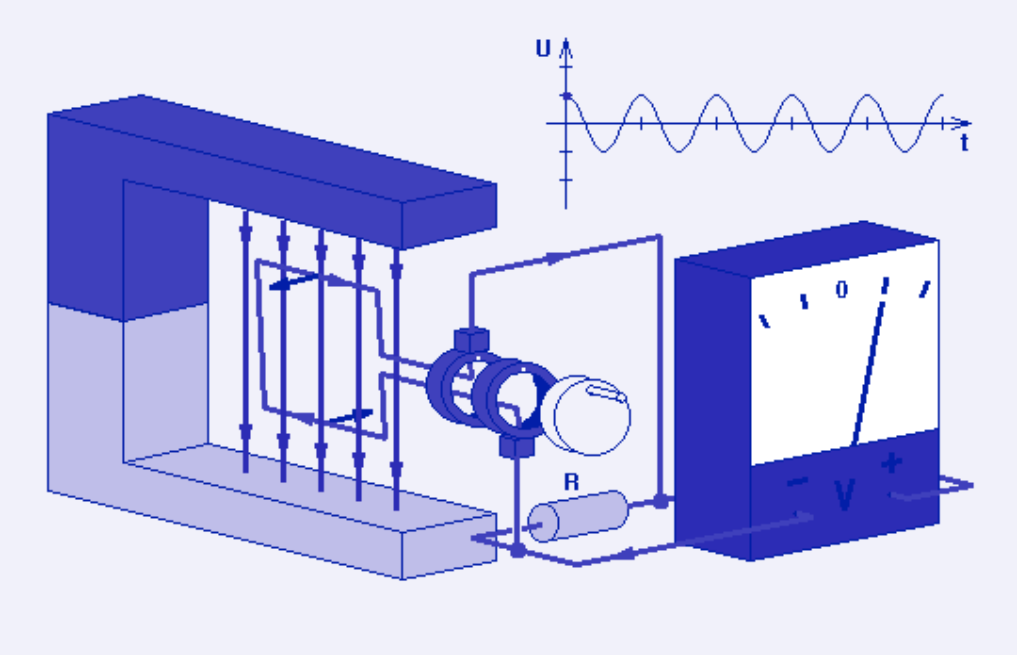
Welcome to Physics 212



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!

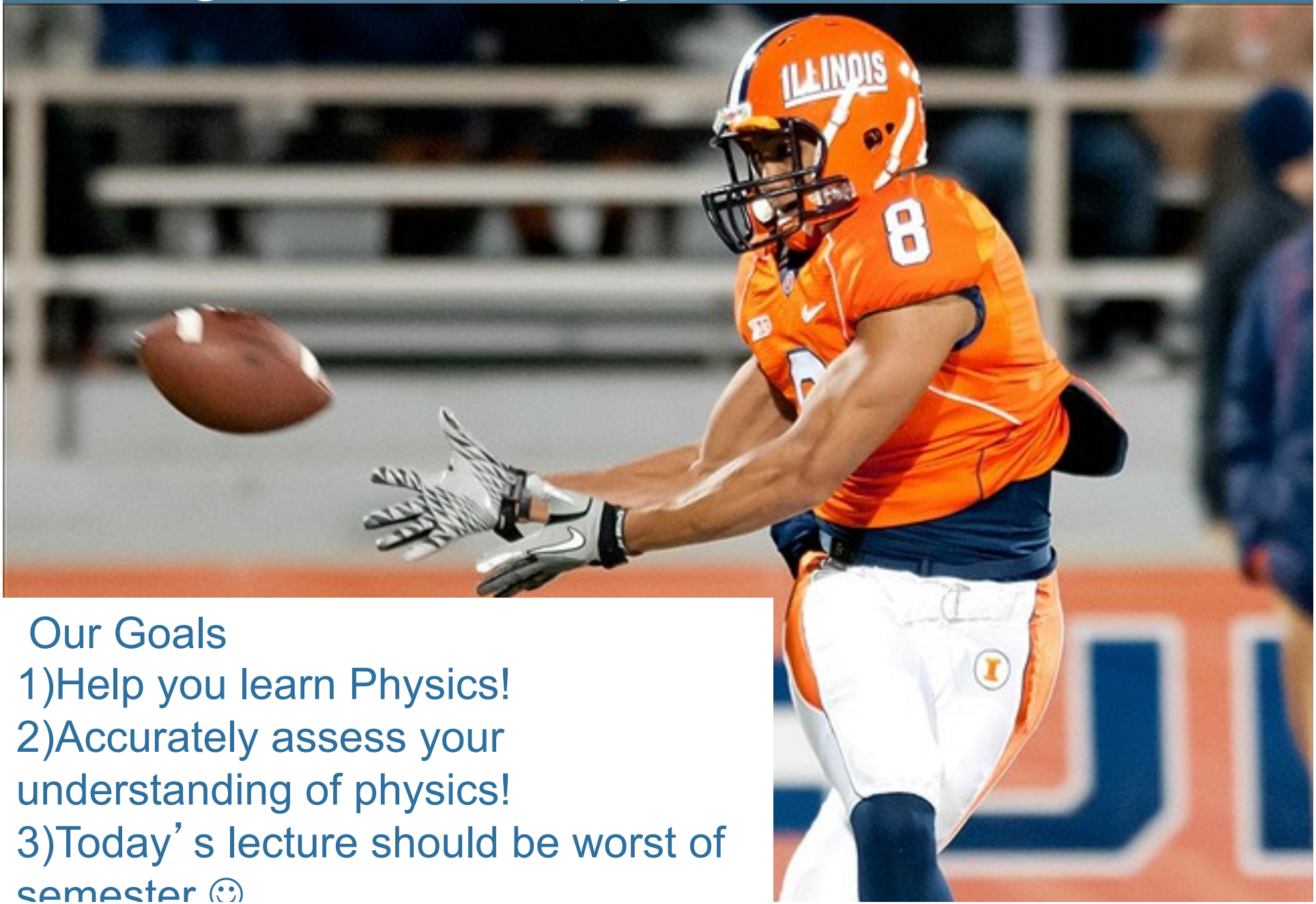
Rumors about Physics 212

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!



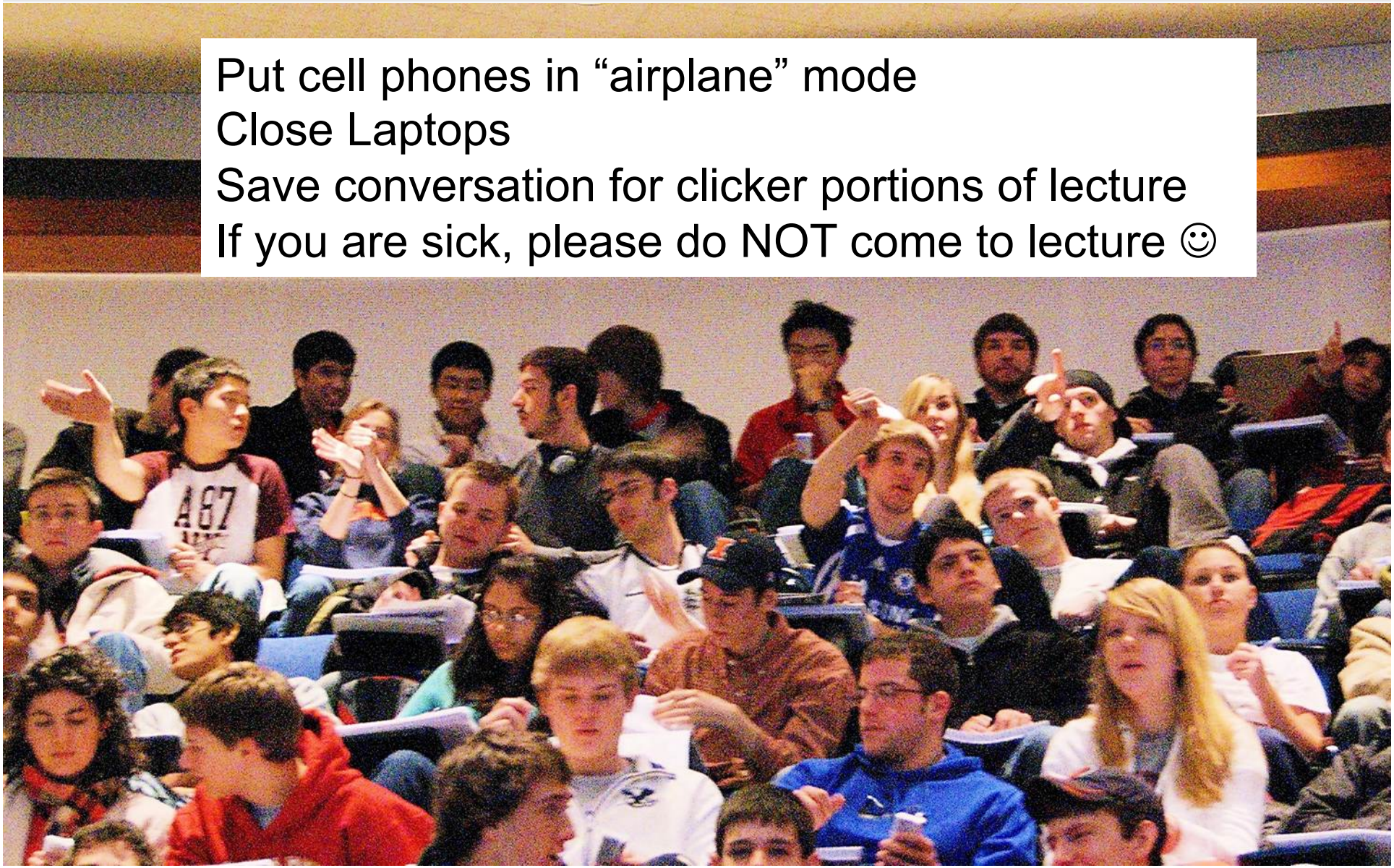
Our Goals

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 ☺

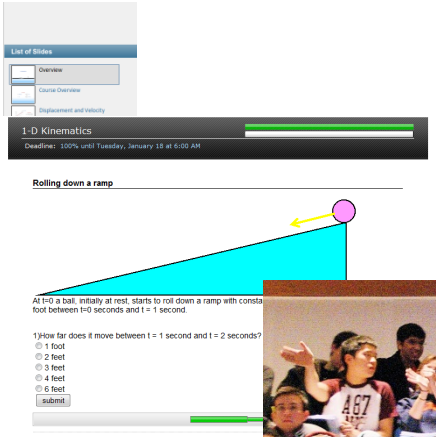
Course Structure

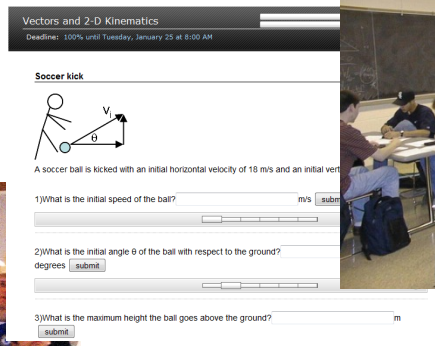
There are several parts, all are important:

smartPhysics

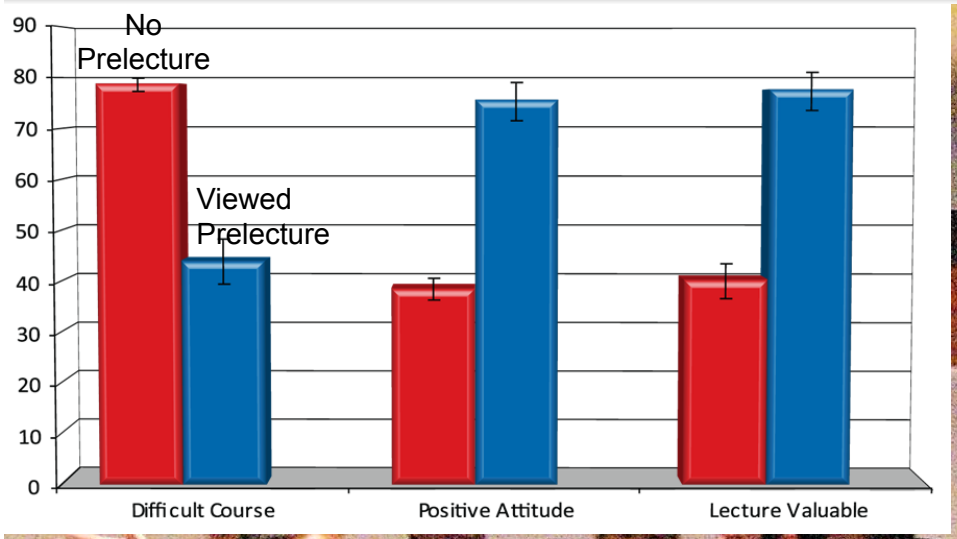
- Online Prelectures (animated textbook, *before lecture*)
- Online CheckPoints (check knowledge, *before lecture*)
- Lectures – interactive, address issues found by checkpoints.
- Online Homework (first deadline next week)
- Discussion Sections (start this week)
- Lab Sections (start next week)

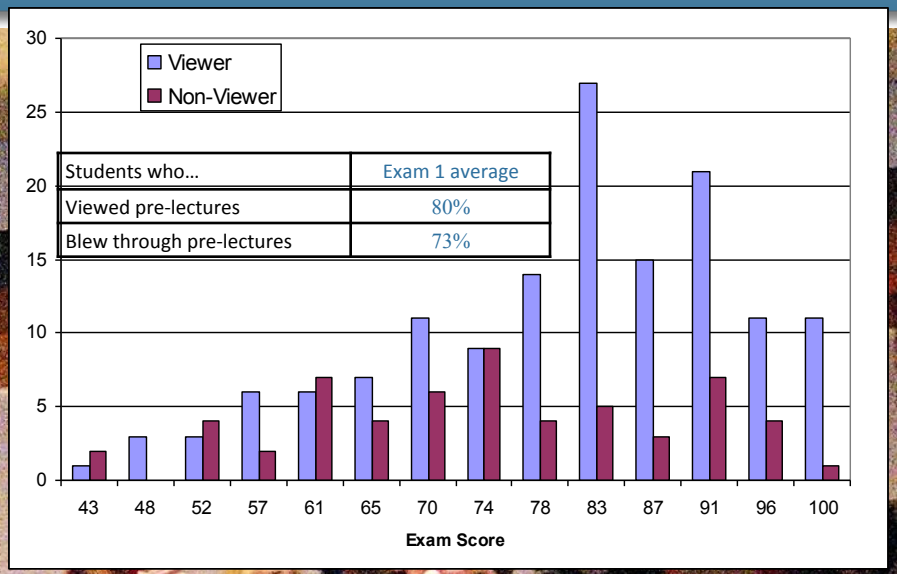
Go to the right one !
Don't be late!

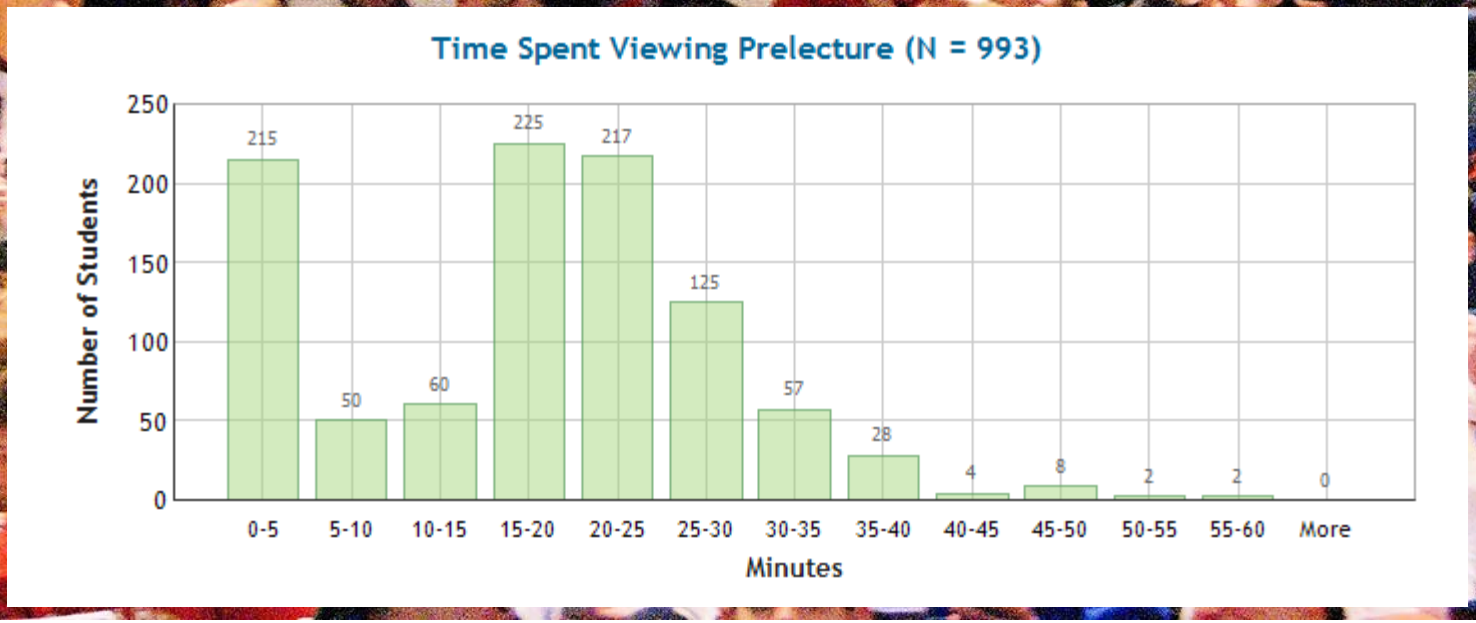




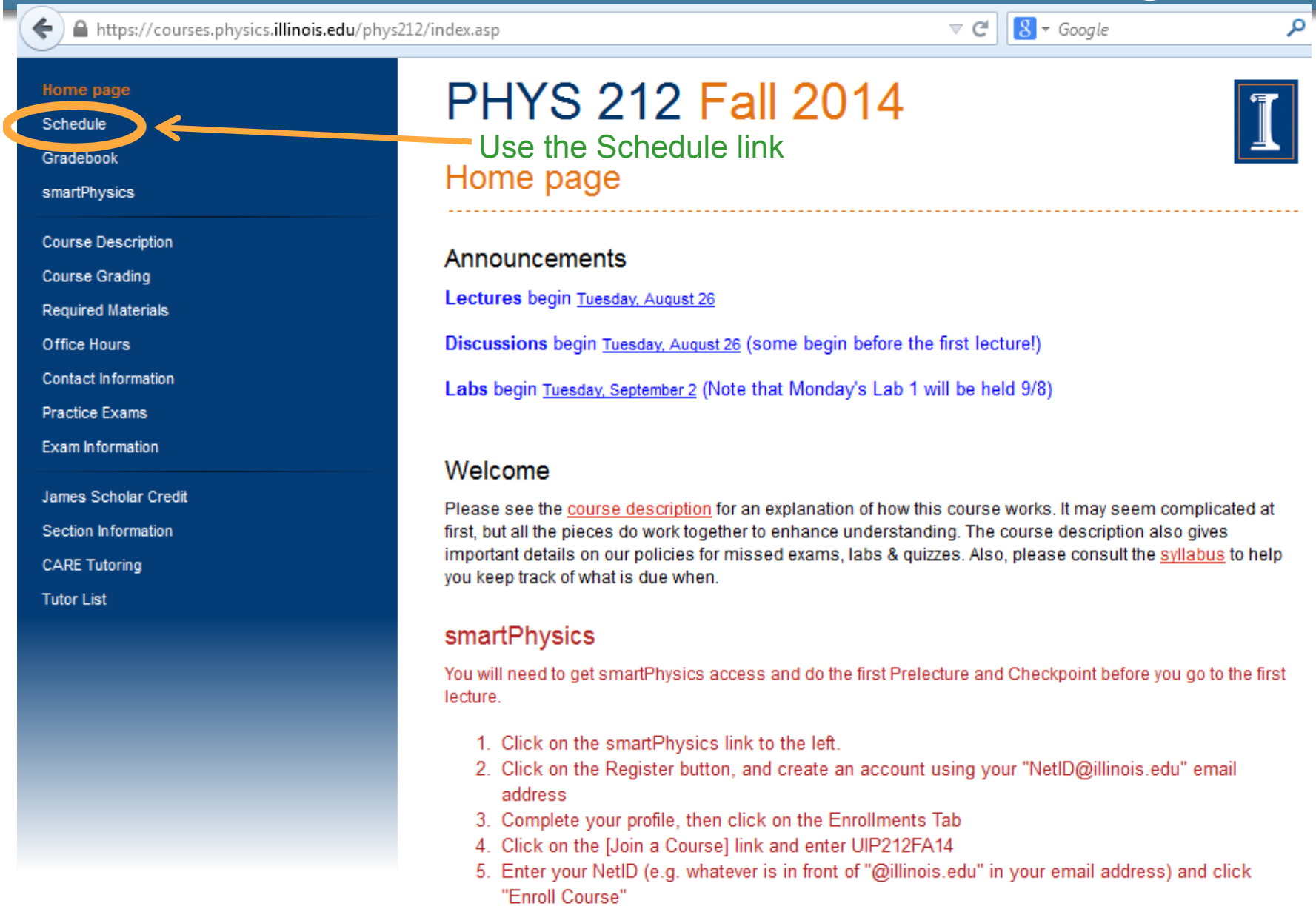
Lecture Prep+Participation: Just Do It







Get to know the course Home Page



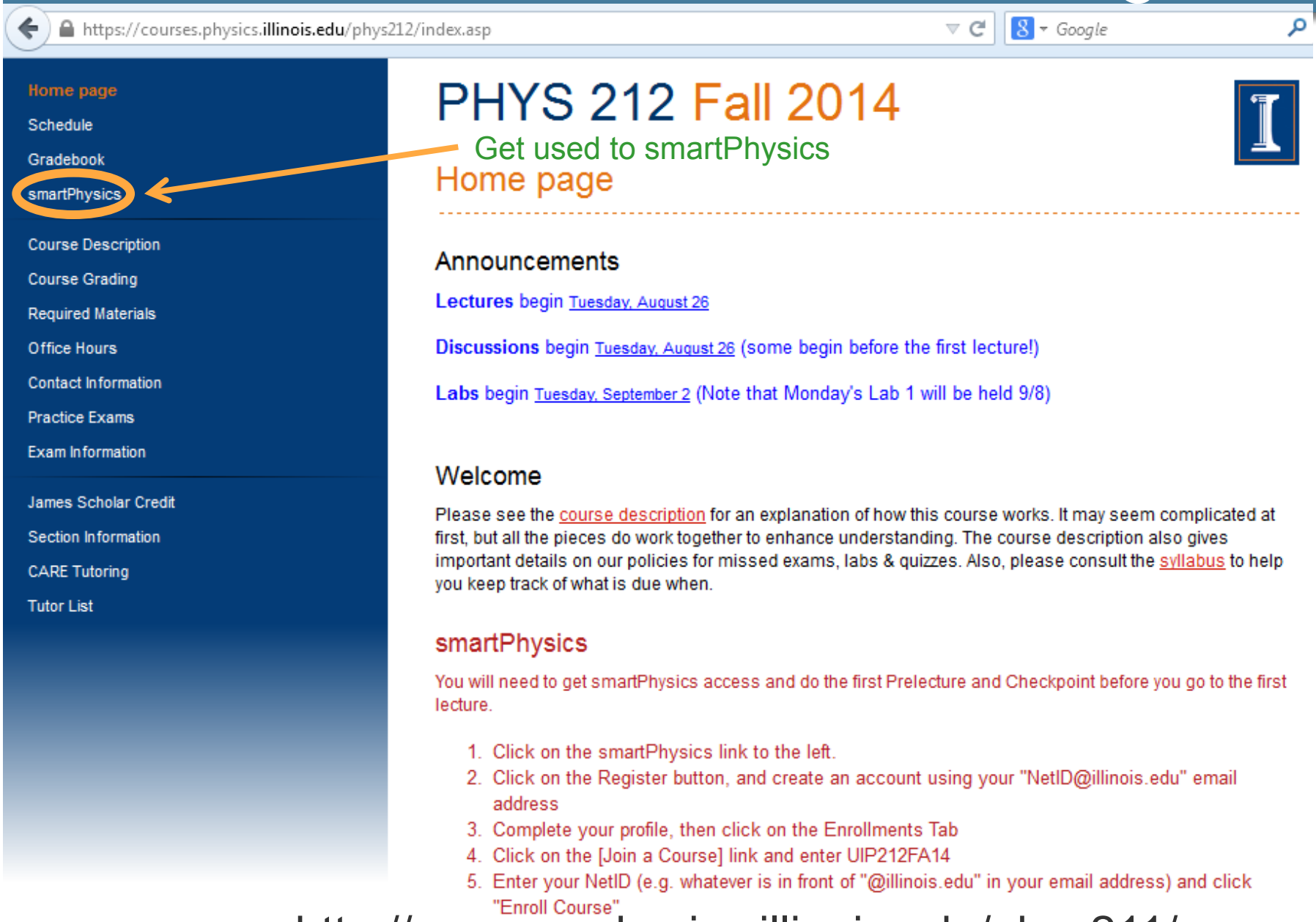
http://courses.physics.illinois.edu/phys212/

Syllabus…

Week	Date	Prelecture	Checkpoint	Lecture	Lab	Discussion	Homework	Exam
1	Monday 8/25/2014							
	Tuesday 8/26/2014	Prelecture 1	Checkpoint 1	Lecture 1: Introduction and Coulomb's Law pdf ppt				
	Wednesday 8/27/2014				***No Lab***	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	Discussion 2 Quiz 1	Homework 1 due	
	Wednesday 9/3/2014							
	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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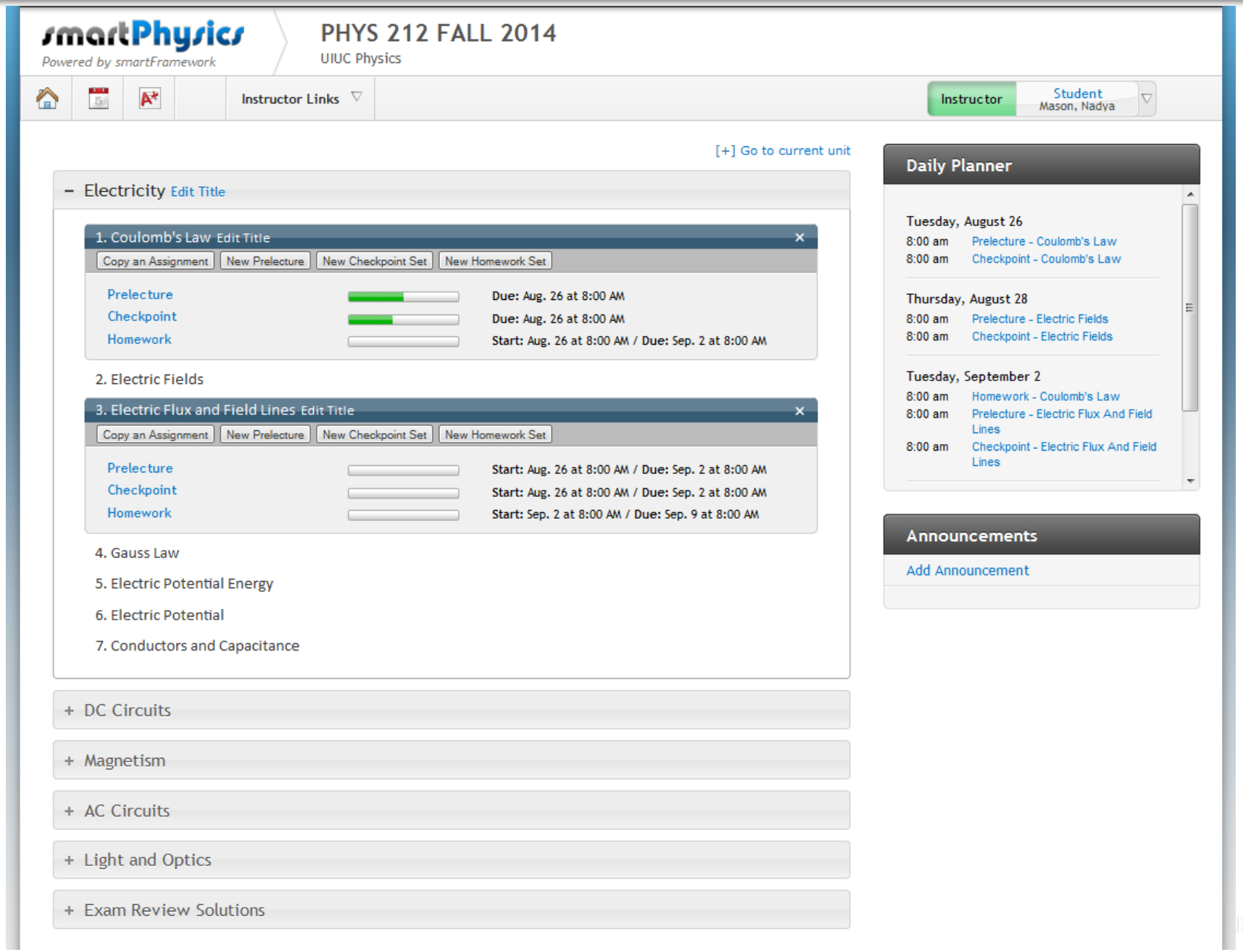
smartPhysics



Homework

smartPhysics

Physics 212 Fall 14
University of Illinois

Administrator Links

Instructor | Student Stelzer, Timothy

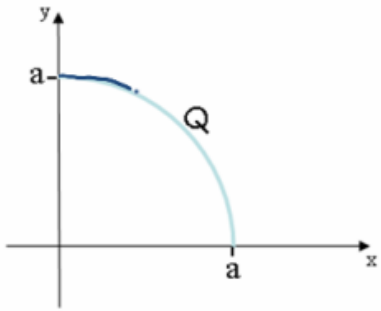
Unit 1: Prelecture / Checkpoint / Homework /

Homework: Coulomb's Law

Help:

1 | 2 | 3 | 4 | 5

A total charge Q = -4.2 μC is distributed uniformly over a quarter circle arc of radius a = 7.7 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

orked Example
oulomb's Law
-- Optional --

andard Exercise
oint Charges in One Dimension

andard Exercise
oint Charges in Two Dimensions

teractive Example
hree Charges

orked Example
lectric Fields
-- Optional --

teractive Example
ero

andard Exercise
lectric Field from Point Charges

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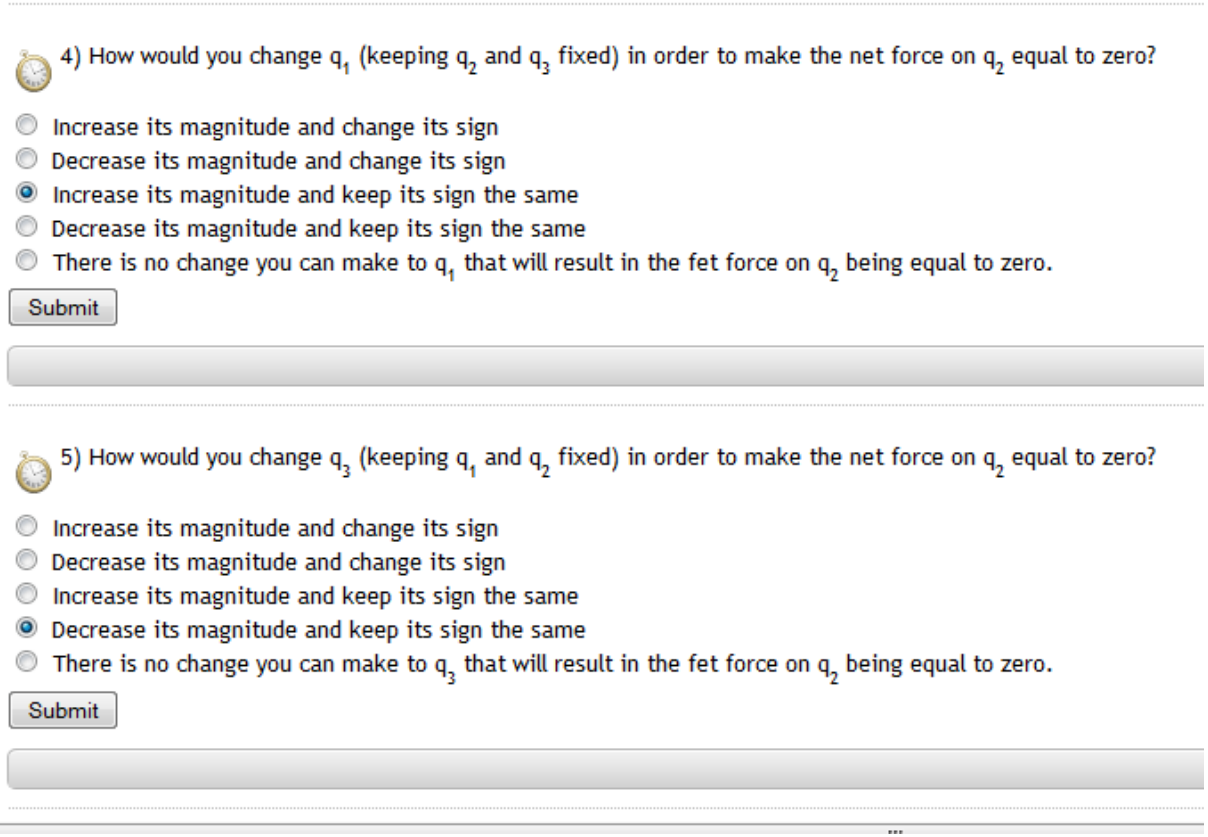
lectric Field from Arc of Charge

andard Exercise
ipler6 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 fet 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?

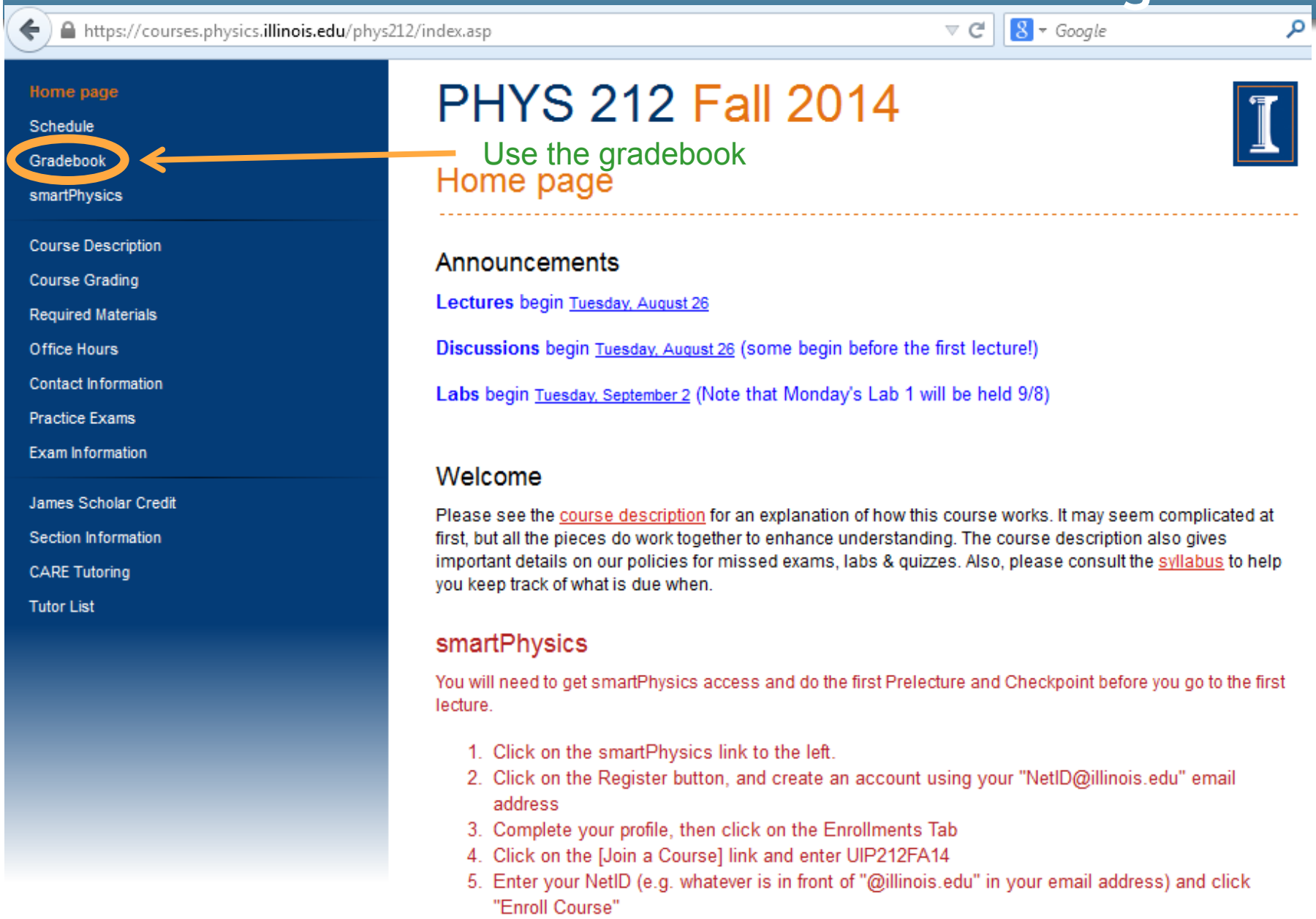
- Increase its magnitude and change its sign
- Decrease its magnitude and change its sign
- Increase its magnitude and keep its sign the same
- Decrease its magnitude and keep its sign the same
- There is no change you can make to q_3 that will result in the fet force on q_2 being equal to zero.

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.

Get to know the course Home Page



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.

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

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 Sign Up

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]

Grade Information

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

Scores will be imported from smartPhysics weekly

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

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

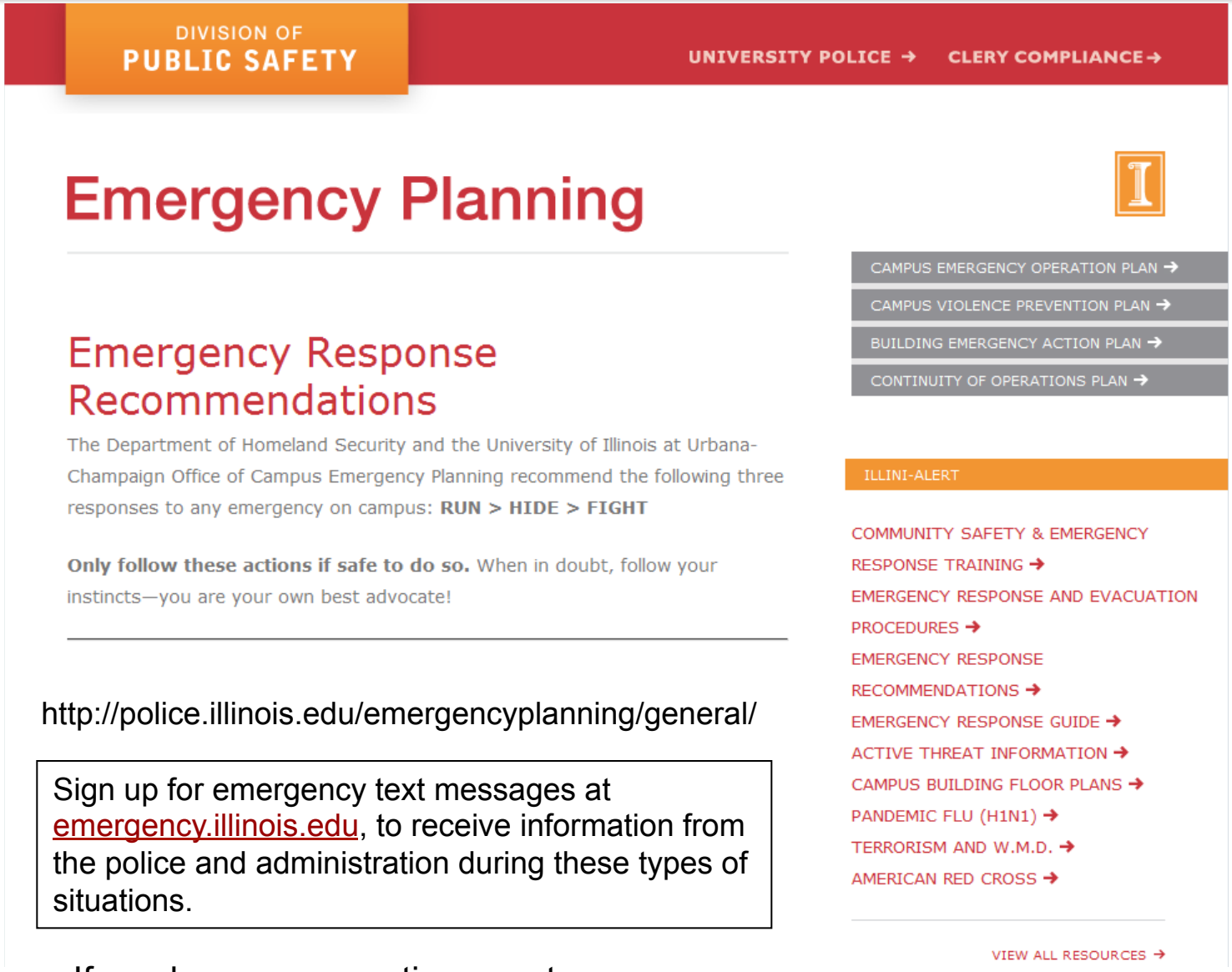
Your top 22 HW/Quiz scores determine your grade out of 250.

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



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

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:

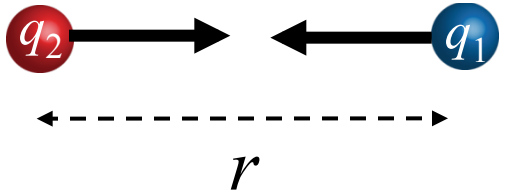
A) Coulomb's Law

B) Superposition

Coulomb's Law:

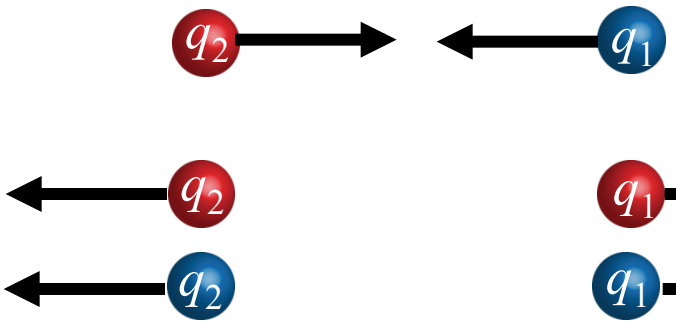
The force on a charge due to another charge is proportional to the product of the charges and inversely proportional to the separation squared.

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:

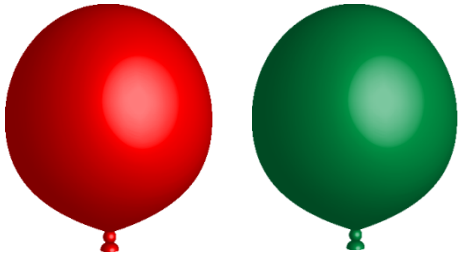


Opposite signs attract

Like signs repel

Balloons

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

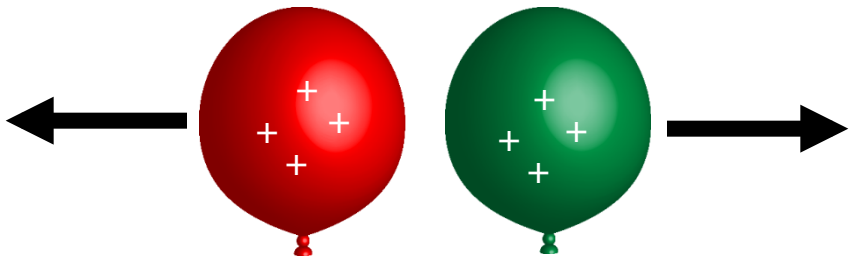


A) Attract each-other
B) Repel each-other
C) Either – it depends on the material of the cloth

Balloons

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

They will repel!



Coulomb's Law

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

Our notation:

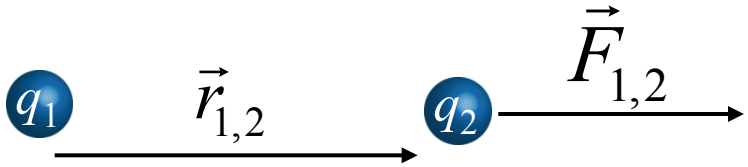
$\vec{F}_{1,2}$ is the force by 1 *on* 2 (think "*by-on* ")

$\hat{r}_{12}$ is the unit vector that points *from* 1 *to* 2.

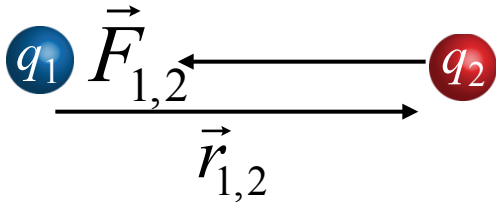
"I would like to know what the r with a carrot sign means at the end of Coulumb's law means."

Examples:

If the charges have the same sign, the force **by** charge 1 on charge 2 would be in the direction of 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 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.

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

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

electron charge = 1.6×10^{-19} 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.

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

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

electron charge = 1.6×10^{-19} Coulombs

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

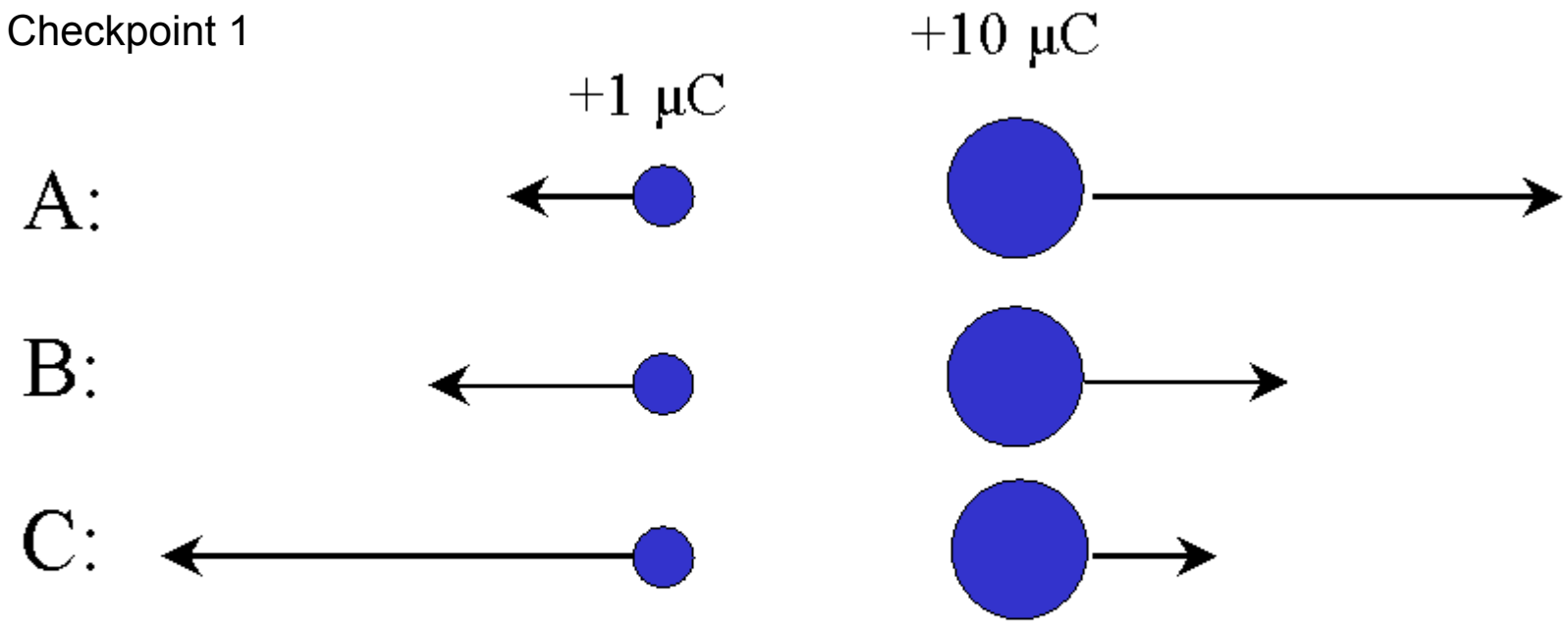
Which weight is closest to the approximate force between those paperclips (recall that weight = mg, g = 9.8 m/s^2)?

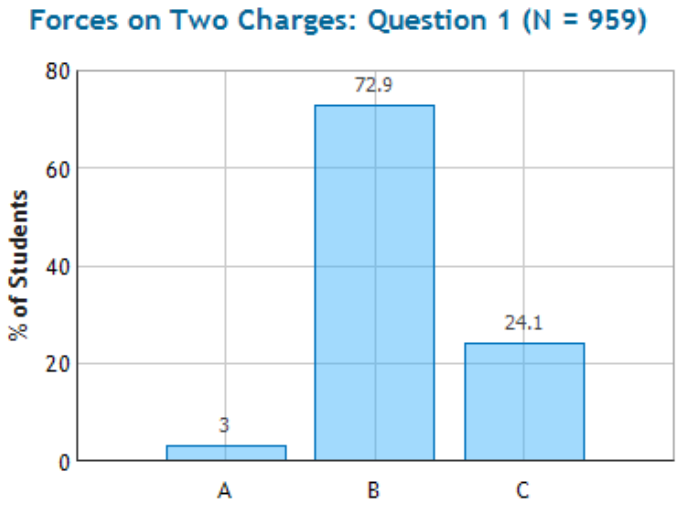
Balloon demo

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

Checkpoint 1





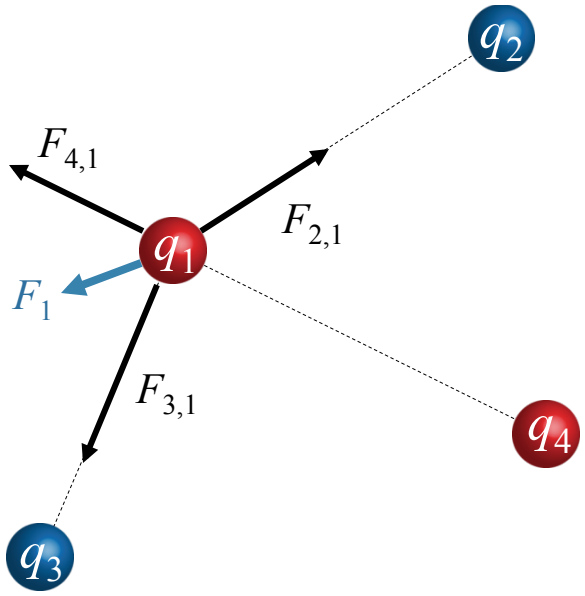
"Because the two charges are positive, they repel (or go in opposite direction). Because the charges are from one atom to another, the sizes of the force go on opposite end."

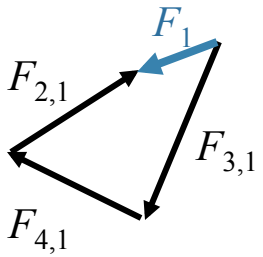
"Due to the newton's third law, the forces acting on these two objects should be equal."

"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:





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

Superposition Clicker Question

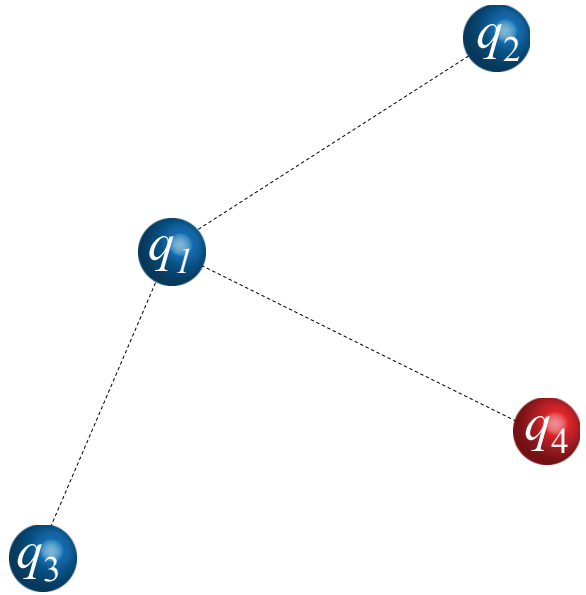
What happens to the magnitude of the Force on q_1 if its sign is changed from negative to positive?

A) $|F_1|$ increases

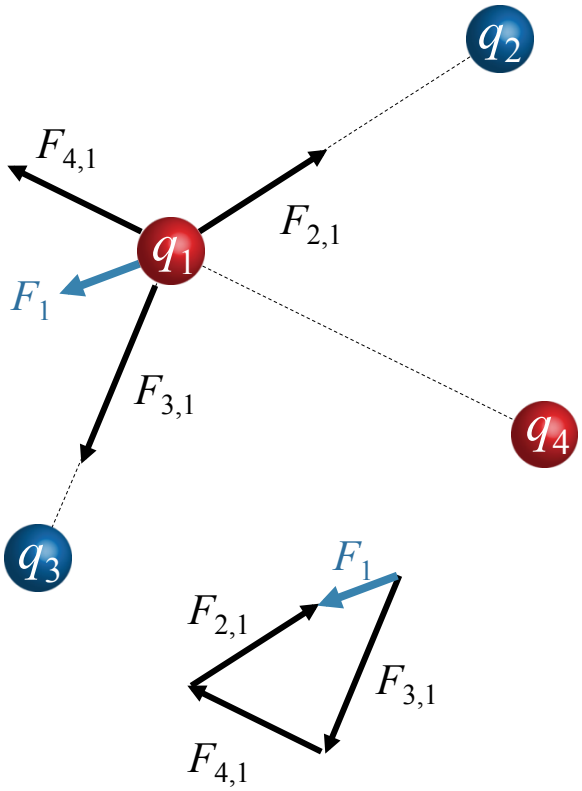
B) $|F_1|$ remains the same

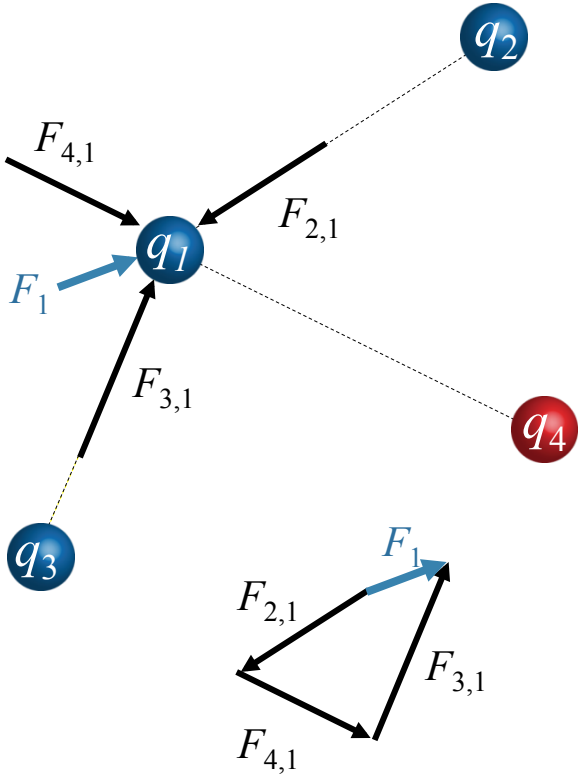
C) $|F_1|$ decreases

D) Need more information to determine



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





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

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

CheckPoint

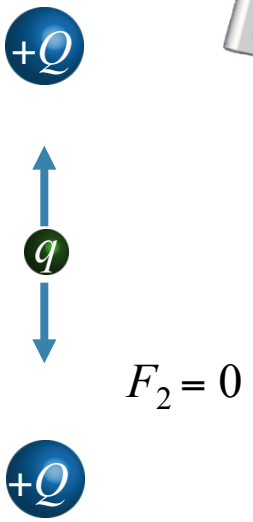
Compare the magnitude of the net force on q in the two cases.

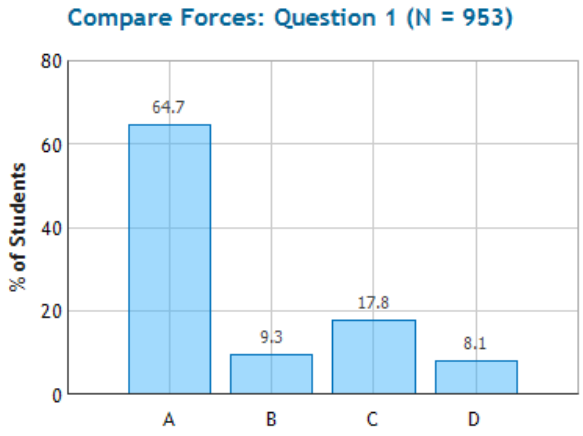
A) $|F_1| > |F_2|$

B) $|F_1| = |F_2|$

C) $|F_1| < |F_2|$

D) Depends on sign of q





"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."

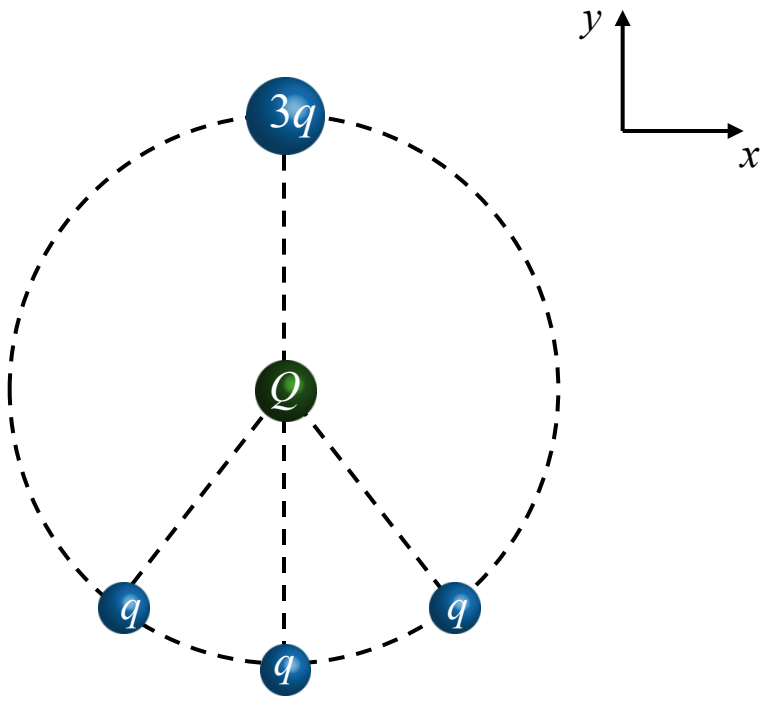
"The magnitudes of the forces are the same because the magnitudes of the charges are the same."

"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"

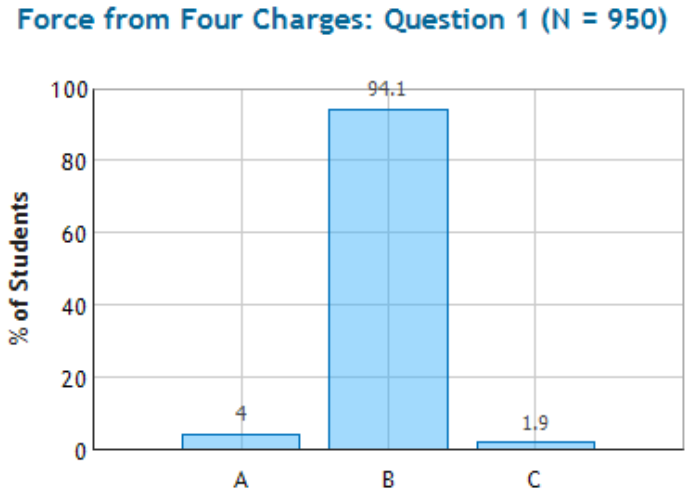
CheckPoint

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) $F_x < 0$

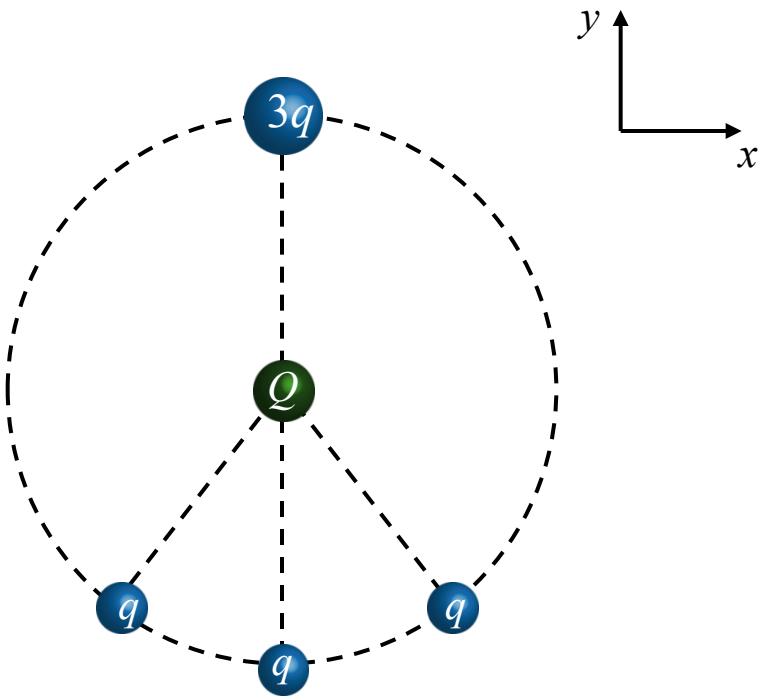


Excellent job!

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

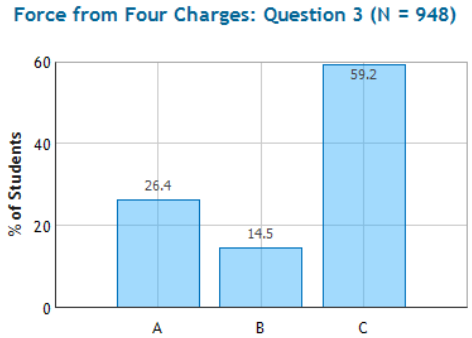
CheckPoint

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) $F_y < 0$



"Fy 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 qs 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.