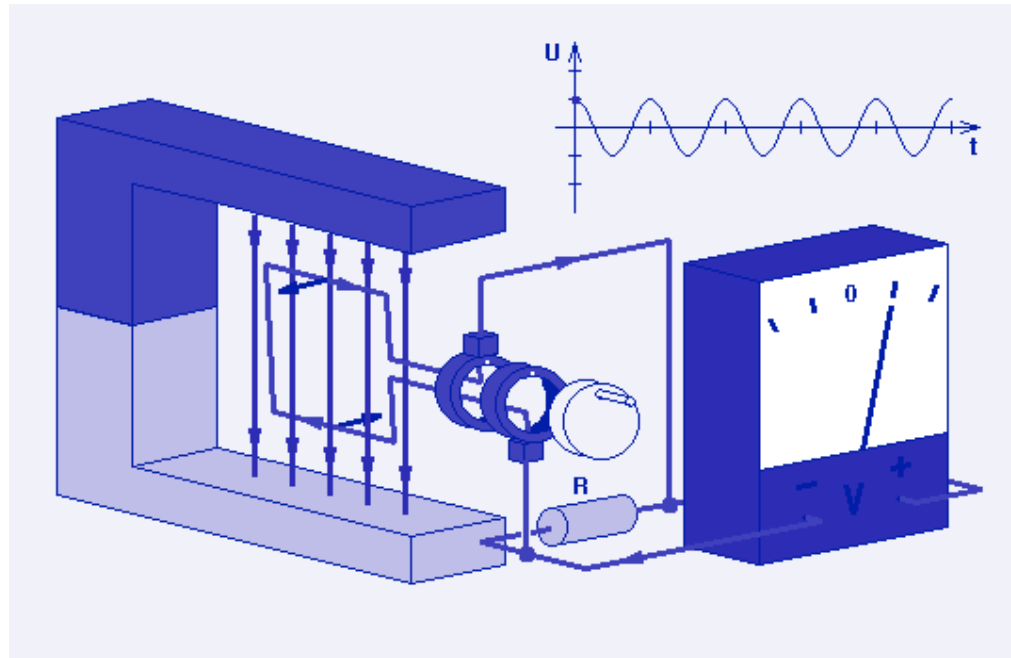


Welcome to Physics 212



<http://online.physics.uiuc.edu/courses/phys212>

This lecture is VERY full. Please sit next to someone nice.
Find out the best thing that happened to them during the summer break!

Course Directors

Lectures

- Prof. Nadya Mason: 1pm, 2pm (nadya@illinois.edu)
- Prof. Seppe Kuehn: 3pm, 4 pm (seppe@illinois.edu)

Discussion

- Prof. Benjamin Hooberman (benhoob@illinois.edu)
- Prof. Verena Martinez Outschoorn (vimartin@illinois.edu)

Labs & Exams

- Prof. Matthias Grosse Perdekamp (mgp@illinois.edu)

We can only use your @illinois.edu email account for course communications.
Be sure yours is working!

Rumors about Physics 212

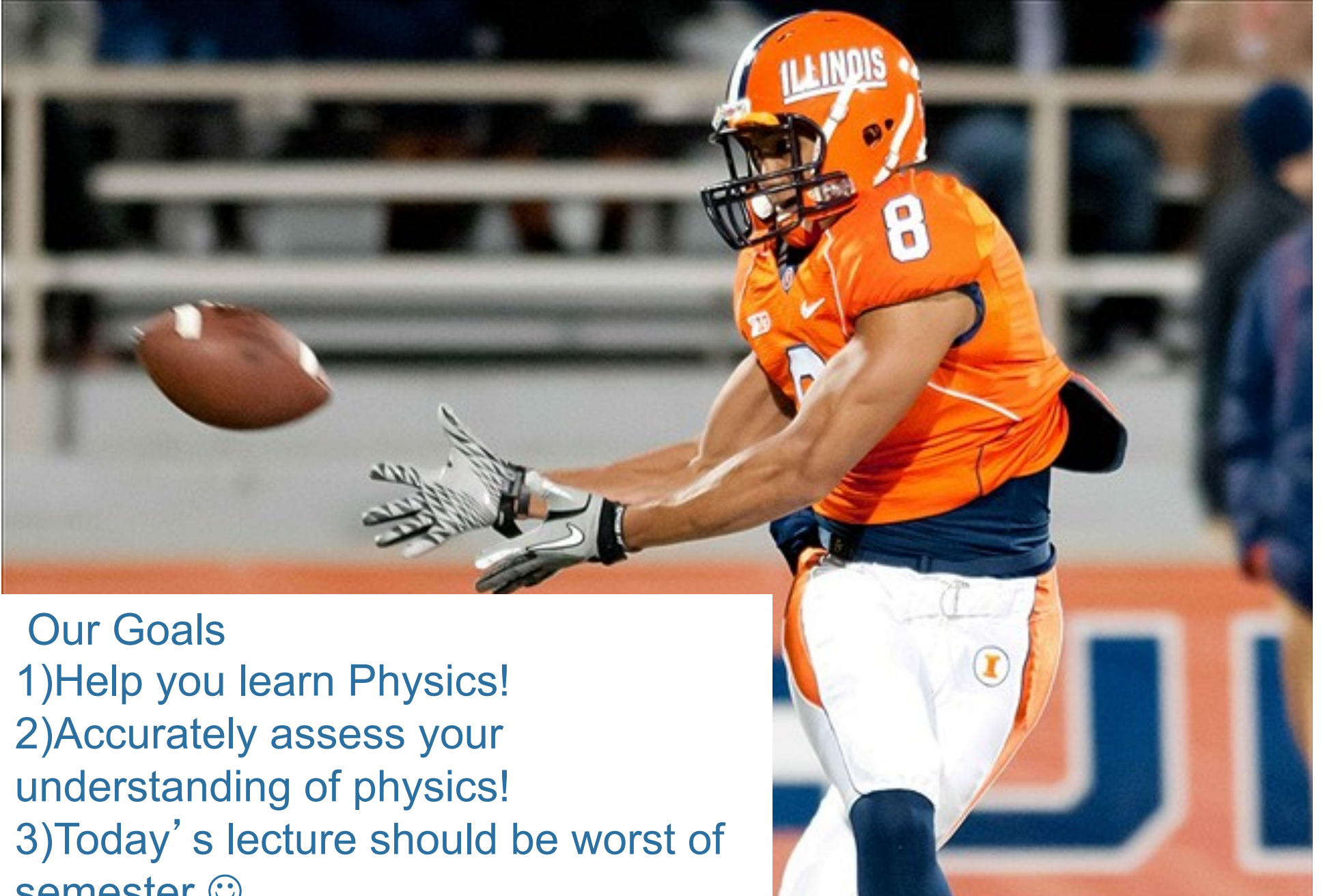
Has the person next to you heard the rumors about 212?

- A) Yes
- B) No
- C) I forgot my iclicker



The problem I, and I assume many others, always have with E&M is that unlike mechanics, conceptualizing the objects and fields discussed is extremely difficult since we don't perceive these things the way we do regular objects. It's tempting to try and relate these things to concepts I do understand, but their complex nature seems resistant to direct comparison. It seems necessary to establish a mostly new framework to view these concepts in, which I think this lecture has done well so far. Still, I always feel like I'm barely holding this framework together and it would help if some things could be made more concrete (like the nature of these fields and charges and forces, as they are all very abstract at this point, it's hard to hold abstractions in my head when doing problems).

Congratulations, you made the team!



Our Goals

- 1) Help you learn Physics!
- 2) Accurately assess your understanding of physics!
- 3) Today's lecture should be worst of semester 😊

Be Respectful of your Classmates

Put cell phones in “airplane” mode
Close Laptops
Save conversation for clicker portions of lecture
If you are sick, please do NOT come to lecture ☺



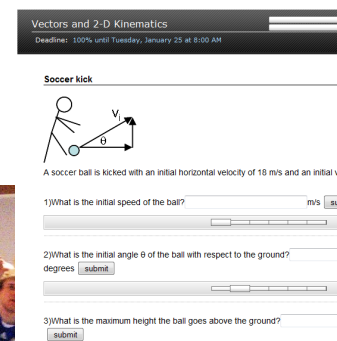
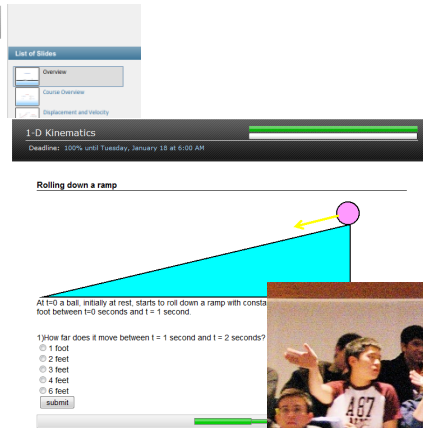
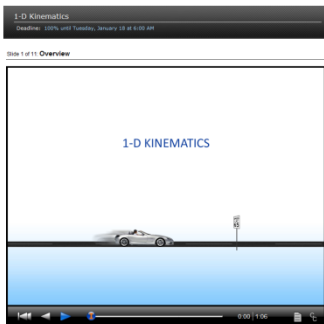
Course Structure

There are several parts, all are important:

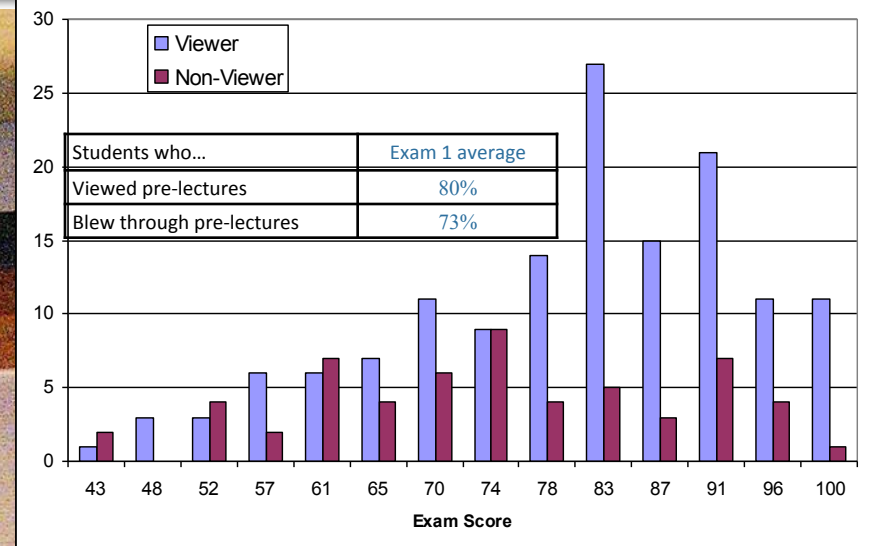
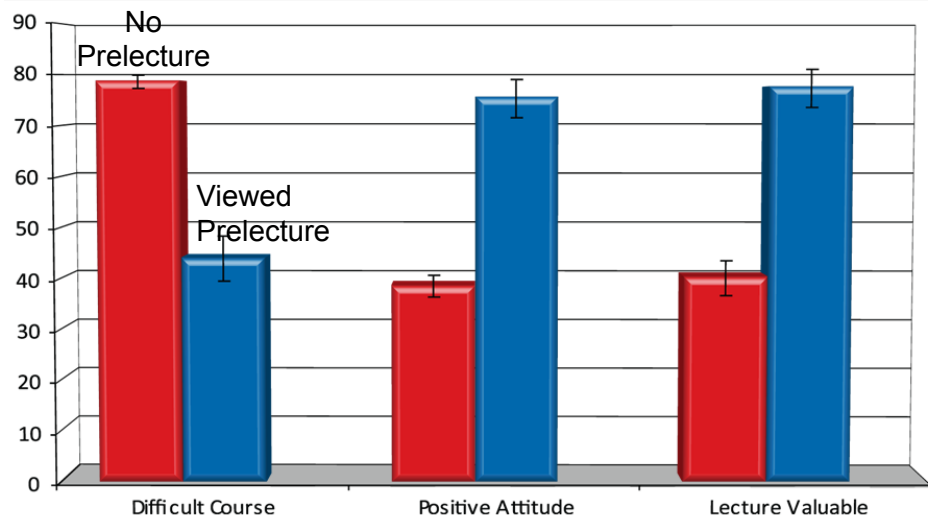
smartPhysics

- Online Prelectures (animated textbook, before lecture)
- Online CheckPoints (check knowledge, before lecture)
- Lectures – interactive, address issues found by checkpoints.
- Online Homework (first deadline next week)
- Discussion Sections (start this week)
- Lab Sections (start next week)

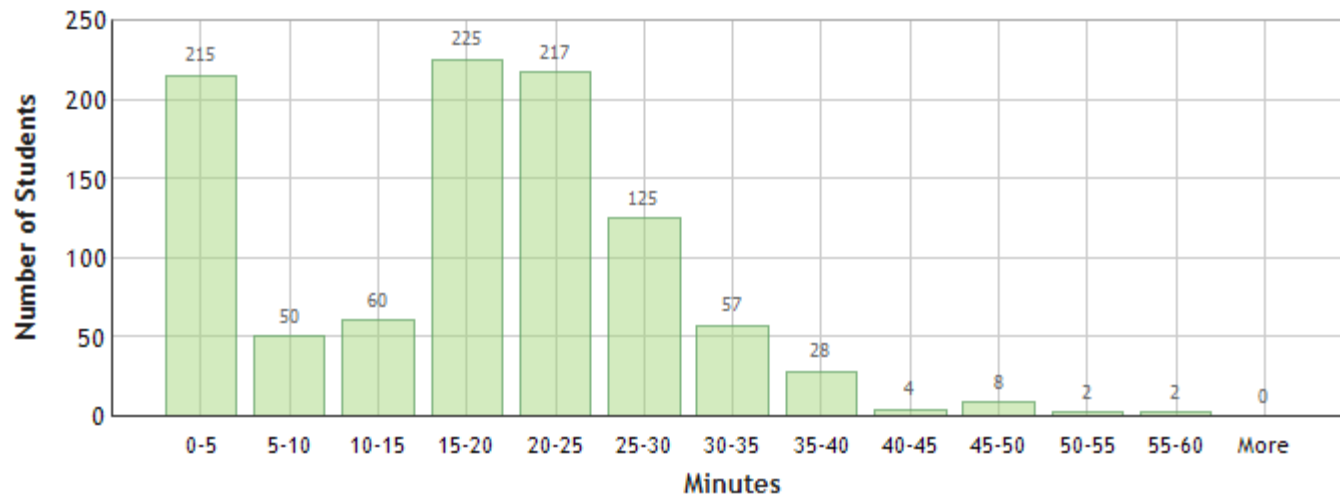
Go to the right one !
Don't be late!



Lecture Prep+Participation: Just Do It



Time Spent Viewing Prelecture (N = 993)



Get to know the course Home Page

The screenshot shows a web browser window with the URL <https://courses.physics.illinois.edu/phys212/index.asp>. The page has a dark blue sidebar on the left with a list of links. The 'Schedule' link is circled in orange, and an orange arrow points from it to the text 'Use the Schedule link' on the main page. The main content area has a white background with the title 'PHYS 212 Fall 2014' in large blue and orange letters. Below the title is a dashed orange line. The 'Announcements' section contains three blue links: 'Lectures begin Tuesday, August 26', 'Discussions begin Tuesday, August 26 (some begin before the first lecture!)', and 'Labs begin Tuesday, September 2 (Note that Monday's Lab 1 will be held 9/8)'. The 'Welcome' section has a paragraph of text and two red links: 'course description' and 'syllabus'. The 'smartPhysics' section has a paragraph of text and a list of five numbered steps in red text.

Home page
Schedule
Gradebook
smartPhysics

Course Description
Course Grading
Required Materials
Office Hours
Contact Information
Practice Exams
Exam Information

James Scholar Credit
Section Information
CARE Tutoring
Tutor List

PHYS 212 Fall 2014

Use the Schedule link

Announcements

Lectures begin [Tuesday, August 26](#)

Discussions begin [Tuesday, August 26](#) (some begin before the first lecture!)

Labs begin [Tuesday, September 2](#) (Note that Monday's Lab 1 will be held 9/8)

Welcome

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smartPhysics

You will need to get smartPhysics access and do the first Prelecture and Checkpoint before you go to the first lecture.

1. Click on the smartPhysics link to the left.
2. Click on the Register button, and create an account using your "NetID@illinois.edu" email address
3. Complete your profile, then click on the Enrollments Tab
4. Click on the [Join a Course] link and enter UIP212FA14
5. Enter your NetID (e.g. whatever is in front of "@illinois.edu" in your email address) and click "Enroll Course"

<http://courses.physics.illinois.edu/phys212/>

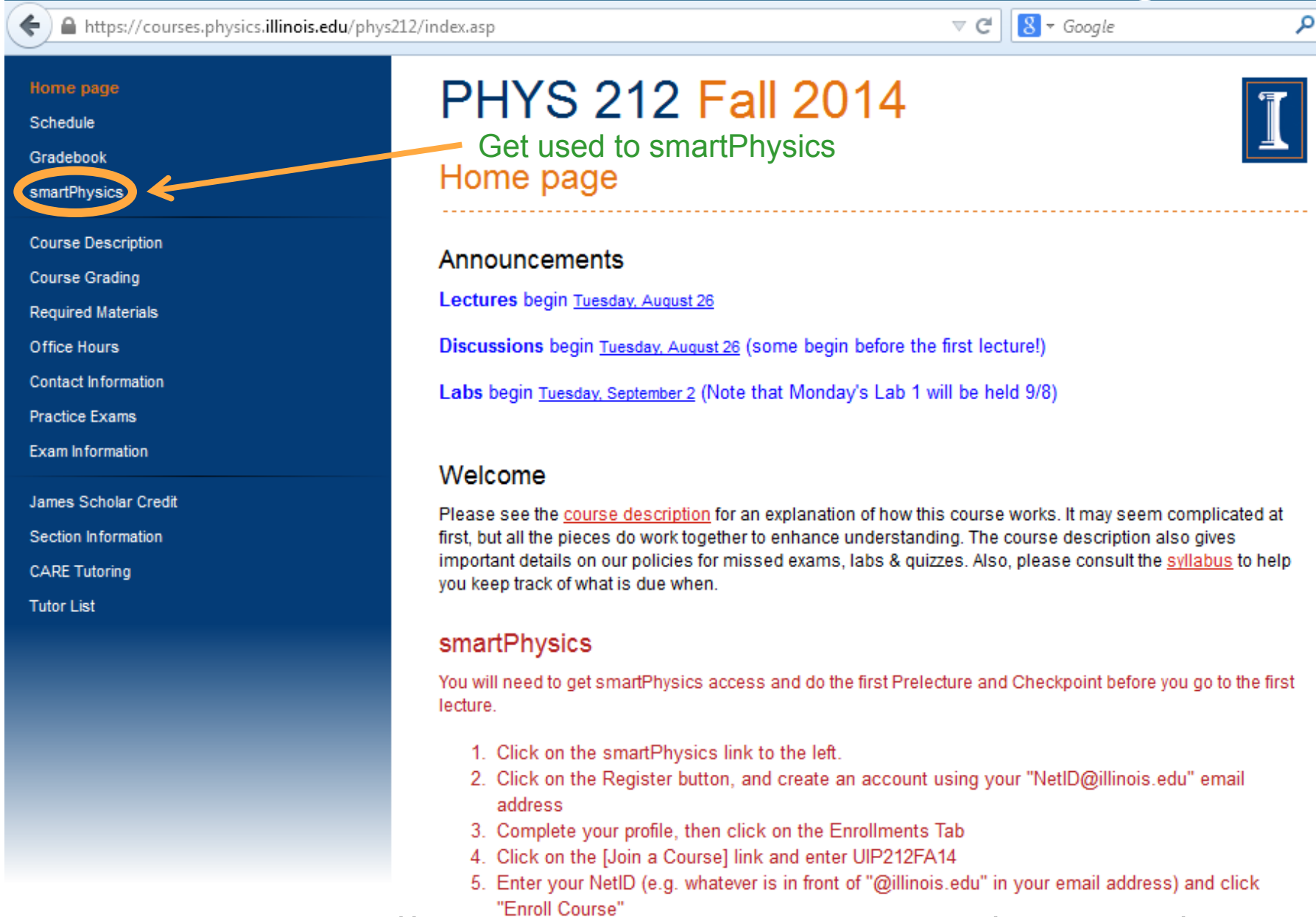
Syllabus...

Week	Date	Prelecture	Checkpoint	Lecture	Lab	Discussion	Homework	Exam
1	Monday 8/25/2014				No Lab			
	Tuesday 8/26/2014	Prelecture 1	Checkpoint 1	Lecture 1: Introduction and Coulomb's Law pdf ppt				
	Wednesday 8/27/2014					Discussion 1		
	Thursday 8/28/2014	Prelecture 2	Checkpoint 2	Lecture 2: Electric Fields pdf ppt				
	Friday 8/29/2014							
2	Monday 9/1/2014	Labor Day Holiday						
	Tuesday 9/2/2014	Prelecture 3	Checkpoint 3	Lecture 3: Electric Fields and Electric Flux pdf ppt	Lab 1: Coulomb's Law: Electrostatic Charges		Homework 1 due	
	Wednesday 9/3/2014					Discussion 2 Quiz 1		
	Thursday 9/4/2014	Prelecture 4	Checkpoint 4	Lecture 4: Gauss's Law pdf ppt				
	Friday 9/5/2014							
					Lab 1: Coulomb's Law:			

Lecture slides are available here
after every lecture



Get to know the course Home Page



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Home page
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PHYS 212 Fall 2014

Get used to smartPhysics
Home page

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<http://courses.physics.illinois.edu/phys211/>

smartPhysics

smartPhysics
Powered by smartFramework

PHYS 212 FALL 2014
UIUC Physics



Instructor Links ▾

Instructor

Student
Mason, Nadya ▾

[+] [Go to current unit](#)

– Electricity [Edit Title](#)

1. Coulomb's Law [Edit Title](#) ×

[Copy an Assignment](#) [New Prelecture](#) [New Checkpoint Set](#) [New Homework Set](#)

[Prelecture](#)



Due: Aug. 26 at 8:00 AM

[Checkpoint](#)



Due: Aug. 26 at 8:00 AM

[Homework](#)



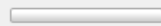
Start: Aug. 26 at 8:00 AM / Due: Sep. 2 at 8:00 AM

2. Electric Fields

3. Electric Flux and Field Lines [Edit Title](#) ×

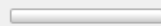
[Copy an Assignment](#) [New Prelecture](#) [New Checkpoint Set](#) [New Homework Set](#)

[Prelecture](#)



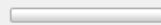
Start: Aug. 26 at 8:00 AM / Due: Sep. 2 at 8:00 AM

[Checkpoint](#)



Start: Aug. 26 at 8:00 AM / Due: Sep. 2 at 8:00 AM

[Homework](#)



Start: Sep. 2 at 8:00 AM / Due: Sep. 9 at 8:00 AM

4. Gauss Law

5. Electric Potential Energy

6. Electric Potential

7. Conductors and Capacitance

+ DC Circuits

+ Magnetism

+ AC Circuits

+ Light and Optics

+ Exam Review Solutions

Daily Planner

Tuesday, August 26

8:00 am [Prelecture - Coulomb's Law](#)

8:00 am [Checkpoint - Coulomb's Law](#)

Thursday, August 28

8:00 am [Prelecture - Electric Fields](#)

8:00 am [Checkpoint - Electric Fields](#)

Tuesday, September 2

8:00 am [Homework - Coulomb's Law](#)

8:00 am [Prelecture - Electric Flux And Field Lines](#)

8:00 am [Checkpoint - Electric Flux And Field Lines](#)




Announcements

[Add Announcement](#)

Homework

smartPhysics

Physics 212 Fall 14
University of Illinois

 Administrator Links ▾

Instructor Student
Stelzer, Timothy ▾

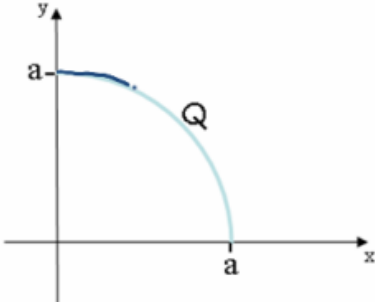
Unit 1: Prelecture / Checkpoint / Homework /

Homework: Coulomb's Law

Help: 1 2 3 4 5

A total charge $Q = -4.2 \mu\text{C}$ is distributed uniformly over a quarter circle arc of radius $a = 7.7 \text{ cm}$ as shown.


We will try to produce a solution for 1 problem each week.



1) What is λ the linear charge density along the arc?

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

Problems

 Print Assignment View

Worked Example
Coulomb's Law
-- Optional --

Standard Exercise
Point Charges in One Dimension

Standard Exercise
Point Charges in Two Dimensions

Interactive Example
Three Charges

Worked Example
Electric Fields
-- Optional --

Interactive Example
Ero


Standard Exercise
Electric Field from Point Charges

Standard Exercise
Electric Field from Arc of Charge


Standard Exercise
Chapter 21.P.012
-- Optional --

Homework: Delayed Feedback

Purpose:
Promote
REFLECTION

-  4) How would you change q_1 (keeping q_2 and q_3 fixed) in order to make the net force on q_2 equal to zero?
- ☐ Increase its magnitude and change its sign
 - ☐ Decrease its magnitude and change its sign
 - ☒ Increase its magnitude and keep its sign the same
 - ☐ Decrease its magnitude and keep its sign the same
 - ☐ There is no change you can make to q_1 that will result in the net force on q_2 being equal to zero.

Submit

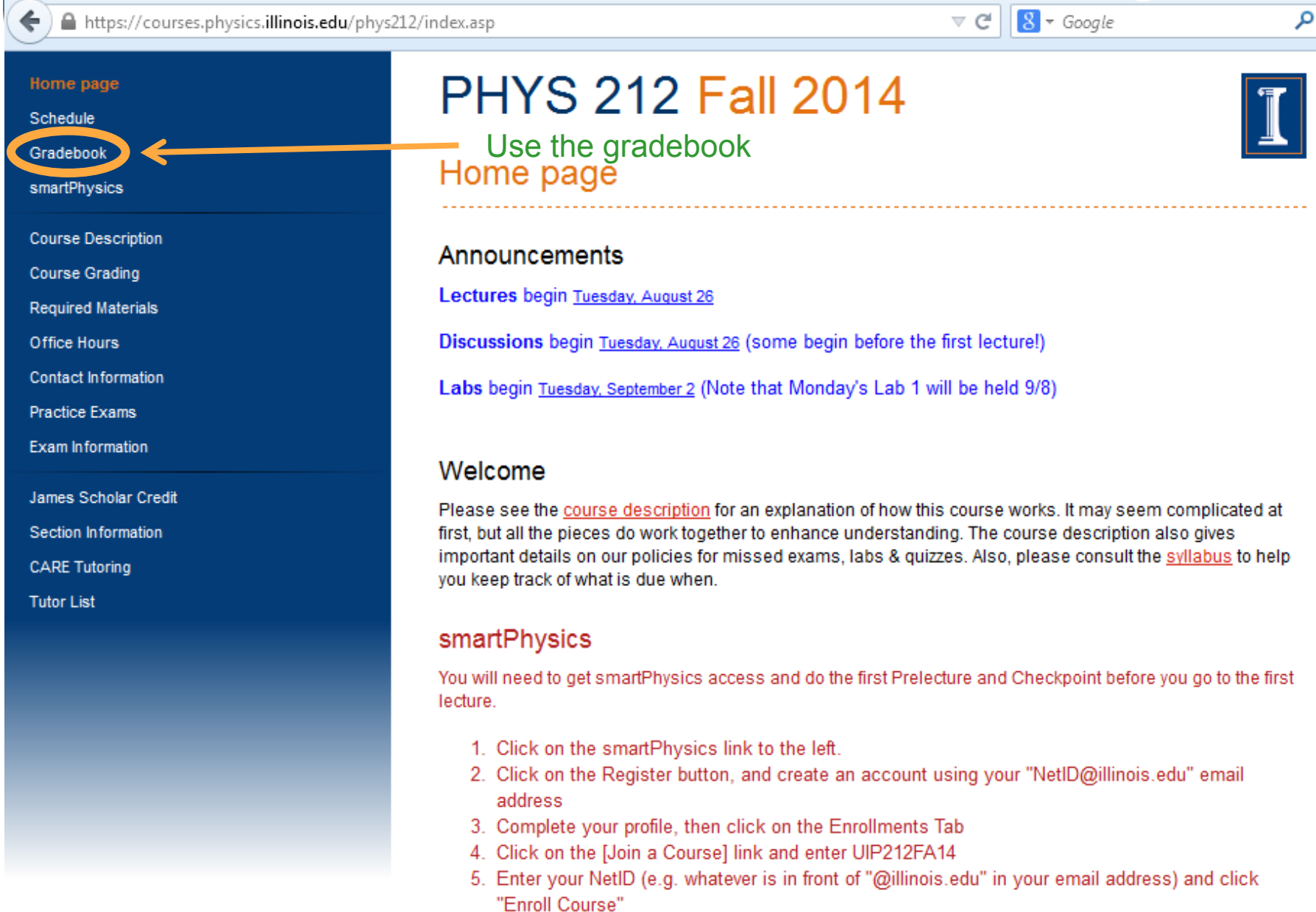
-  5) How would you change q_3 (keeping q_1 and q_2 fixed) in order to make the net force on q_2 equal to zero?
- ☐ Increase its magnitude and change its sign
 - ☐ Decrease its magnitude and change its sign
 - ☐ Increase its magnitude and keep its sign the same
 - ☒ Decrease its magnitude and keep its sign the same
 - ☐ There is no change you can make to q_3 that will result in the net force on q_2 being equal to zero.

Submit

These questions serve as a test of your understanding of the questions posed as immediate feedback.

After first deadline
Delayed feedback questions turn into immediate feedback questions. 80% credit can be obtained by answering these questions correctly before the second deadline.

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PHYS 212 Fall 2014

Use the gradebook
Home page

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5. Enter your NetID (e.g. whatever is in front of "@illinois.edu" in your email address) and click "Enroll Course"

<http://courses.physics.illinois.edu/phys212/>

Course Gradebook

i>clicker Information

No registered i>clickers found for Roberto Arellano.

[Register a new i>clicker](#)

i>clicker registrations and scores are updated in gradebook when your professor uploads them.
Last time i>clicker scores were uploaded: *Not yet uploaded for this term.*

Go here to register your i>clicker.

Upcoming Exam Information

You are currently signed up to take the following exams at the times below.

Exam Name	Exam Date	Exam Start Time	Exam End Time	Date/Time you have to change your mind	Room
Hour Exam 1	Wednesday 9/25/2013	7:00 PM	8:30 PM	Tuesday 9/24/2013 10:00 PM	View Room Info
Hour Exam 2	Wednesday 10/30/2013	7:00 PM	8:30 PM	Tuesday 10/29/2013 10:00 PM	View Room Info
Hour Exam 3	Wednesday 12/4/2013	7:00 PM	8:30 PM	Tuesday 12/3/2013 10:00 PM	View Room Info

If you have a conflict with the above time, sign-up for a conflict exam by selecting one below.

Choose a conflict exam time

Do you have a conflict with the exam times above?

You can request a special conflict exam time, but you must give a valid academic reason why you need one.

[\[Request a special conflict exam\]](#)

Voting for someone else violates U of I academic integrity rules!

Grade Information

Use your mouse to hover over the assignment number to see more information about that assignment.

Assignment Name	Point Breakdown																		
Bonus	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.
[edit]																			
Discussions	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.									
[edit]																			
Exams	1.	2.	3.	4.															
[edit]																			

Scores will be imported from
smartPhysics weekly

How Your Grade will be Calculated

See homepage for Excused Absence Policy.

Prelectures + Preflights + Lectures	100
14 Homework + 10 Quizzes	250
Labs	150
Hour exams (3 x 100 each)	300
Final Exam	200

Prelectures: 50
Preflights: 25
Lecture participation: 25

Your top 22 HW/Quiz scores determine your grade out of 250.

Bonus Points: You can earn up to 1 extra bonus point in every lecture (for a maximum of 25 bonus points for the semester) by getting the right answers to all of the clicker questions.

At the end of the semester your lecture bonus points are added to your HW/Quiz score (250 max).

We do not excuse missed Prelectures, Checkpoints, Lectures, Homework.

We do drop several of these so missing a few won't matter much.

You can also make up missed points with bonus points.

Don't forget the "week late" 80% HW deadline.

Emergency Response

DIVISION OF
PUBLIC SAFETY

UNIVERSITY POLICE → CLERY COMPLIANCE →

Emergency Planning



Emergency Response Recommendations

The Department of Homeland Security and the University of Illinois at Urbana-Champaign Office of Campus Emergency Planning recommend the following three responses to any emergency on campus: **RUN > HIDE > FIGHT**

Only follow these actions if safe to do so. When in doubt, follow your instincts—you are your own best advocate!

<http://police.illinois.edu/emergencyplanning/general/>

Sign up for emergency text messages at emergency.illinois.edu, to receive information from the police and administration during these types of situations.

If you have any questions, go to police.illinois.edu, or call [217-333-1216](tel:217-333-1216)

CAMPUS EMERGENCY OPERATION PLAN →

CAMPUS VIOLENCE PREVENTION PLAN →

BUILDING EMERGENCY ACTION PLAN →

CONTINUITY OF OPERATIONS PLAN →

ILLINI-ALERT

COMMUNITY SAFETY & EMERGENCY
RESPONSE TRAINING →
EMERGENCY RESPONSE AND EVACUATION
PROCEDURES →
EMERGENCY RESPONSE
RECOMMENDATIONS →
EMERGENCY RESPONSE GUIDE →
ACTIVE THREAT INFORMATION →
CAMPUS BUILDING FLOOR PLANS →
PANDEMIC FLU (H1N1) →
TERRORISM AND W.M.D. →
AMERICAN RED CROSS →

[VIEW ALL RESOURCES →](#)

Electricity & Magnetism

Lecture 1

Excited to get started !

Electromagnetism has always been slightly harder for me to grasp than mechanics. I would just like the lectures to be really detailed in order to conceptualize the big ideas.

Please go over the direction of charges. I'm confused how one knows toward which charge a force will point.

I gave away all my dead batteries today. FREE OF CHARGE!!

Electricity & Magnetism

Lecture 1

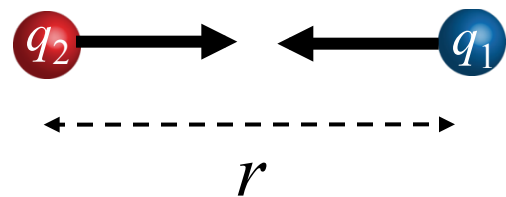
Today's Concepts:

- A) Coulomb's Law
- B) Superposition

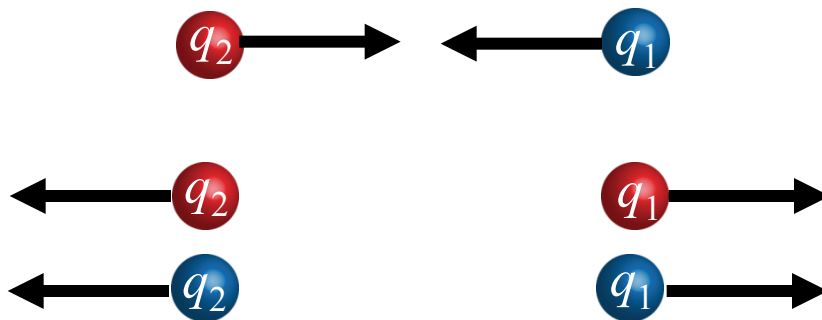
Coulomb's Law:

The force on a charge due to another charge is proportional to the product of the charges and inversely proportional to the separation squared.

Why is the force inversely related to the square of the distance?


$$F \propto \frac{q_1 q_2}{r^2}$$

The force is always parallel to a line connecting the charges, but the direction depends on the signs of the charges:



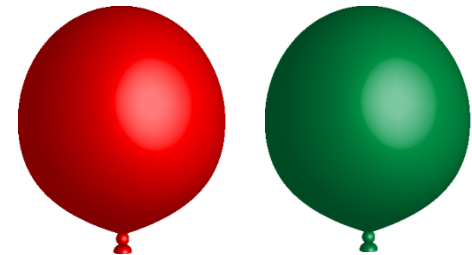
Opposite signs attract

Like signs repel

Balloons



Take two balloons and rub them both with a piece of cloth.
After you rub them they will:

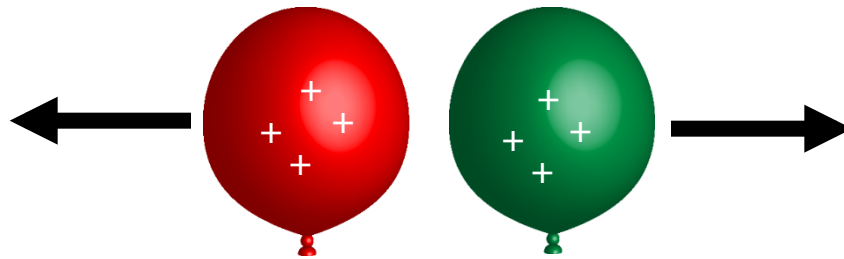


- A) Attract each-other
- B) Repel each-other
- C) Either – it depends on the material of the cloth

Balloons

If the **same** thing is done to both balloons they will acquire the **same** sign charge.

They will repel!



Coulomb's Law

Our notation:

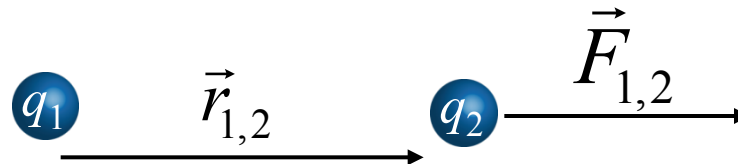
$\vec{F}_{1,2}$ is the force by 1 *on* 2 (think “*by-on*”)
 \hat{r}_{12} is the unit vector that points *from* 1 *to* 2.

$$\vec{F}_{1,2} = \frac{kq_1q_2}{r_{1,2}^2} \hat{r}_{1,2}$$

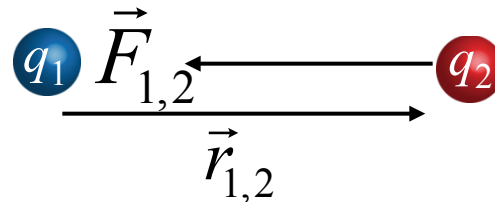
“I would like to know what the r with a carrot sign means at the end of Coulomb's law means.”

Examples:

If the charges have the same sign, the force **by** charge 1 on charge 2 would be in the direction of \hat{r}_{12} (to the right).



If the charges have opposite sign, the force **by** charge 1 on charge 2 would be opposite the direction of \hat{r}_{12} (left).



Example: Coulomb Force



Two paperclips are separated by 3 meters. Then you remove 1 electron from each atom on the first paperclip and place it on the second one.

$$\vec{F} = k \frac{q_1 q_2}{r_{12}^2} \hat{r}_{12}$$

$$k = 9 \times 10^9 \text{ N m}^2 / \text{C}^2$$

$$\text{electron charge} = 1.6 \times 10^{-19} \text{ Coulombs}$$

$$N_A = 6.02 \times 10^{23}$$

What will the direction of the force be?

A) Attractive

B) Repulsive

Example: Coulomb Force



Two paperclips are separated by 3 meters. Then you remove 1 electron from each atom on the first paperclip and place it on the second one.

$$\vec{F} = k \frac{q_1 q_2}{r_{12}^2} \hat{r}_{12}$$

$$k = 9 \times 10^9 \text{ N m}^2 / \text{C}^2$$

$$\text{electron charge} = 1.6 \times 10^{-19} \text{ Coulombs}$$

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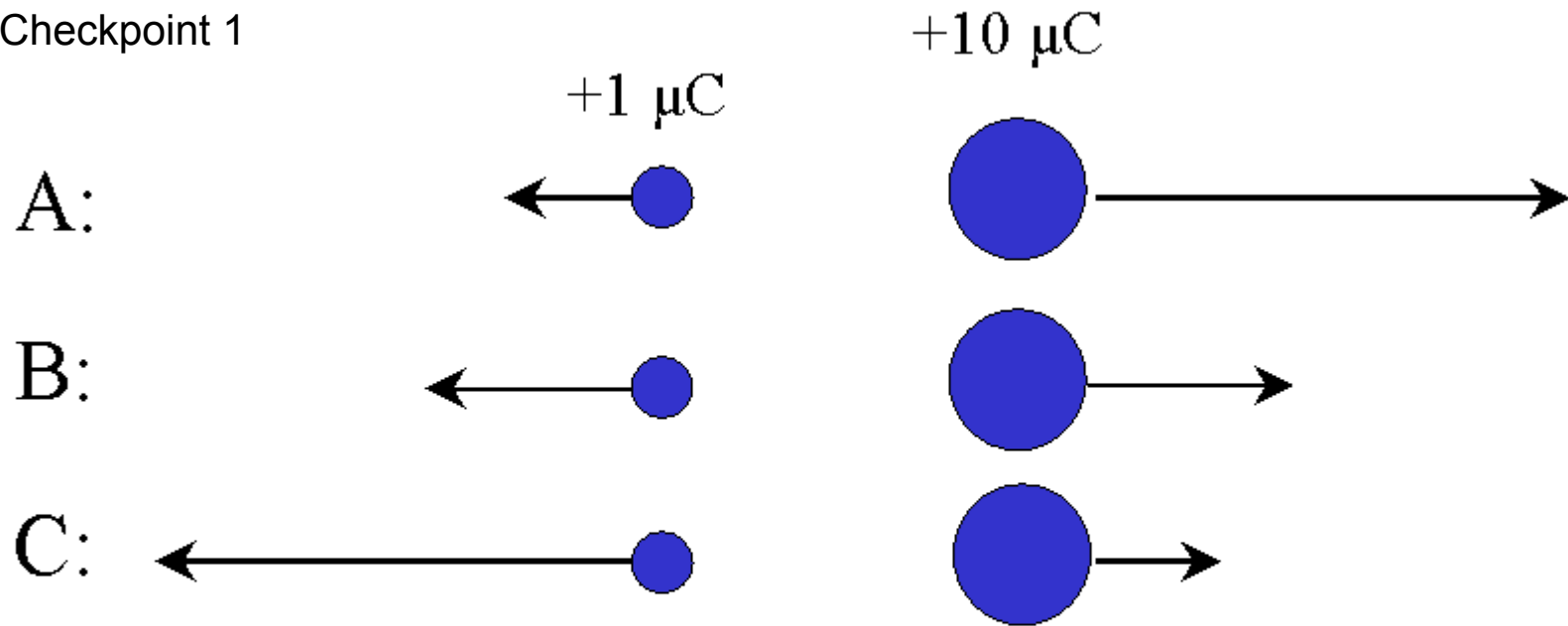
Which weight is closest to the approximate force between those paperclips (recall that weight = mg , $g = 9.8 \text{ m/s}^2$)?

Balloon demo

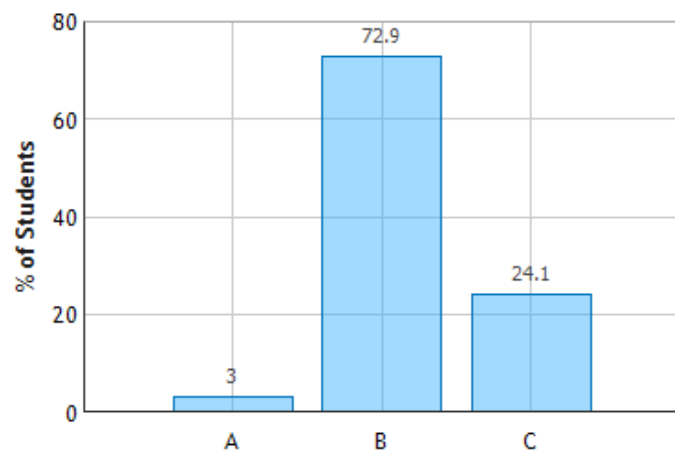
- A) Paperclip (1 g x g)
- B) Text book (1 kg x g)
- C) Truck (10^4 kg x g)
- D) Aircraft carrier (10^8 kg x g)
- E) Mt. Everest (10^{14} kg x g)

1) Two charges $q = +1 \mu\text{C}$ and $Q = +10 \mu\text{C}$ are placed near each other as shown in the figure. Which of the following diagrams depicts the forces acting on the charges:

Checkpoint 1



Forces on Two Charges: Question 1 (N = 959)



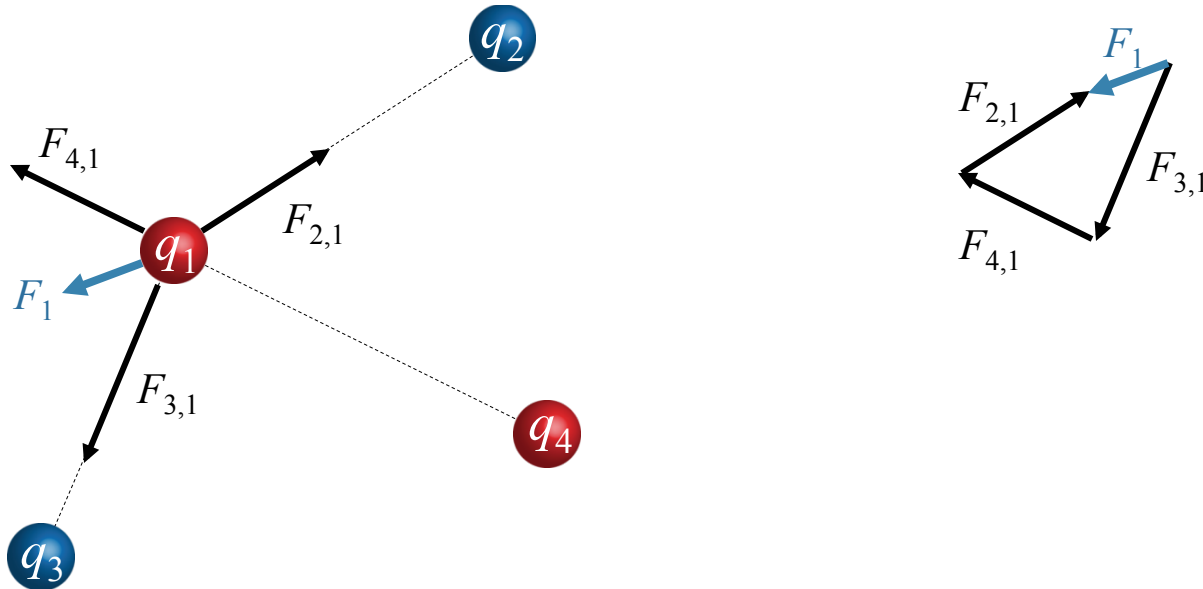
“Because the two charges are positive, they repel (or go in opposite direction). Because the charges are from one atom to another, the sizes of the force go on opposite end.”

“Due to the newton's third law, the forces acting on these two objects should be equal.”

“When multiplying, the order of the charges doesn't matter. The forces are equal in magnitude and opposite.”

Superposition:

If there are more than two charges present, the total force on any given charge is just the **vector sum** of the forces due to each of the other charges:



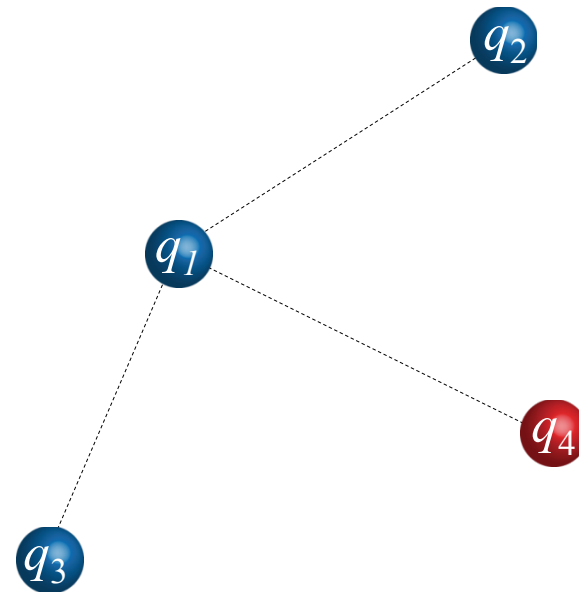
$$\vec{F}_1 = \vec{F}_{2,1} + \vec{F}_{3,1} + \vec{F}_{4,1} + \dots$$

Superposition Clicker Question

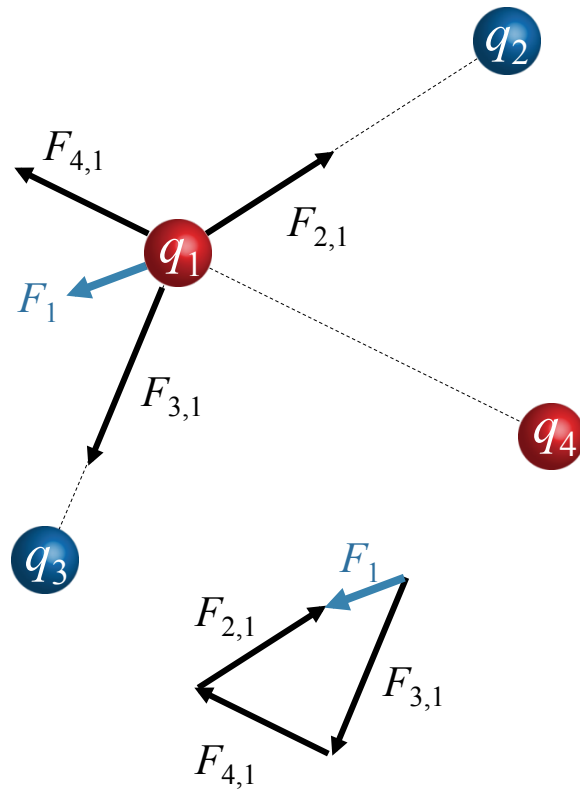


What happens to the magnitude of the Force on q_1 if its sign is changed from negative to positive?

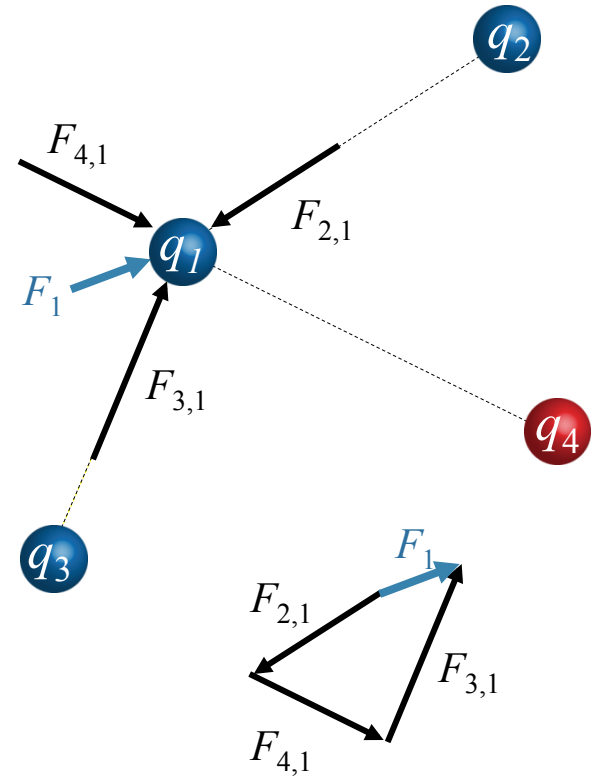
- A) $|F_1|$ increases
- B) $|F_1|$ remains the same
- C) $|F_1|$ decreases
- D) Need more information to determine



The **direction** of all forces changes by 180° – the **magnitudes** stay the same:



$$\vec{F}_1 = \vec{F}_{2,1} + \vec{F}_{3,1} + \vec{F}_{4,1} + \dots$$



$$-\vec{F}_1 = -\vec{F}_{2,1} - \vec{F}_{3,1} - \vec{F}_{4,1} - \dots$$

CheckPoint



Compare the magnitude of the net force on q in the two cases.

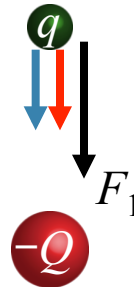
A) $|F_1| > |F_2|$

B) $|F_1| = |F_2|$

C) $|F_1| < |F_2|$

D) Depends on sign of q

$+Q$

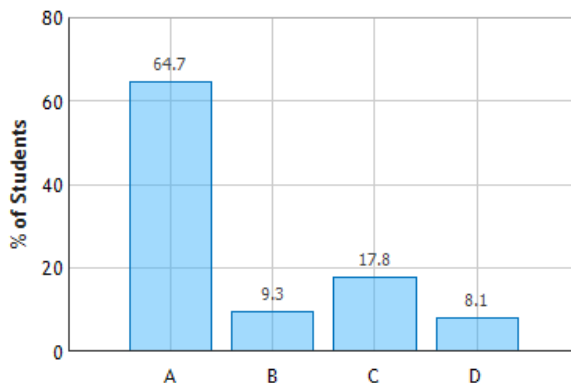


$+Q$



$F_2 = 0$

Compare Forces: Question 1 (N = 953)



“In case 1, no matter the sign of q the force on q from $+Q$ and $-Q$ will act in the same direction. Whereas in Case 2 the direction of the force of q from $+Q$ and $-Q$ act in opposite directions (cancel each other out). Therefore the magnitude of case 1 is bigger.”

“The magnitudes of the forces are the same because the magnitudes of the charges are the same.”

“In case 2 the symmetry cancels out all force on q .”

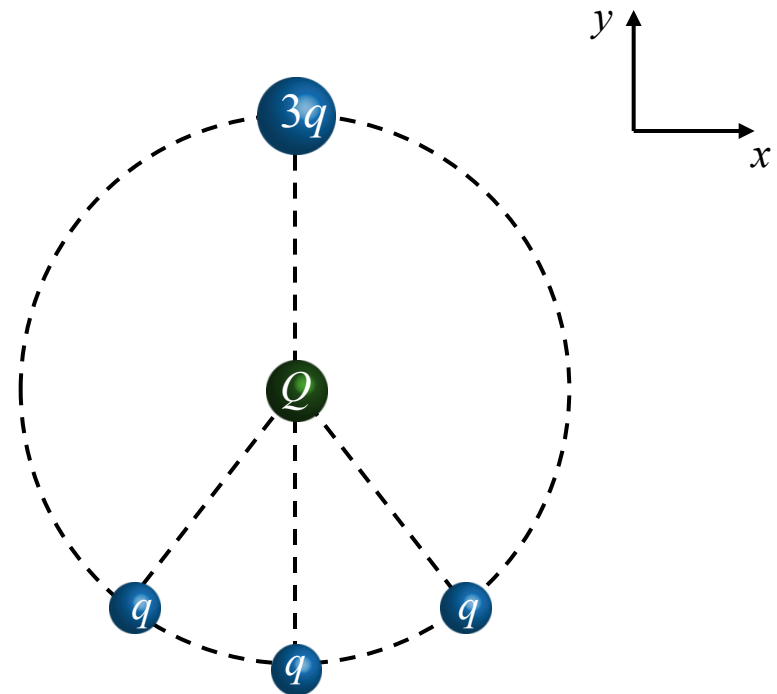
“You have to know the charge of q because the middle charge is what will determine the force of the whole system”

CheckPoint

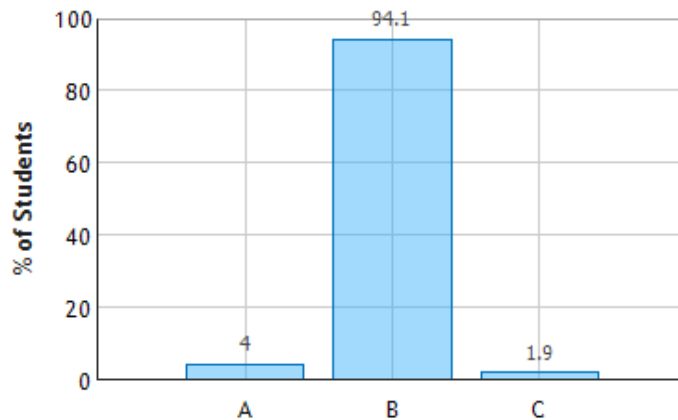
Four charged particles are placed on a circular ring with radius 3 m as shown below. A particle with charge Q is placed in the center of the ring

What is the direction of horizontal force on Q ?

- A) $F_x > 0$ B) $F_x = 0$ C) $F_x < 0$



Force from Four Charges: Question 1 (N = 950)



Excellent job!

“The two outer smaller charges will cancel in the x direction and the middle smaller charge does not have an x component”

Checkpoint

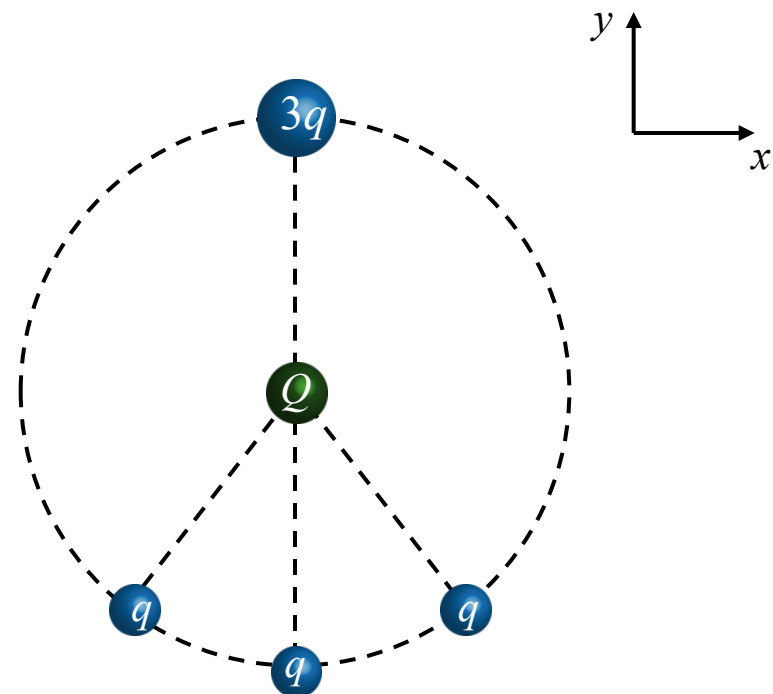
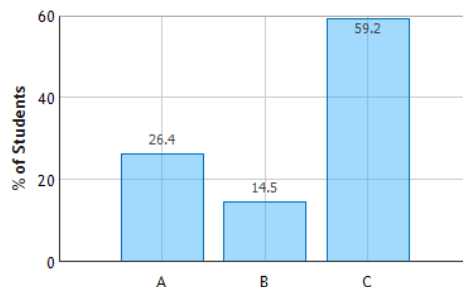


Four charged particles are placed on a circular ring with radius 3 m as shown below. A particle with charge Q is placed in the center of the ring

What is vertical force on Q ?

- A) $F_y > 0$ B) $F_y = 0$ C) $F_y < 0$

Force from Four Charges: Question 3 (N = 948)



“ F_y should also be zero because the top vertical force cancels out with the bottom vertical force.”

“Since they are all positive, the 3 q 's on the bottom exerts a net force that the $3Q$ charge also exerts, canceling each other out.”

“2 of the q s in the $-y$ direction don't contribute all of their magnitude to the y direction.”

See you Thursday!

Discussion Sections meet this week!

Be sure to complete prelecture 2 and preflight 2.

Labs begin next week.