Last time

- Vectors and vector addition
- Practice Group Activity

This time

- Reminder about how to use Coulomb's Law
- TopHat questions about Coulomb's Law
- Using the superposition principle

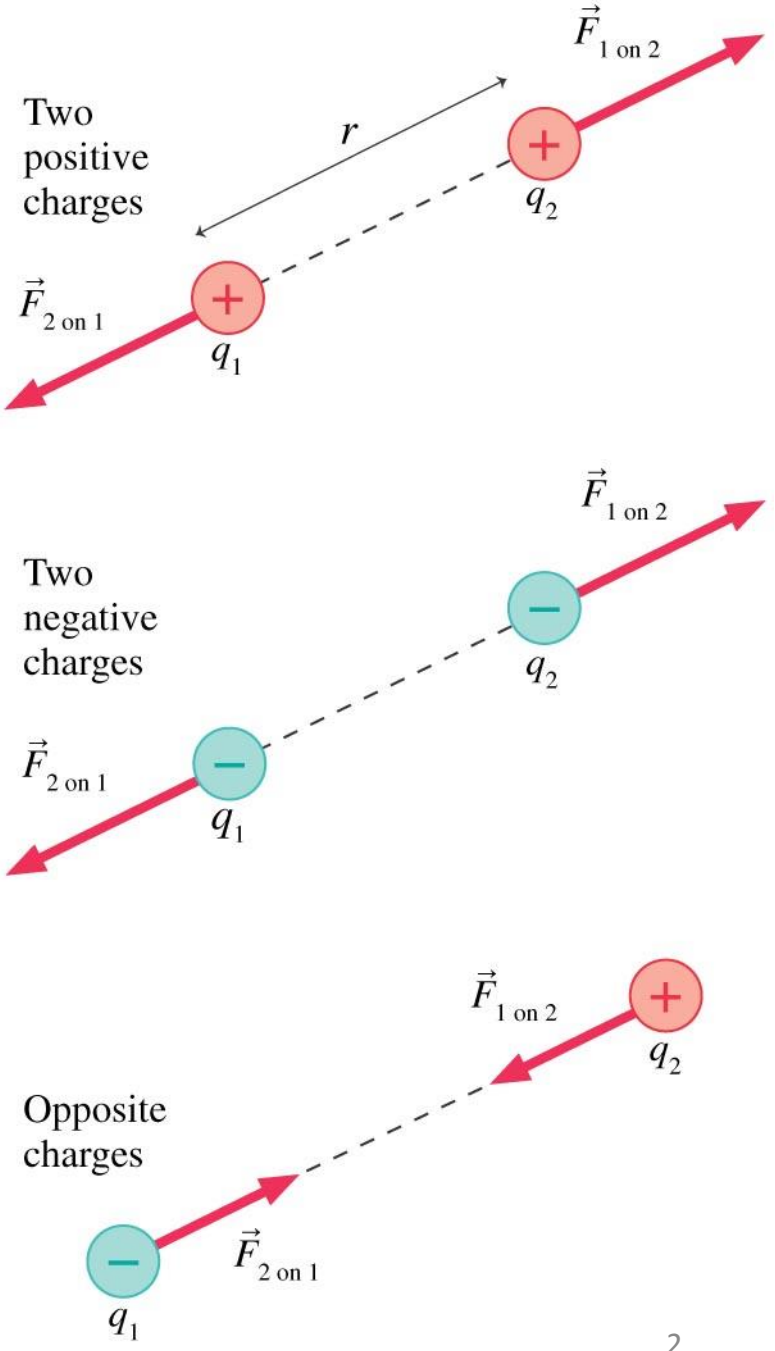
Coulomb's Law

There are only two kinds of charges:

positive and **negative**.

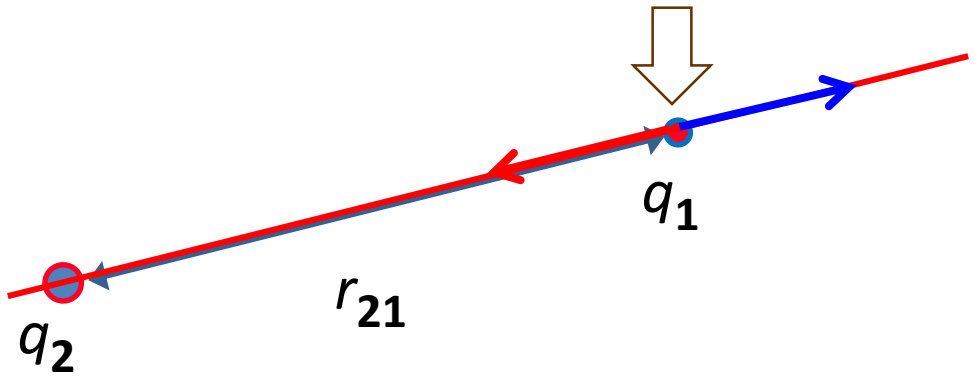
Charges of the **same** sign **repel** each other.

Charges of **opposite** sign **attract** each other.



Coulomb's Law

How to compute the magnitude and direction properly.



$$\left|\vec{F}_{21}\right| = K\frac{|q_1||q_2|}{r_{21}^2}$$

1) Find the distance between the charges.

2) Draw a line passing through the two charges.

3) The force on q_1 due to q_2 has its tail at location 1 and points either towards q_2 or away from q_2.

4) Pick the direction according to basic rule of charges:

Like charges repel, Opposite charges attract

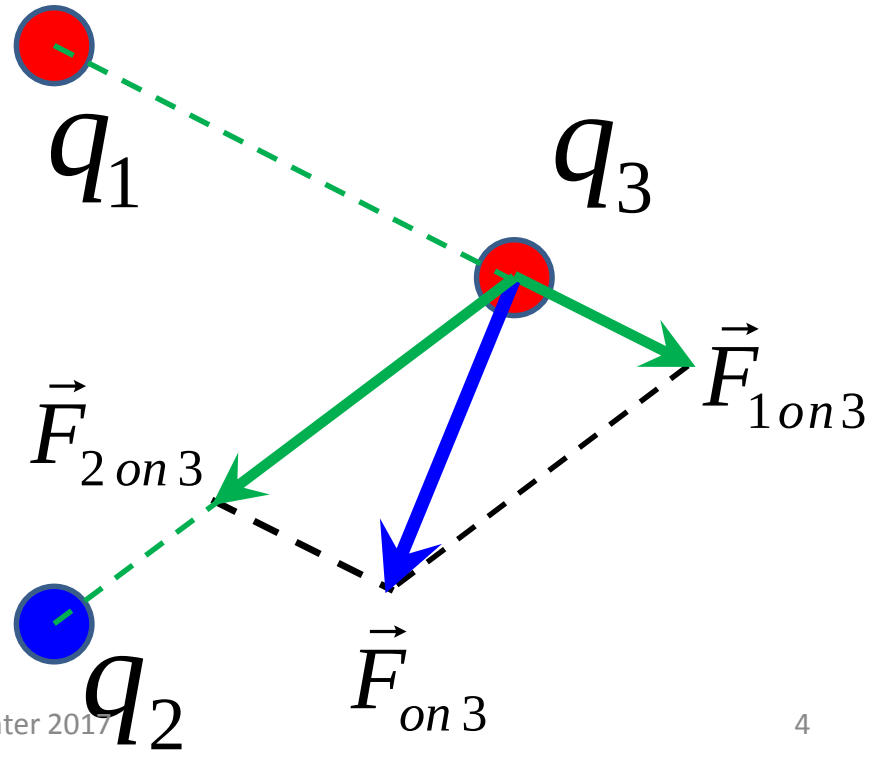
Superposition Principle

q_1 exerts a force $\vec{F}_{1\,on\,3}$ on q_3.

q_2 exerts a force $\vec{F}_{2\,on\,3}$ on q_3.

The total force on q_3 is the vector sum of the individual forces:

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

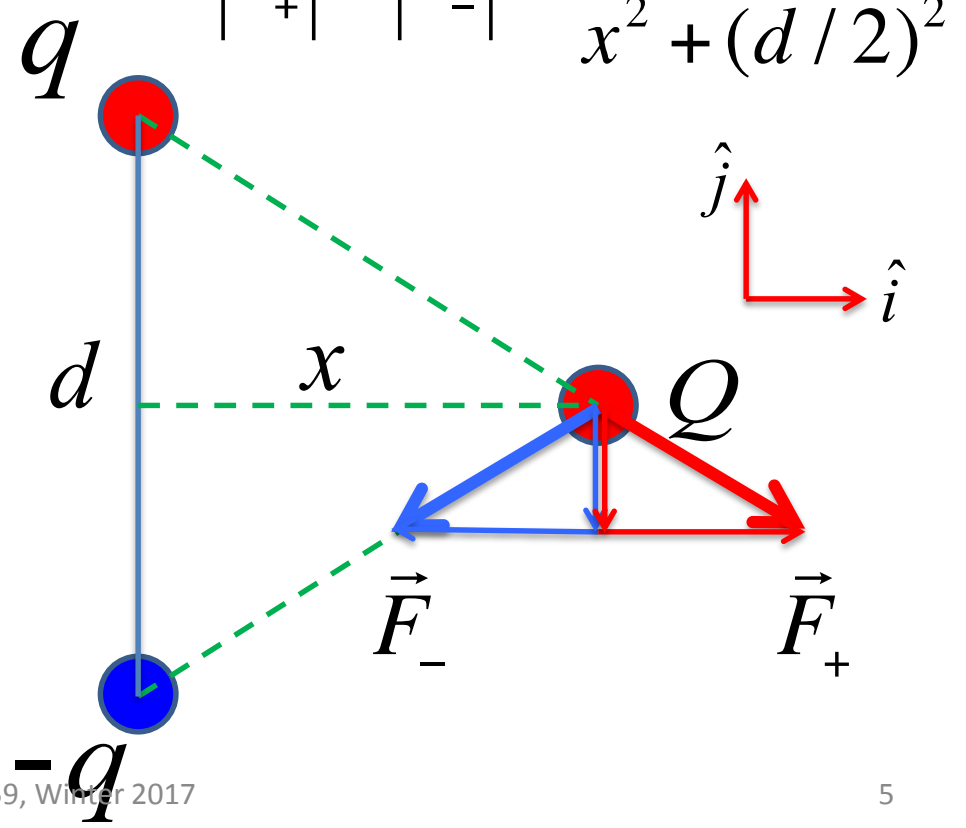


Example: force due to a dipole

A charge *Q* sits at a distance *x* on the axis perpendicular to the dipole. What is the force (magnitude and direction) it experiences?

$$\left|\vec{F}_+\right| = \left|\vec{F}_-\right| = \frac{KqQ}{x^2 + (d/2)^2}$$

FBD:



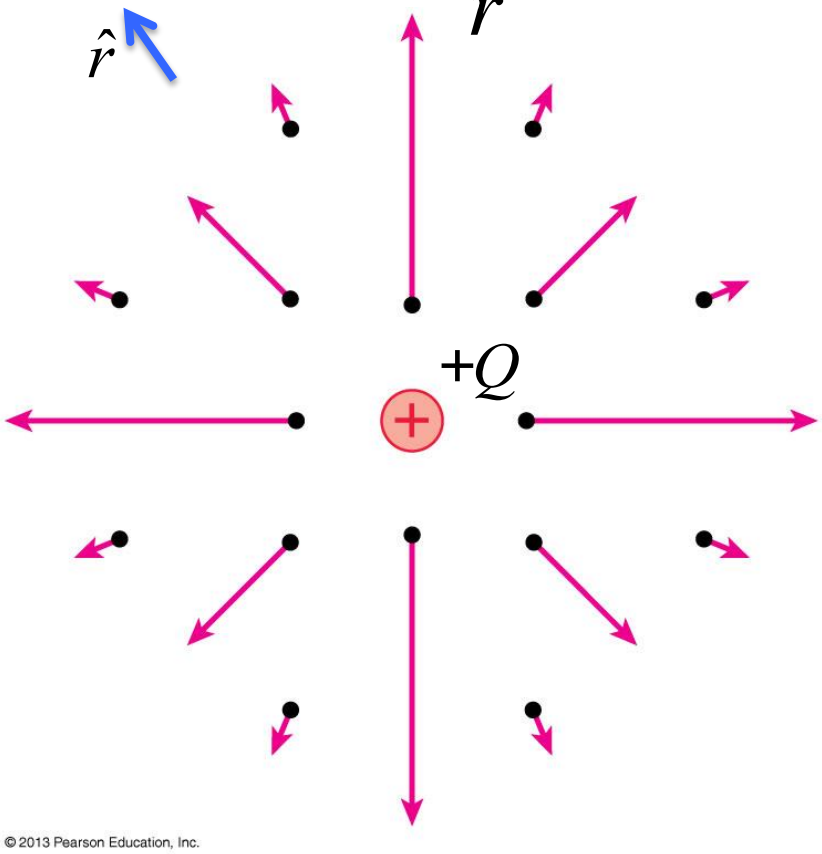
Horizontal components cancel.
Vertical components add.
SYMMETRY!

TopHat questions

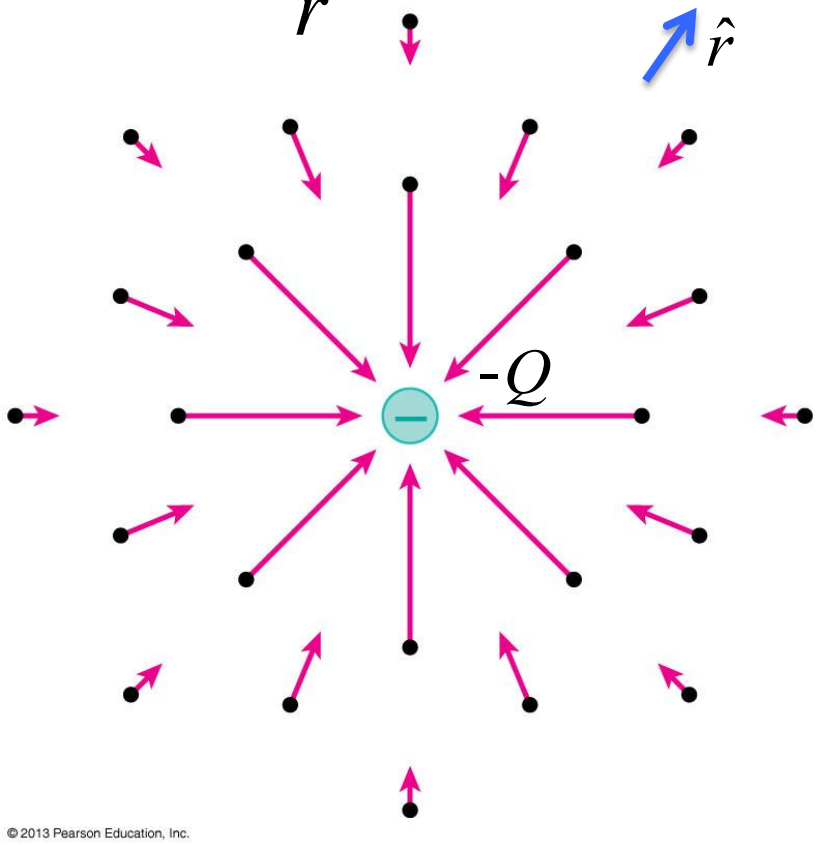
JOIN CODE: 131299

Building blocks of electric force

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



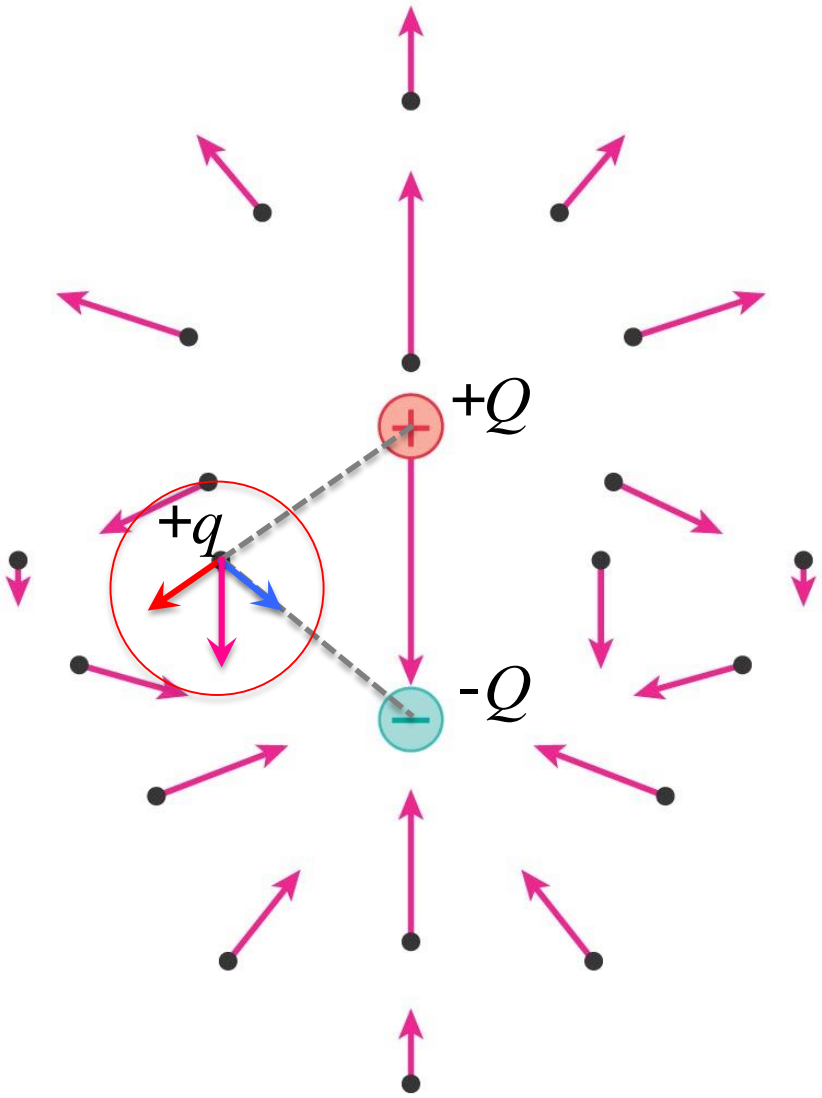
$$\vec{F} = \frac{-KQq}{r^2}\hat{r}$$



● = positive charge q at the position indicated

Superposition with Building Blocks

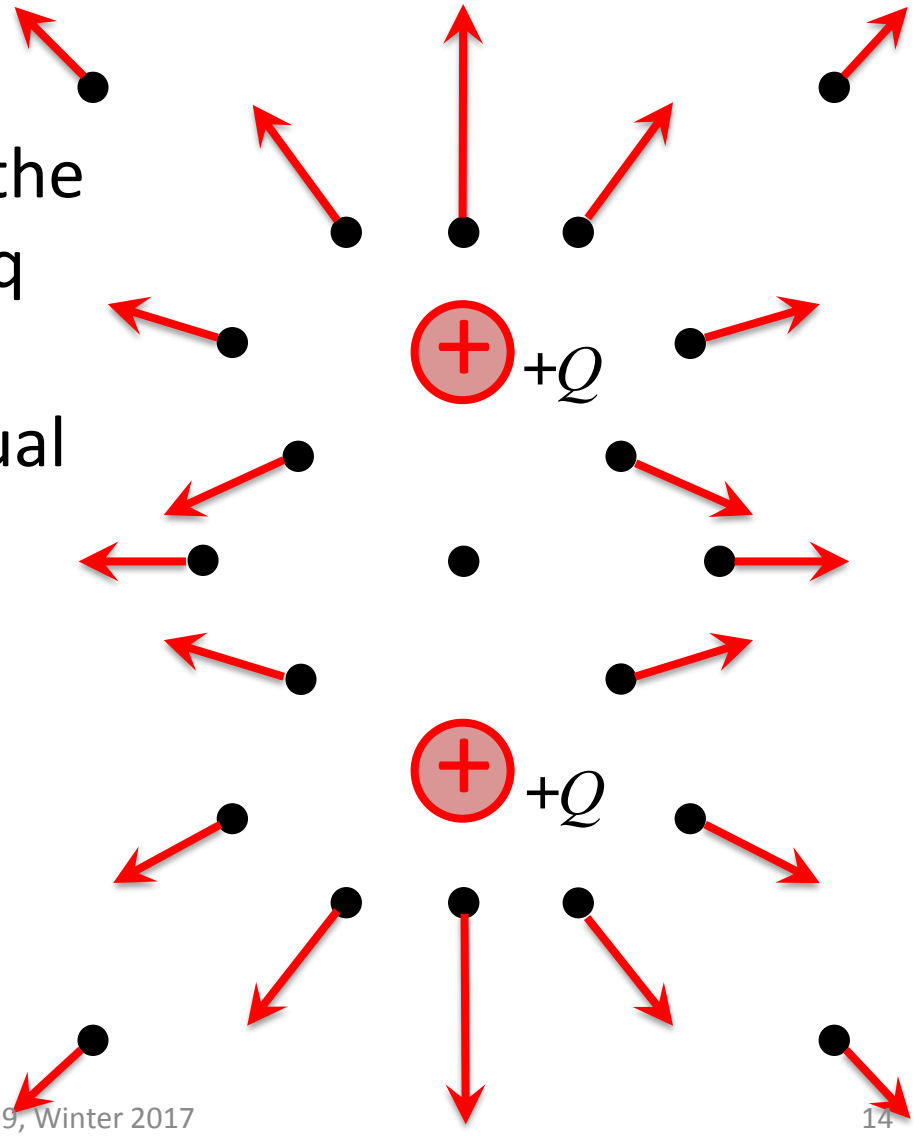
The vector represents the magnitude and direction of the electric force on the charge q **at that point**. It comes from superposition of the individual forces from +Q and –Q.



Step 1: draw the lines connecting the charge pairs
Step 2: draw the force vector for each charge pair
Step 3: sum all forces to find net force

Superposition with Building Blocks

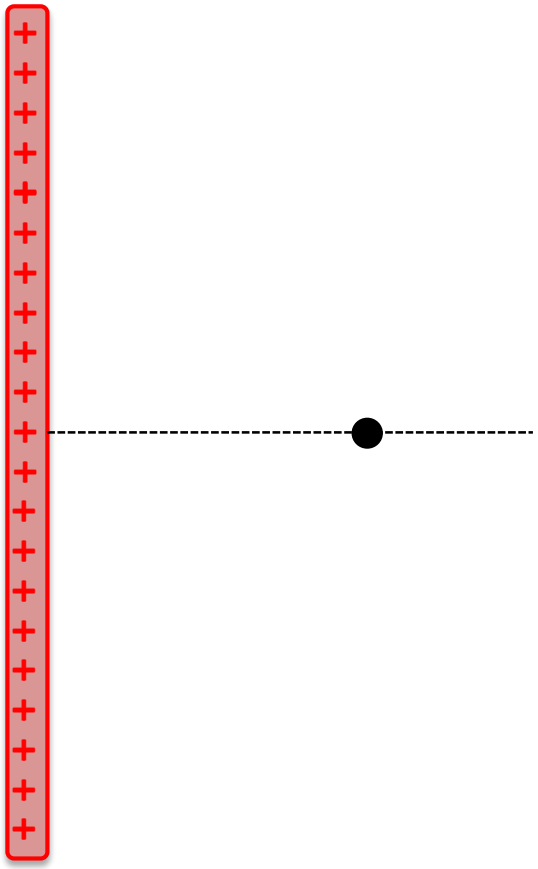
The vector represents the magnitude and direction of the electric force on the charge q **at that point**. It comes from superposition of the individual forces from +Q and +Q.



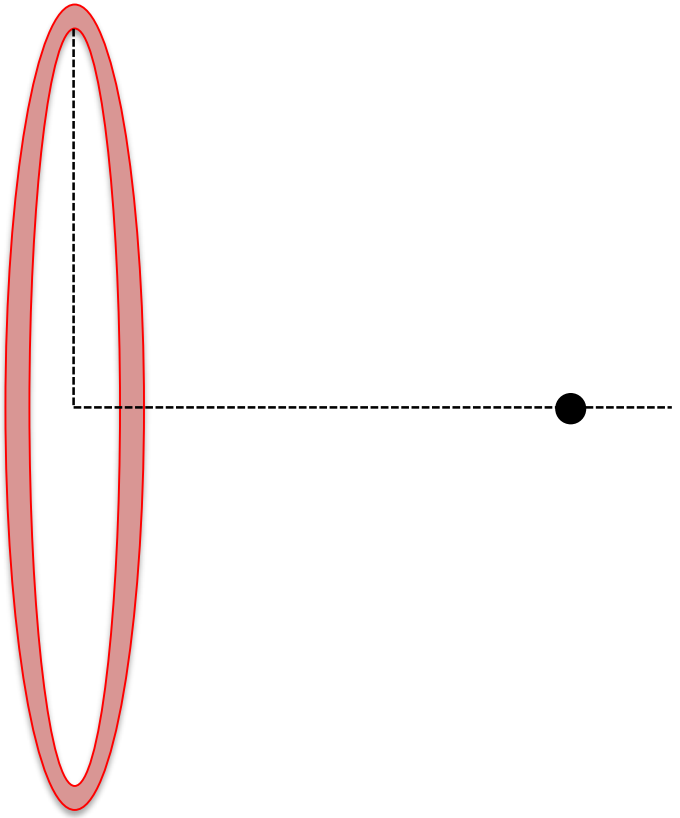
Direction again comes from superposition! Same steps as previous apply here too.

Superposition with Building Blocks

1. Force from a line of charge



2. Force from a ring of charge



Why should we care? Applications:

Attractor plate in 2D plotter

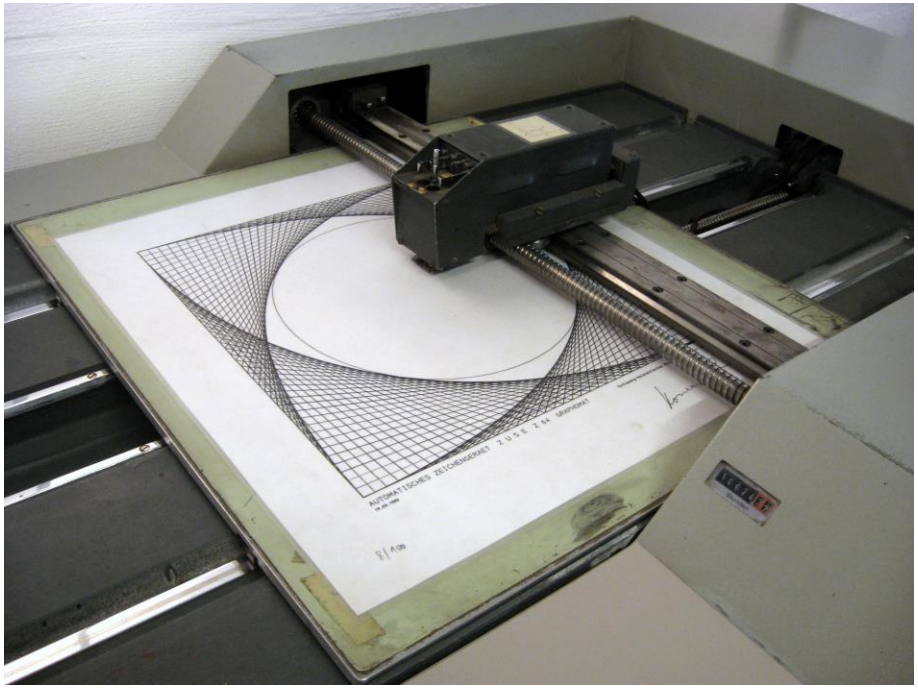


Photo taken from https://en.wikipedia.org/wiki/Plotter

Ring antenna (very directional)

Photo taken from https://en.wikipedia.org/wiki/Loop_antenna