Announcements

- Homework
  - Online HW1 is due at midnight tonight
    - If you haven't yet, at least make sure you can log in!
  - Video HW1 will be due Monday at midnight! (More info to follow)
- Tutoring will be starting Sunday night! 7:30-9:30 in the Physics Hearth!
- No Physics Tea or seminar today due to MLK celebration so go volunteer somewhere!
- Polling: `rembold-class.ddns.net`

Video Homework

Rubric Essentials

Description	Points
Question well defined	1
Objective fully satisfied	1
Solution accurate and complete	2
Quality of explanation	1
Quality of video	1

- Please keep shorter than 4 minutes
- Make sure that text is visible and readable in your video! Depending on camera you may need to explore other options.
- Please make sure things are rotated the correct direction. You can do it post-uploading to Youtube if you like.
- Make sure you have the video set to Unlisted or Public on Youtube, or else I can't see it even if you send me the link!

Warm Up Question

Vector A is $\langle 6, 4, 3\rangle$m whereas Vector B is $\langle -2, 1, 3\rangle$m. What is $\left|\vec{\mathbf{A}} + 2\vec{\mathbf{B}}\right|$?

A) 8.77 m

B) 11 m

C) 11.55 m

D) 17 m

Solution: 11 m

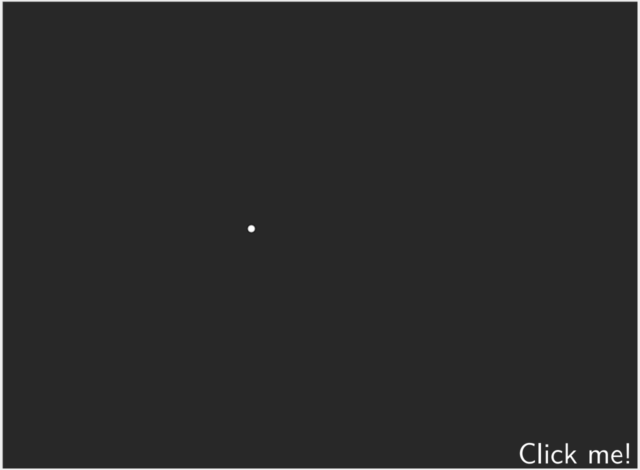
What We Know

- Points of matter can be charged either positively or negatively
  - Can consider point charges if distances large compared to size
  - Units in terms of coulombs, represented by C
- Charged particles exert forces on one another

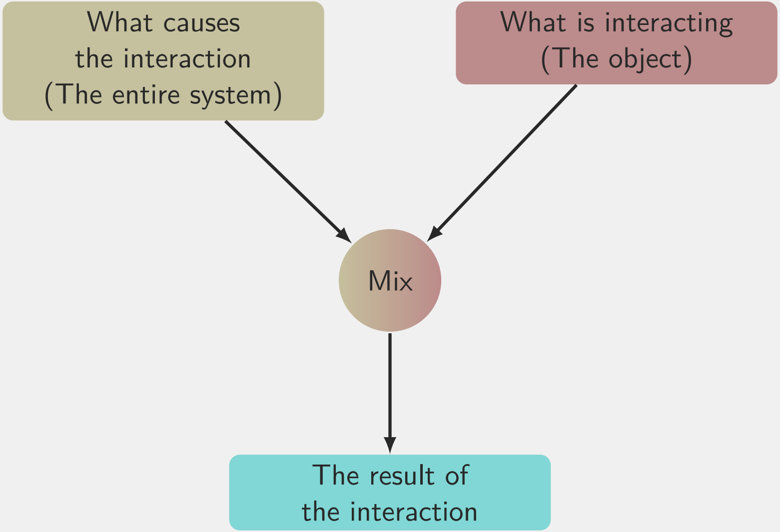
$$\vec{\mathbf{F}}_{el} = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{|\vec{\mathbf{r}}|^2}\hat{\mathbf{r}}$$

- Most frequently will be looking at fundamental particles like protons, electrons and neutrons

The Case for Fields



Graphical Relationships



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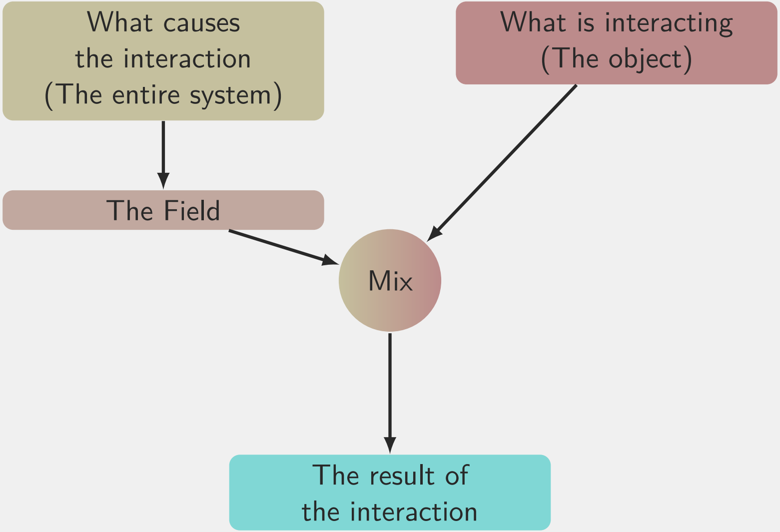

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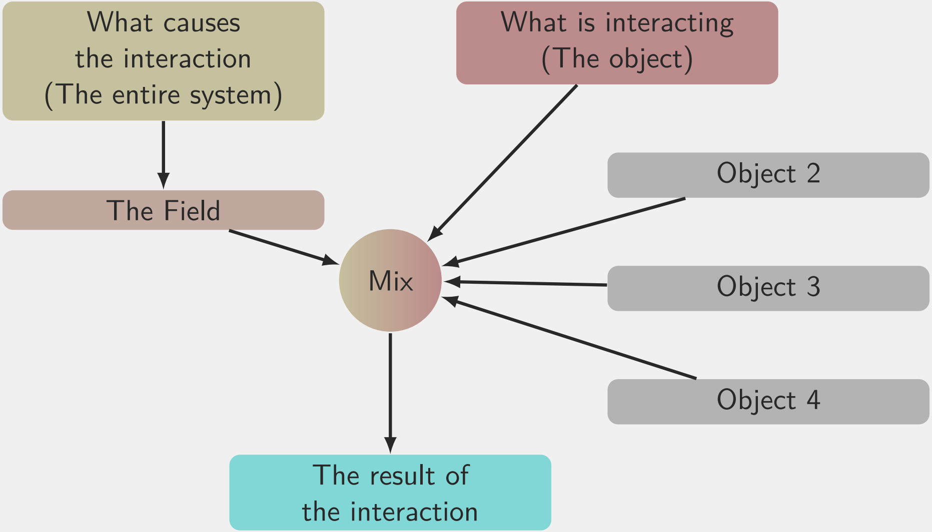


The Electric Field

- Want the field to just represent the system
- Can "divide out" the object's contribution!

$$\vec{\mathbf{F}} = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{|\vec{\mathbf{r}}|^2}\hat{\mathbf{r}}$$

$$\vec{\mathbf{E}} = \frac{\vec{\mathbf{F}}}{q} = \frac{1}{4\pi\epsilon_0}\frac{q_1}{|\vec{\mathbf{r}}|^2}\hat{\mathbf{r}}$$

- Fields exist at all points in space!
- Can be either vector (Electric fields) or scalar (Temperature fields)
- Give you important information about the system without requiring you to understand what the system exactly is!

Some particular electric field is given by

$$\vec{\mathbf{E}} = \langle 6, 3, 0 \rangle \,\mathrm{N/C}$$

You place a $10\,\mathrm{g}$ particle with a charge of $1\,\mathrm{mC}$ at the origin and give it an inital velocity of $\langle -2, 4, 0 \rangle\,\mathrm{m/s}$. What is the velocity of the particle 5 seconds later?

Solution: $\langle 1, 5.5, 0 \rangle\,\mathrm{m/s}$

Understanding Check: Your Turn!

You have an electric field that varies with position and is determined by:

$$\vec{\mathbf{E}}(x, y, z) = \left\langle 3y, -5z, x^2 \right\rangle \mathrm{N/C}$$

What is the magnitude of the force a $-10\,\mathrm{mC}$ particle experiences when it is located at $\vec{\mathbf{r}} = \langle 2, 6, 4\rangle\,\mathrm{m}$?

A) $0.059\,\mathrm{N}$

B) $0.272\,\mathrm{N}$

C) $0.345\,\mathrm{N}$

D) $0.421\,\mathrm{N}$

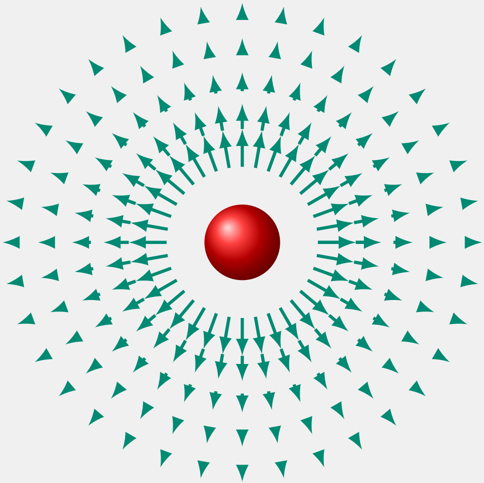
Solution: 0.272 N

Point Charge Electric Fields

- What we calculated earlier was for a point charge, so:

$$\vec{\mathbf{E}}_{point} = \frac{1}{4\pi\epsilon_0}\frac{q_1}{|\vec{\mathbf{r}}|^2}\hat{\mathbf{r}}$$

- Direction depends on location and charge
  - Positive charges have the electric field pointing away from them
  - Negative charges have the electric field pointing toward them
- Strength of field drops quickly with distance



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