Electricity and Magnetism

- Physics 259 – L02
- Lecture 8

Sections 21.1-3

(please read chapter 21 of the textbook)

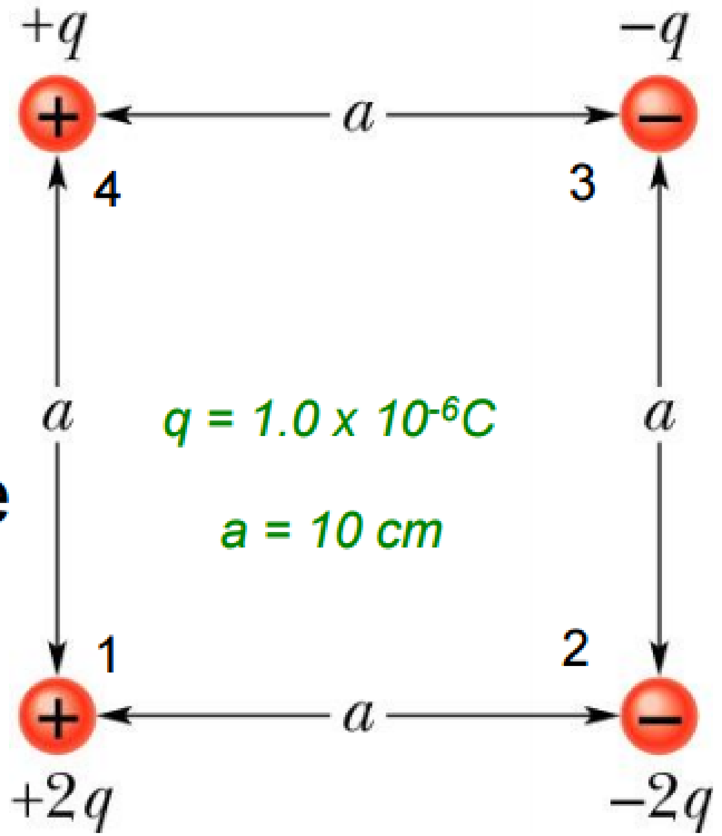
Last time

- Charges and Force Between Charges
- Conductors and Insulators
- Van De Graaff Generator Experiment 
- Solve Class Activity Question
- Coulomb's Law
- Examples for superposition principle 
- Electric Ping Pong Experiment

This time

- Examples for Coulomb's law
- Class Activity

Calculate the net force on particle 1.

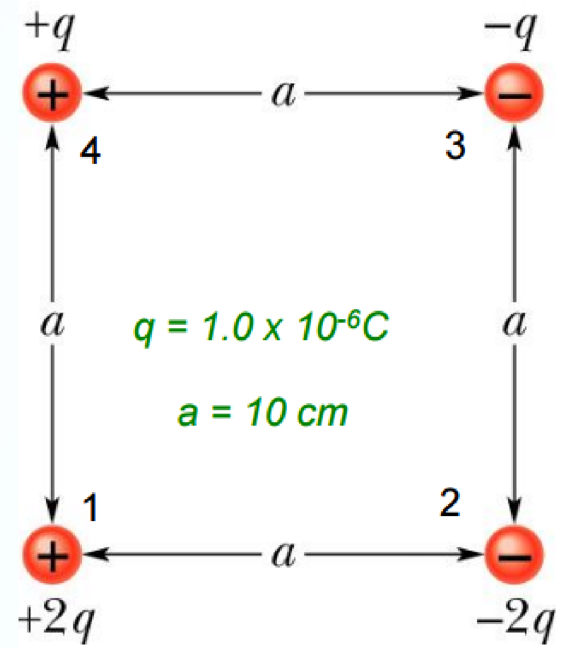


Use superposition principle

$$\vec{F}_{1,net} = \vec{F}_{2\ on\ 1} + \vec{F}_{3\ on\ 1} + \vec{F}_{4\ on\ 1}$$

$$\vec{F}_{3\ on\ 1} = k_e \frac{|q_1||q_3|}{r^2} \hat{r}_{31}$$

$$\begin{aligned}\vec{F}_{3\ on\ 1} &= k_e \frac{|q_1||q_3|}{r^2} \hat{r}_{31} \\ &= k_e \frac{(2q)(q)}{\left(\sqrt{2}a\right)^2} \hat{r}_{31} \\ &= k_e \frac{q^2}{a^2} \hat{r}_{31} = k_e \frac{q^2}{a^2}\left(\cos 45\ \hat{i} + \sin 45\ \hat{j}\right)\end{aligned}$$



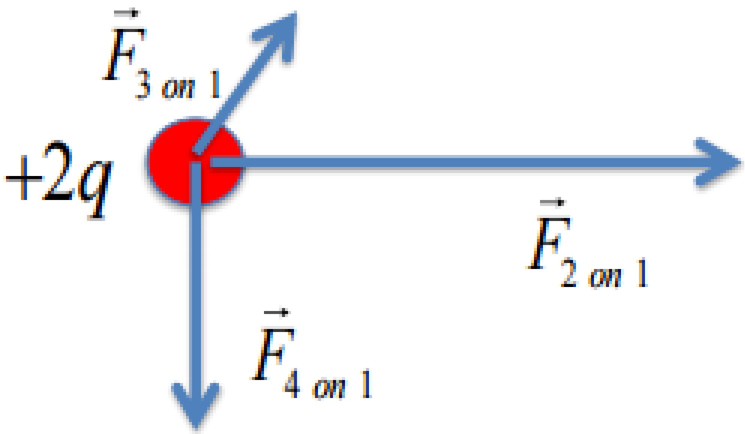
$$\vec{F}_{2\ on\ 1} = k_e \frac{|q_1||q_2|}{r^2} \hat{r}_{21}$$

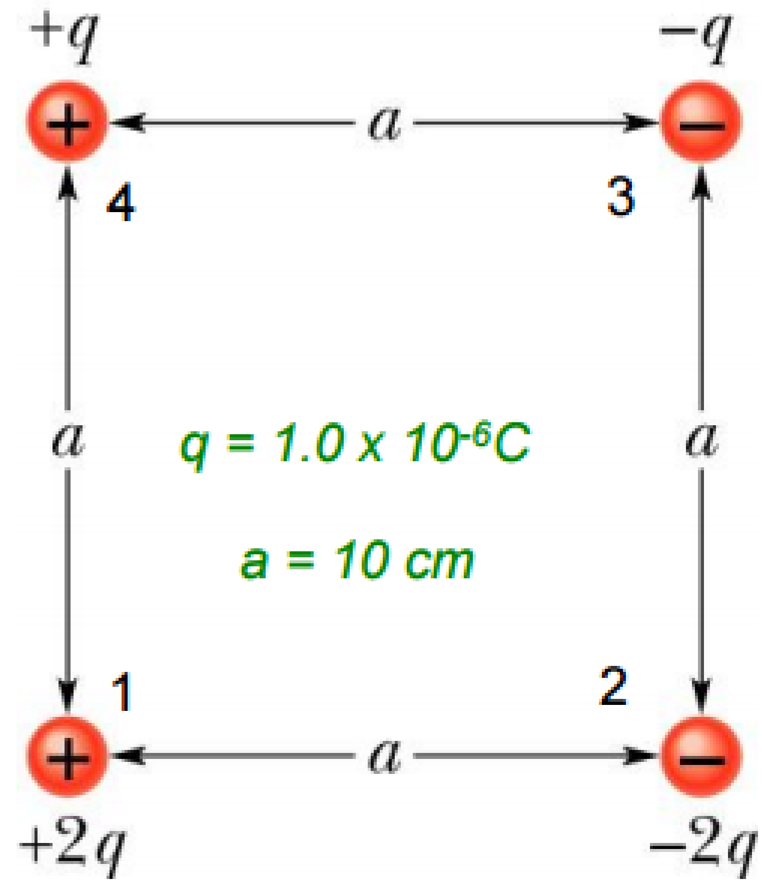
$$\begin{aligned}\vec{F}_{2\ on\ 1} &= k_e \frac{|q_1||q_2|}{r^2} \hat{r}_{21} \\ &= k_e \frac{(2q)(2q)}{a^2} \hat{i} \\ &= 4k_e \frac{q^2}{a^2} \hat{i}\end{aligned}$$

$$\vec{F}_{4\ on\ 1} = k_e \frac{|q_1||q_4|}{r^2} \hat{r}_{41}$$

$$\begin{aligned}\vec{F}_{4\ on\ 1} &= k_e \frac{|q_1||q_4|}{r^2} \hat{r}_{41} \\ &= k_e \frac{(2q)(q)}{a^2} \hat{r}_{41} \\ &= 2k_e \frac{q^2}{a^2} \hat{r}_{41} = -2k_e \frac{q^2}{a^2} \hat{j}\end{aligned}$$

Putting it all together.

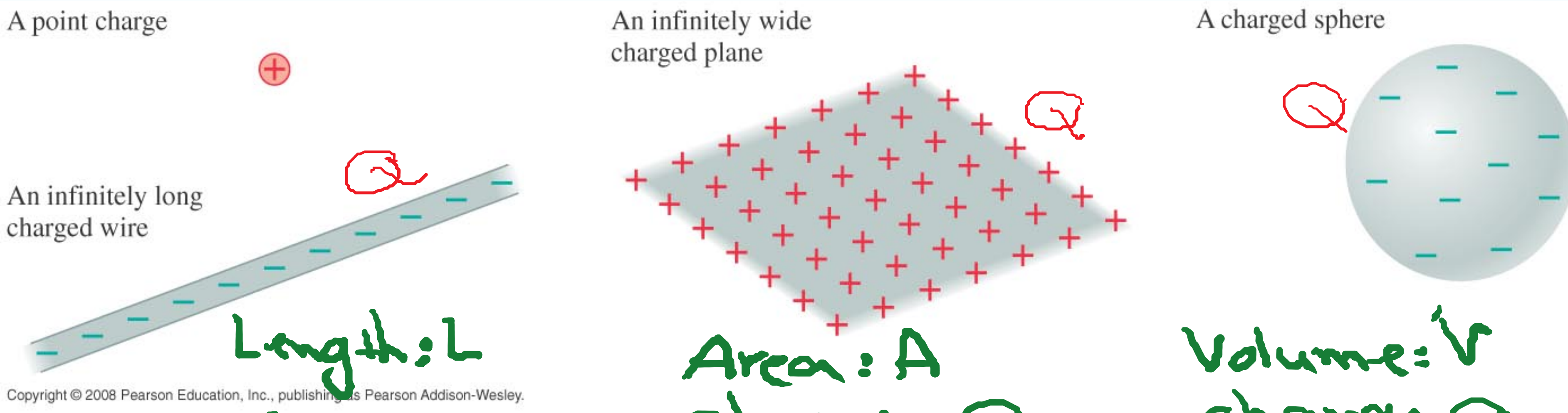




$$\vec{F}_{on\ 1} = 4k_e\frac{q^2}{a^2}\hat{i} + k_e\frac{q^2}{a^2}\left(\cos 45\ \hat{i} + \sin 45\ \hat{j}\right) - 2k_e\frac{q^2}{a^2}\hat{j}$$

$$= k_e\frac{q^2}{a^2}\left[(4+\cos 45)\ \hat{i} + (-2+\sin 45)\ \hat{j}\right]$$

4 basic geometries



Length: L
Charge: Q

Area: A
charge: Q

Volume: V
charge Q

- These geometries are basic because they're very symmetrical

Linear, surface and volume charge densities

$$\lambda = \frac{Q}{L}$$

linear charge density

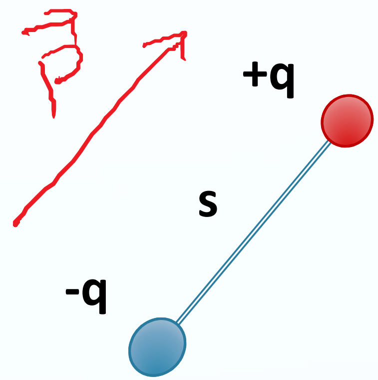
$$\sigma = \frac{Q}{A}$$

Surface charge density

$$\rho = \frac{Q}{V}$$

Volume charge density

Electric dipole moment



distance between charges

$$\vec{p} = (qs\text{, from the negative to positive charge})$$

charge of one of the charges

EM Force VS. Gravitational Force

This section we talked about:

Chapter 21.1-3

See you on Monday