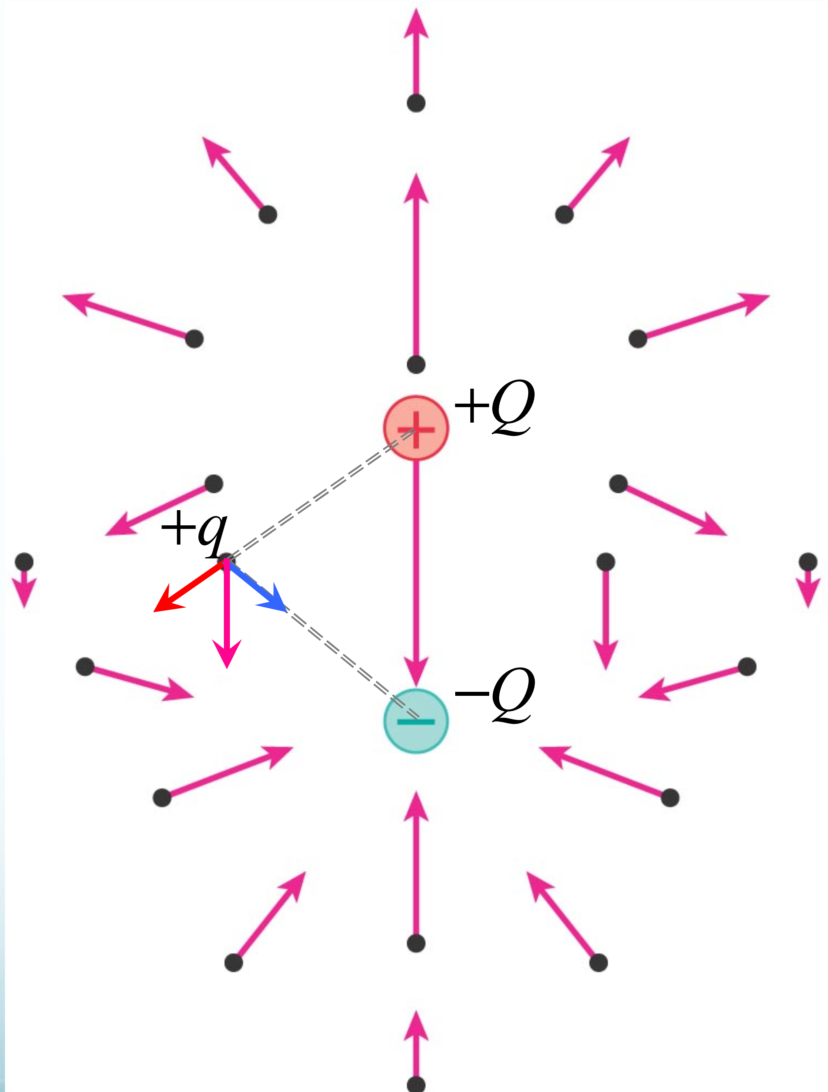
Example #4: Two point charges (Electric Dipole)



$$\left|\vec{F}_{net}\right| = 2\left(\frac{KqQ}{\left(x^2 + (d/2)^2\right)^{3/2}}\right)\sin\theta = \frac{KqQd}{\left(x^2 + (d/2)^2\right)^{3/2}}$$

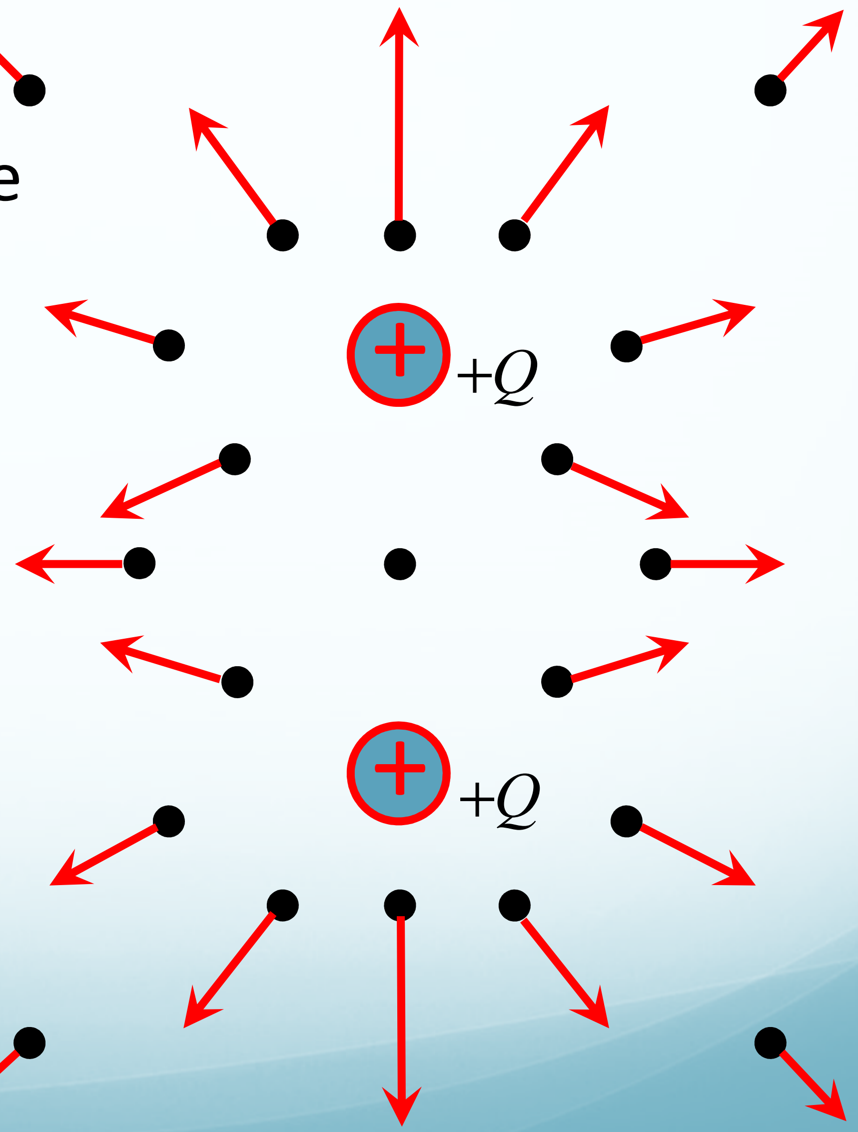
Superposition with Building Blocks

The vector represents the magnitude and direction of the electric force on the charge q **at that point**. It comes from superposition of the individual forces from +Q and –Q.



Superposition with Building Blocks

The vector represents the magnitude and direction of the electric force on the charge q **at that point**. It comes from superposition of the individual forces from +Q and +Q.



This section we talked about:

Chapter 21.1-3: Examples

See you on Wednesday