



# Best Practices for Effective Support of Student Learning in Algebra-Based Physics Courses

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# Teaching Experience in College Physics

	<b>Clemson U</b>	<b>St. John's U</b>	<b>Del State U</b>
<b>Years</b>	5	5	11
<b>Setting</b>	Rural	Urban	Suburban
<b>Type</b>	Public	Private Catholic	Public HBCU
<b>Enrollment</b>	~25,000	~20,000	~5,000
<b>Sessions</b>	Labs	Lectures	Lectures & Labs
<b>Class Size</b>	~20	50 to 70	10 to 30
<b>Student Demographics</b>	>70% white	Diverse	>70% black

# High School Physics in the US

- Only **1/3** of US high school students take physics.
- Only **1/3** of all high school physics teachers have a degree in physics or physics education.
- Almost **1/3** of all high school physics teachers have taken fewer than **3** college physics classes.

# Student Backgrounds

Majors
Aviation
Biology
Chemistry
Kinesiology
Pre-vet
Pre-med
Psychology
Others

Algebra Proficiency	
Advanced	10%
Intermediate	30%
Beginning	40%
Weak	20%

Physics Preparation	
AP	10%
Honors	10%
Regular	40%
None	40%

# Goals

## ○ **Students'**

- Get a good grade
- Fulfill the curriculum requirement
- Prepare for grad school admission tests (GRE, MCAT, PCAT, OAT, etc.)
- Learn physics
- Do math

## ○ **Mine**

- Understand physical laws
- Solve problems in mathematical approaches
- Analyze based on observations
- Apply to life
- Expand the worldview



## What are the demographics of public school students?

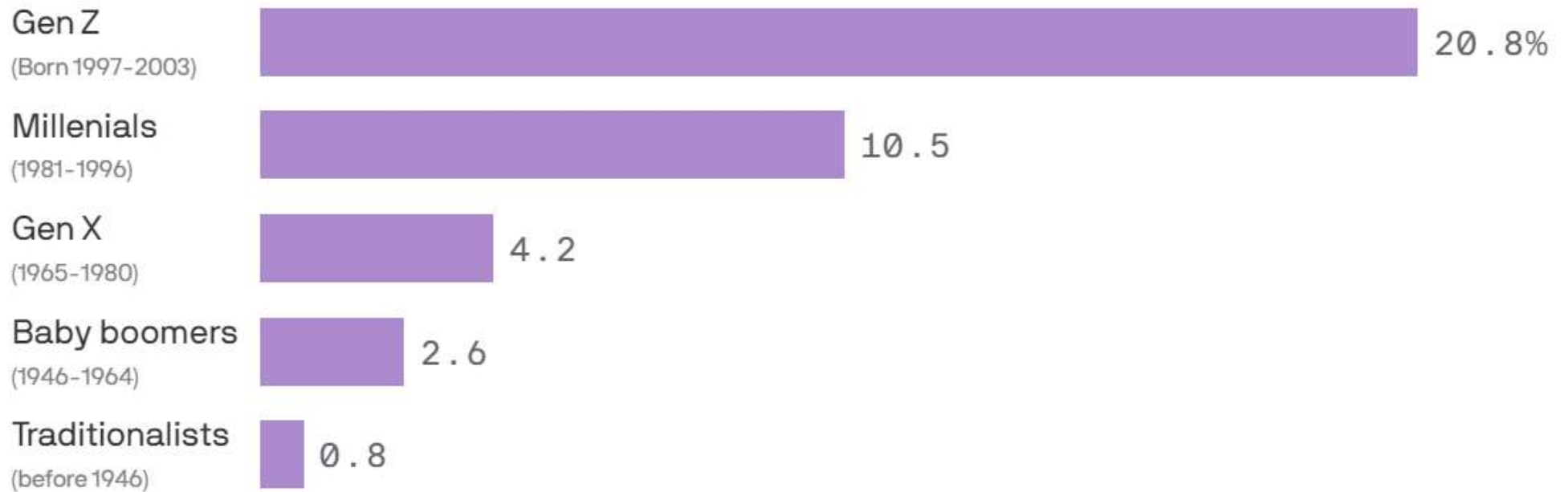
Here's a racial breakdown of the student population in American public schools, as of 2020:

- White students: **45.8%**
- Hispanic students: **28.0%**
- Black students: **15.0%**
- Asian students: **5.4%**
- Two or more race students: **4.5%**
- American Indian/Alaska Native students: **0.9%**
- Pacific Islander students: **0.4%**



# Americans who self-identified as LGBTQ in 2021, by generation


Surveys of 12,416 U.S. adults conducted between January and December 2021



Data: [Gallup](#); Chart: Baidi Wang/Axios


# Practice I: Repeat the Basics

DO NOT assume what your students know or not know. Repeat the basics as needed to remove the learning obstacles.

- Notations  $\vec{F}, t, T, \omega, \hat{i}, \hat{j}, \hat{k}, \vec{E} = k \frac{q}{r^2} \hat{r}$   $r$  vs  $\hat{r}$
- Units Hz or  $s^{-1}$ , rad/s, SI units
- Trig functions   $\sin \theta = \frac{\text{opp}}{\text{hyp}}$   $\cos \theta = \frac{\text{adj}}{\text{hyp}}$
- Order of magnitude  $m = 10^{-3}$ ,  $\mu = 10^{-6}$ ,  $n = 10^{-9}$
- Correct use of a calculator

$$\lambda = \frac{d \cdot y}{m L} = \frac{(0.2 \times 10^{-3} \text{ m}) (15 \times 10^{-3} \text{ m})}{(2 \times 2 \text{ m})}$$



Mary O'Donovzn said: 

Hi

I am struggling big time with Physics and vectors and I keep coming across  $\hat{r}$  like what is it exactly and how do you calculate it?

Thanks in advance

The hat on a vector usually means it is a unit vector, i.e. a vector of length 1 in the direction of  $r$ .

**Mary O'Donovzn** 

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okay so in the exam paper it says that " *$\hat{r}$  is the unit vector along the line of action between the charges. the question is regarding coloumbs law*"

so I'm given the magnitude of the vectors and the corordinates of three charges and I need  $\hat{r}$  to solve it

<https://www.physicsforums.com/threads/what-is-r-hat-in-physics.776853/>

# Electric Field of a Point Charge

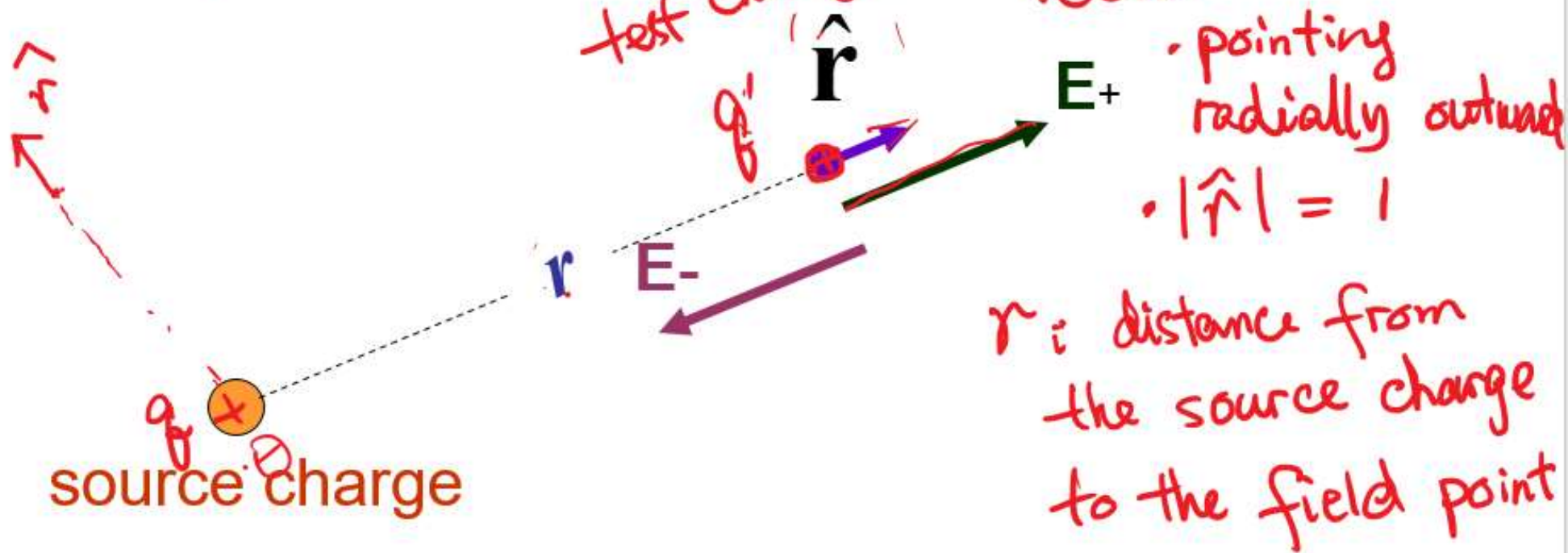
$\hat{i}, \hat{j}, \hat{k}$

$$\vec{E} = \frac{\vec{F}}{q'} = k \frac{q \cdot q'}{r^2} \hat{r}$$

$$\vec{E} = k \frac{q}{r^2} \hat{r}$$

□ A point charge has an associated  $\vec{E}$  field given by

- the strength of the field is  $kq/r^2$
- The direction of the field depends on the sign of the source charge



# Practice II: Simplify the Math

“Do not worry about your difficulties in Mathematics. I can assure you mine are still greater.” – Albert Einstein

## Doppler Shift

$$v_{\text{snd}} = 345 \text{ m/s}, \quad f = 442 \text{ Hz}, \quad f' = 446 \text{ Hz}$$

$$f' = \frac{f}{1 - \frac{v_{\text{src}}}{v_{\text{snd}}}} \quad ? \quad \xrightarrow{\text{plug in number}} \quad 446 = \frac{442}{1 - \frac{v_{\text{src}}}{345}} \quad \xrightarrow{\text{cross multiply}}$$

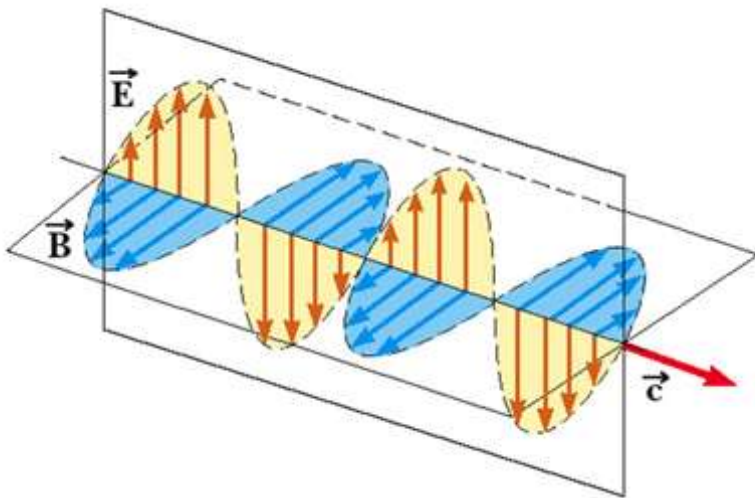
$$1 - \frac{v_{\text{src}}}{345} = \frac{442}{446} \quad \rightarrow \quad \cancel{1} - \frac{v_{\text{src}}}{345} = \frac{442}{446} = 0.991$$

$$\rightarrow \quad \cancel{(-345)} - \frac{v_{\text{src}}}{345} = \cancel{-0.009} \quad (\rightarrow 345) \rightarrow v_{\text{src}} = \boxed{3.11 \text{ m/s}}$$

# Practice III: Visualize the Formulation

The formulation of physics always comes with a picture. If possible, help your students to visualize it.

## Electromagnetic Waves



## Doppler Effect



## Corrective Lens

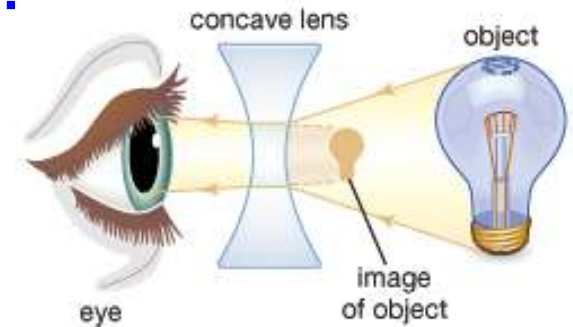
What is the focal length of a lens that corrects nearsighted vision when the far point is 20 cm?  
Is the lens converging or diverging?

$$s = \infty, \quad s' = -20 \text{ cm}$$

$$\frac{1}{f} = \frac{1}{s} + \frac{1}{s'}$$

$$\frac{1}{f} = \frac{1}{\infty} + \frac{1}{-20}$$

$$f = -20 \text{ cm}$$



$$\text{power of lens} = \frac{1}{f} = \frac{1}{-0.20 \text{ m}} = -5.0 \text{ diopters}$$

# Practice IV: Quiz the Concepts

Students can use LAQs (learning assessment quizzes) to review and reinforce the physics concepts.

- 10% of grades
- Unlimited attempts
- No due dates
- 5 questions
- 5 to 10 minutes
- Concepts and formulation



[LAQ21A Electric Flux and Gauss's Law](#) ▼

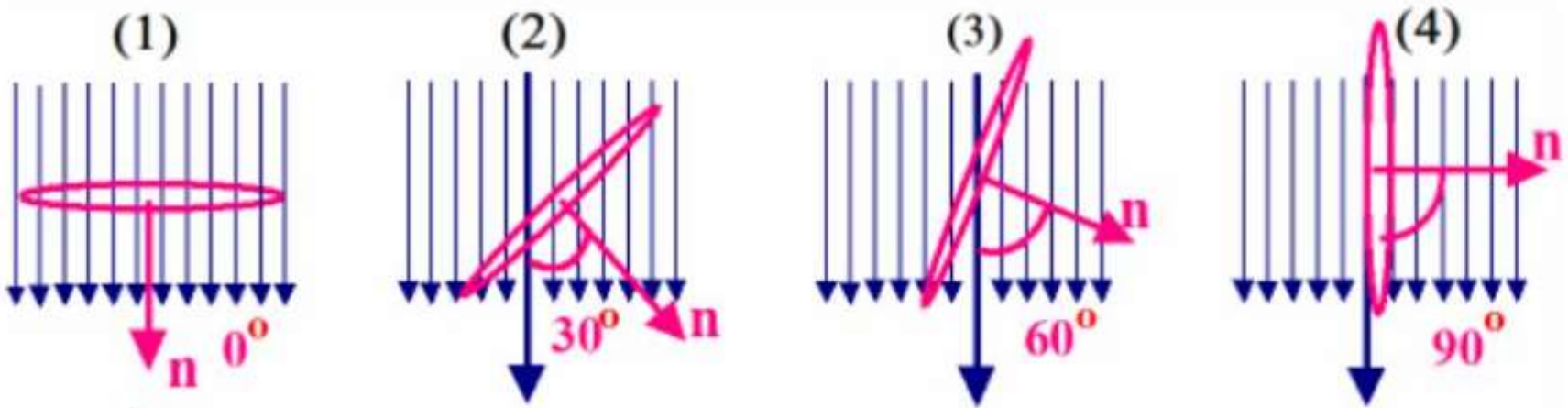


[LAQ21B Charges in a Conductor](#) ▼

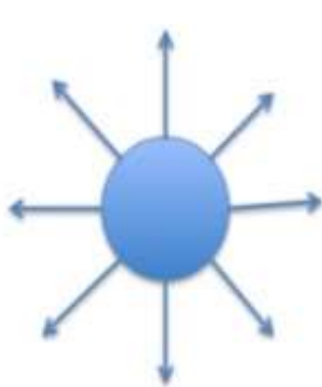


[LAQ21C Electric Field of Spheres](#) ▼

Which of the following circular surfaces is subject to the greatest electric flux?  
 Note that vector  $\mathbf{n}$  is the surface vector directing towards the front of the surface.



Which of the following Gaussian surfaces encloses a negative charge?



(A)



(B)



(C)

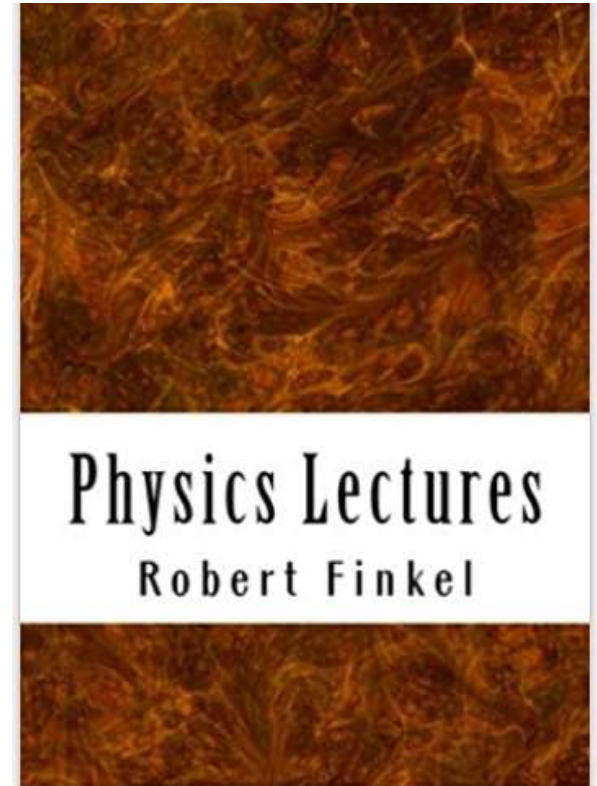
- (A)
- (C)
- (B)
- None

The List Goes On...



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<https://www.amazon.com/Physics-Lectures-Concise-Outlines-University/dp/1466218274>

THANK  
YOU!