Welcome to Physics 212 – Fall 2025!

Electricity & Magnetism
Lecture 1

- Coulomb's Law
- electric fields
- Gauss' Law
- electric potential
- capacitance
- circuits
- magnetic forces and fields
- Ampere's law
- induction
- electromagnetic waves
- polarization
- geometrical optics.

Instructor

Prof. Chao Qian

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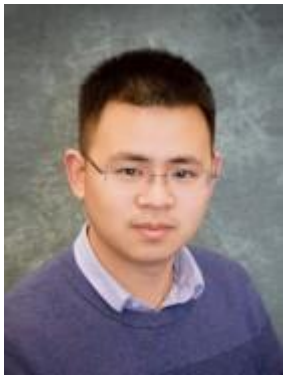

Prof. Ruisheng Diao

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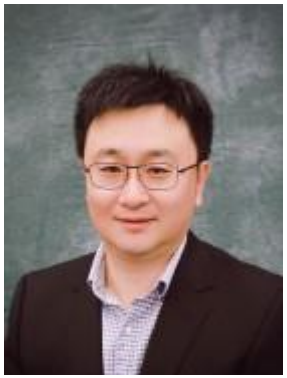
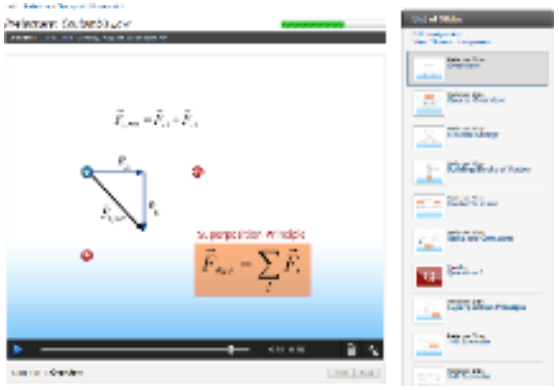


Course Structure

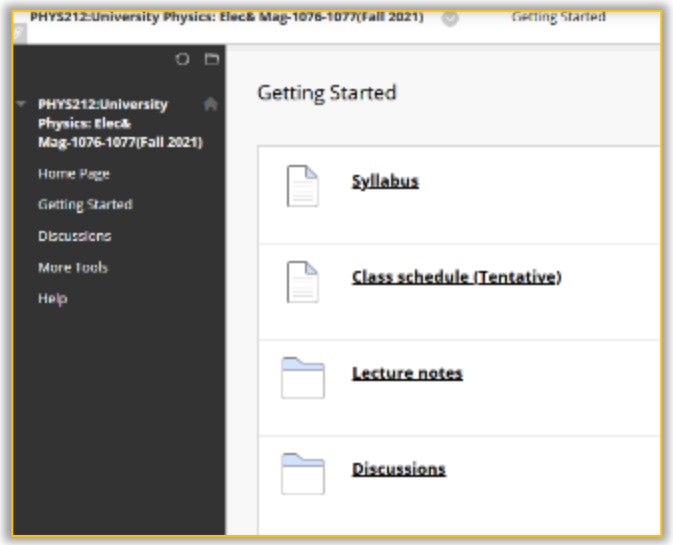
There are several parts, all are important:

- **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)
- Exams (don't worry about that yet!)

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



Syllabus…



PHYS 212 Fall 2025

University Physics: Electricity & Magnetism

Instructor: **Prof. Chao Qian & Prof. Ruisheng Diao**

Contact Information

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Login the online system to find your pre-lectures and homework:

https://byteshelf.physics.illinois.edu/

PHYS 212 Class Schedule

Fall 2025

Week	Date	Event	Reading	Notes
1	**Monday** 9/15/2025	**Lecture 1:** Introduction and Coulomb's Law	OpenStax Vol. 2 5.1-5.3	
	Monday 9/15/2024	Discussion 1-8		
	Wednesday 9/17/2024	**Lecture 2:** Electric Fields	5.4-5.5	
2	**Monday** 9/22/2024	**Lecture 3:** Electric Fields and Electric Flux	5.6, 5.7, 6.1	
	Monday 9/22/2024	Discussion 1-8		Quiz 1
	Wednesday 9/24/2024	**Lecture 4:** Gauss's Law	6.2-6.4	
3	**Monday** 9/29/2024	**Lecture 5:** Electric Potential	7.1	
	Monday 9/29/2024	Discussion 1-8		Quiz 2
	Wednesday 10/1/2024	No class		National Day Holiday

Grading…

14 weeks in this semester (except holiday)

Your final grade for Physics 212 will be based upon your total score on all the components of the course. The total possible score is 1000 points.

Course component	Number of assignments	Number dropped per semester	Maximum points per semester
Prelectures	28	3	25
Checkpoints	28	3	25
Lecture (Participation)	28	3	50
Homework	14	1	130
Discussion quizzes	10	1	130
Labs	9	1	120
Hour exams	3	0	3 X 80= 240
Final exam	1	0	280

Bonus Points: 25 points

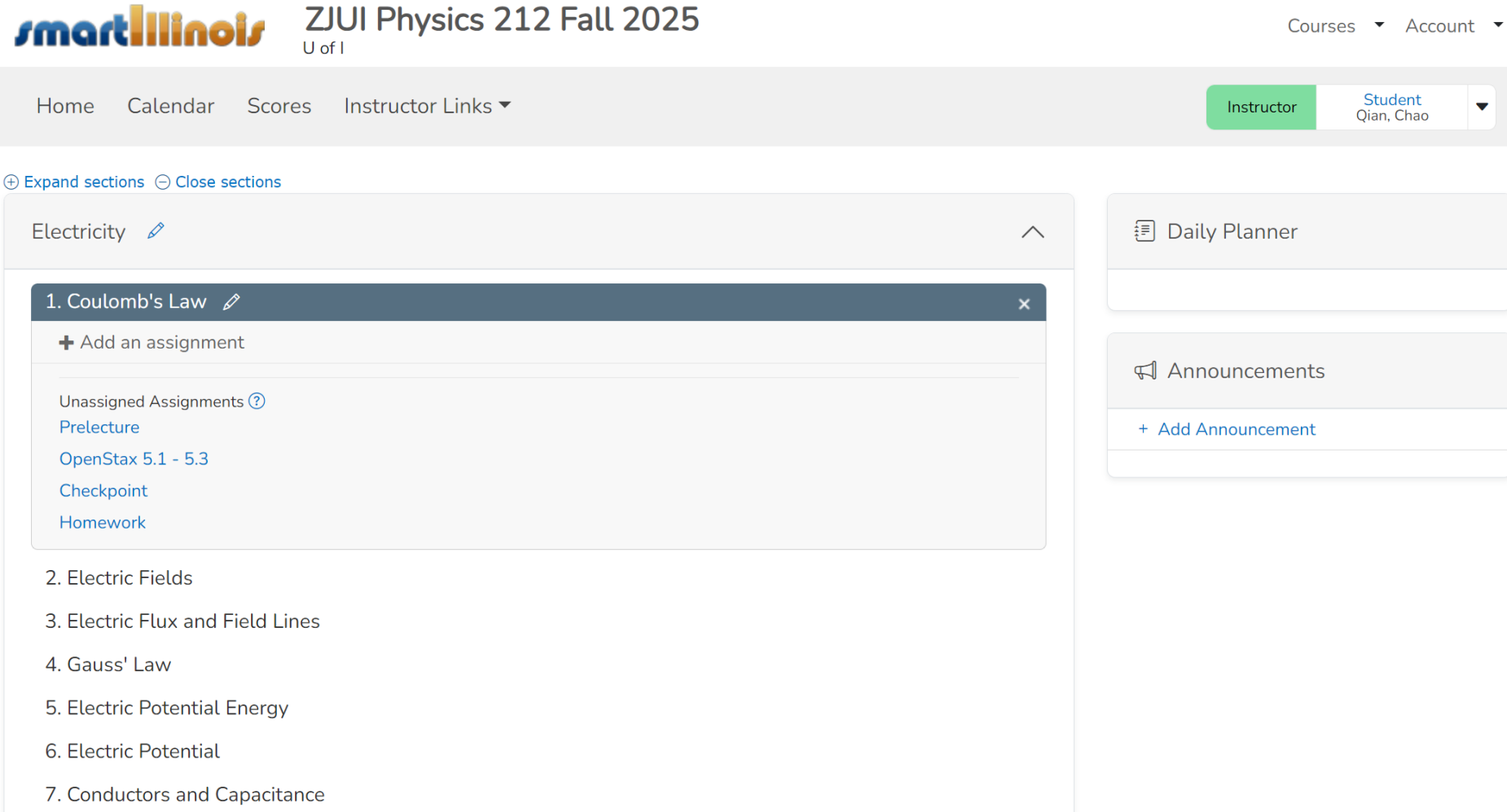
You will have an opportunity to earn up to 25 bonus points via the following activities.

- answering *Online Quiz* correctly in lecture (15 points)
- participating in activity correctly in discussion (10 points)

The bonus points will be distributed among any assignment scores except exam scores when calculating your final score at the end of the semester.

Final Grade	Minimum Points
A+	970
A	930
A-	900
B+	870
B	830
B-	800
C+	770
C	730
C-	700
D+	670
D	630
D-	600
F	<600

Smart Physics



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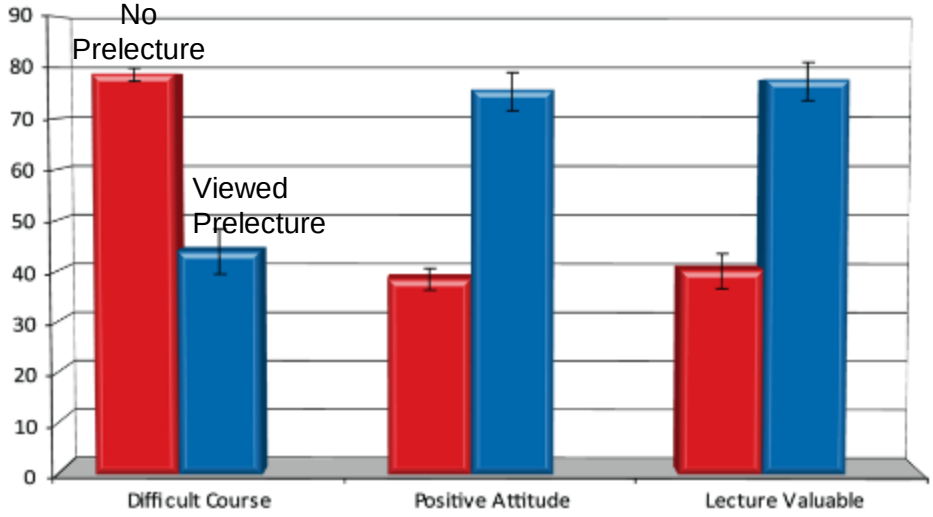
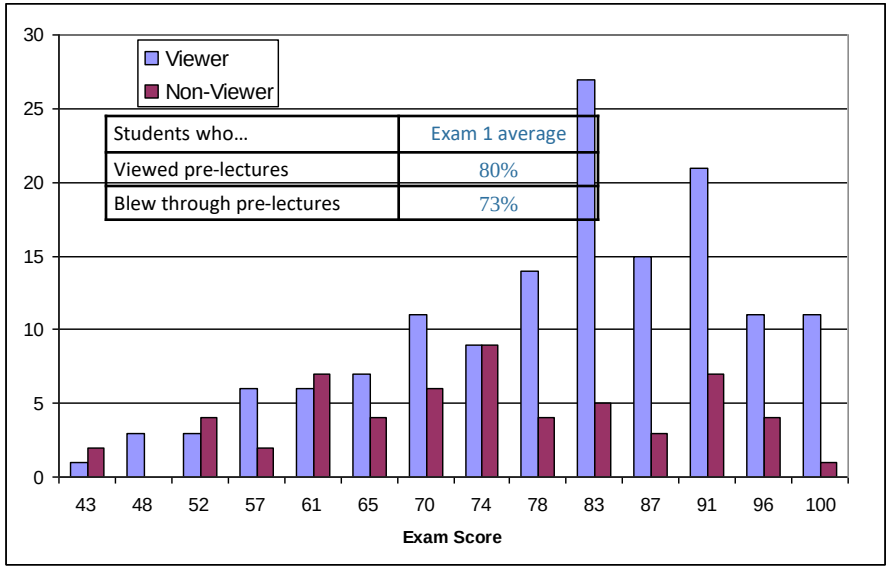
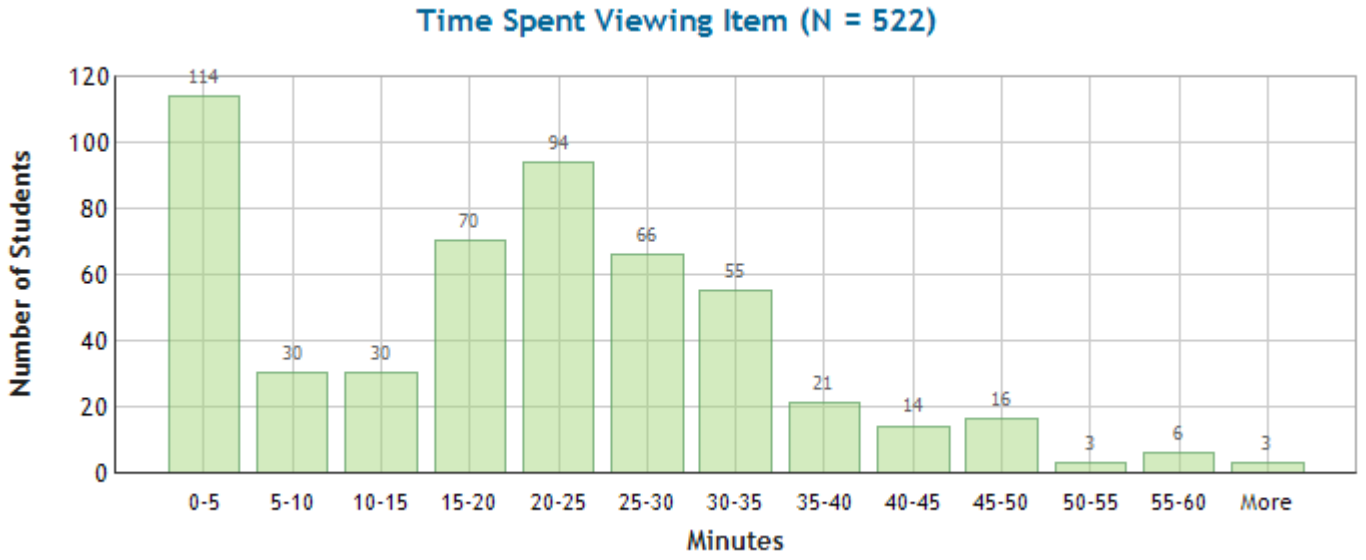
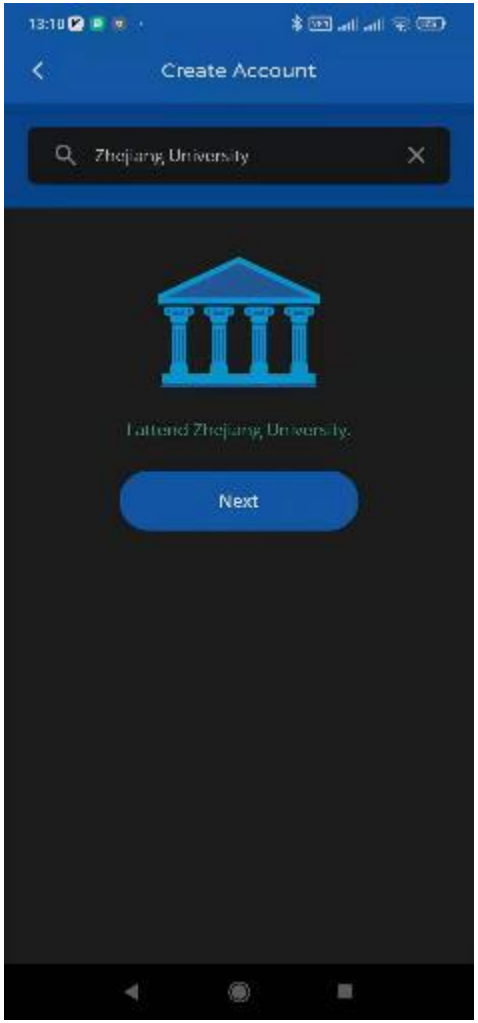
Prelectures: Just Do It

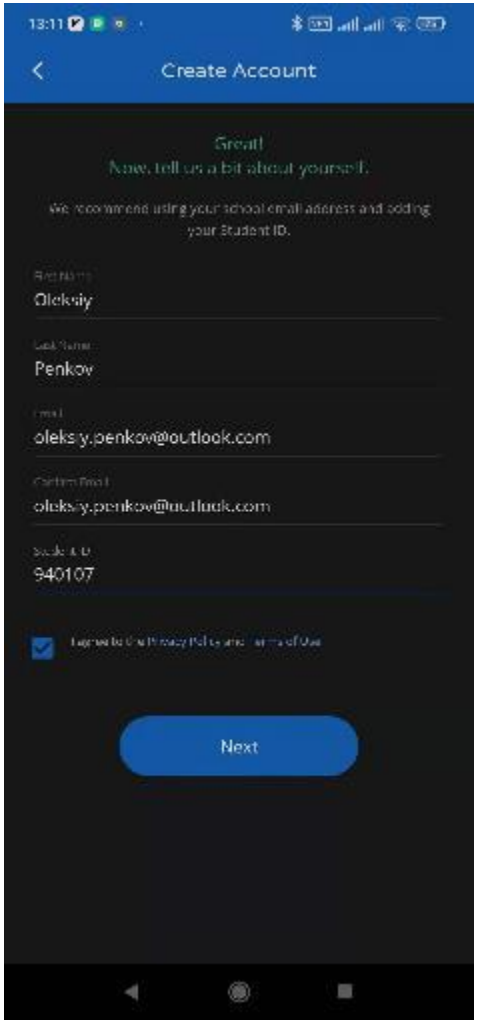






iClicker Cloud!





For 15:00-15:50, select PHYS 212 (class 1)

For 16:00-16:50, select PHYS 212 (class 2)

https://www.iclicker.com/students/

Pop Quiz

Can you make it to the breakout room and back?

A) Yes
B) No
C) I'm trying to use my old physical iClicker and the vote's not registering!
D) Can I vote by mail?

About me…

Electricity & Magnetism
Lecture 1

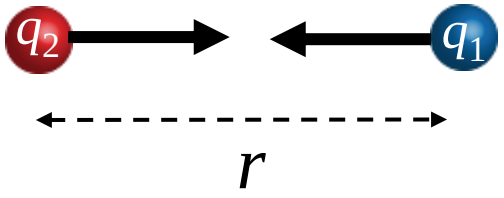
Today's Concepts:

A) Coulomb's Law

B) Superposition

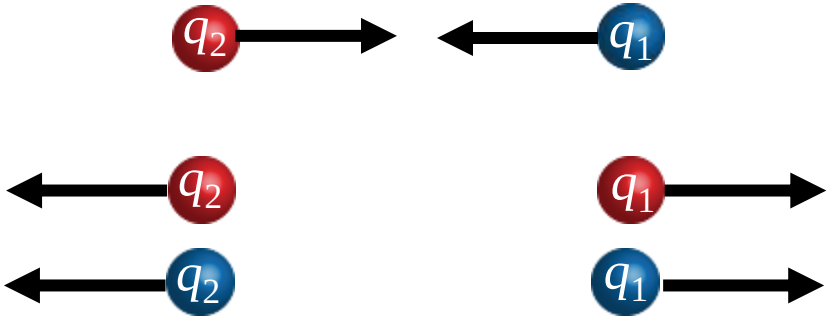
Coulomb's Law:

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



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

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

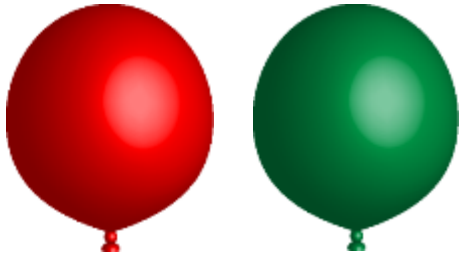


Opposite signs attract

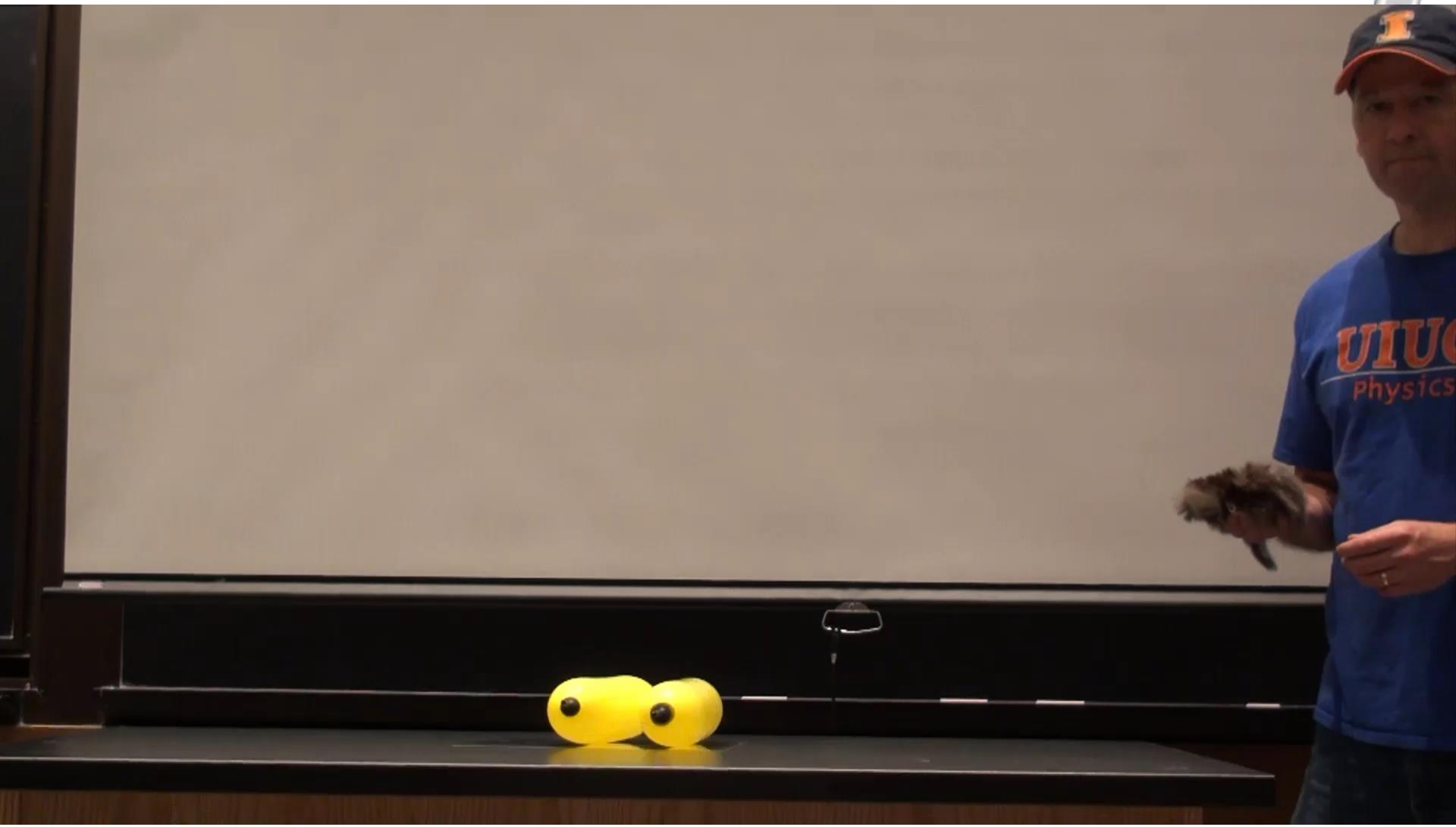
Like signs repel

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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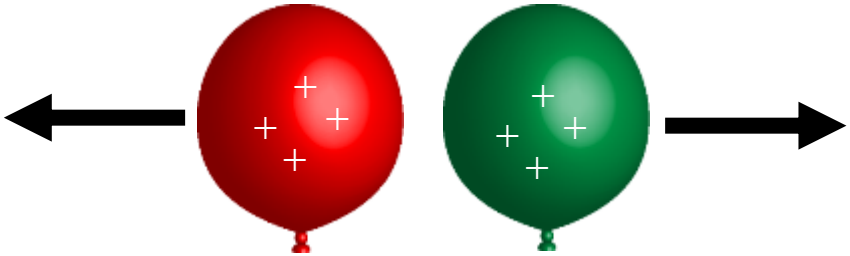
Physics

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:

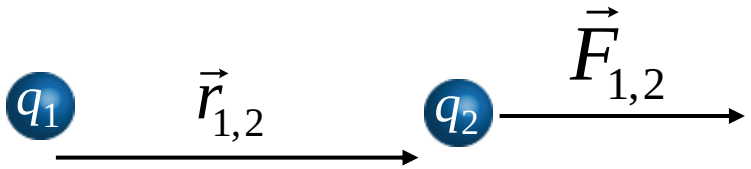
$\vec{F}_{1,2}$ is the force by 1 *on* 2 (think "*by-on* ")

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

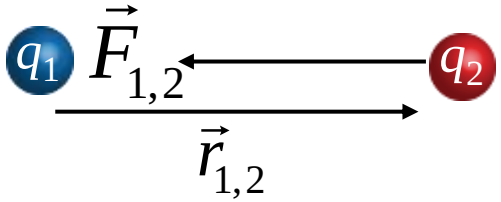
what is 'k'?

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 iron 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.

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

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

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

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

Iron molar mass ~ 56 grams/mol

mass of paper clip ~ 1 grams

What will the direction of the force be?

A) Attractive B) Repulsive

Example: Coulomb Force

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

Iron molar mass ~ 56 grams/mol

mass of paper clip ~ 1 grams

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

A) Paperclip (1 grams x g)

B) Text book (1 kg x g)

C) Truck (10^4 kg x g)

D) Aircraft carrier (10^8 kg x g)

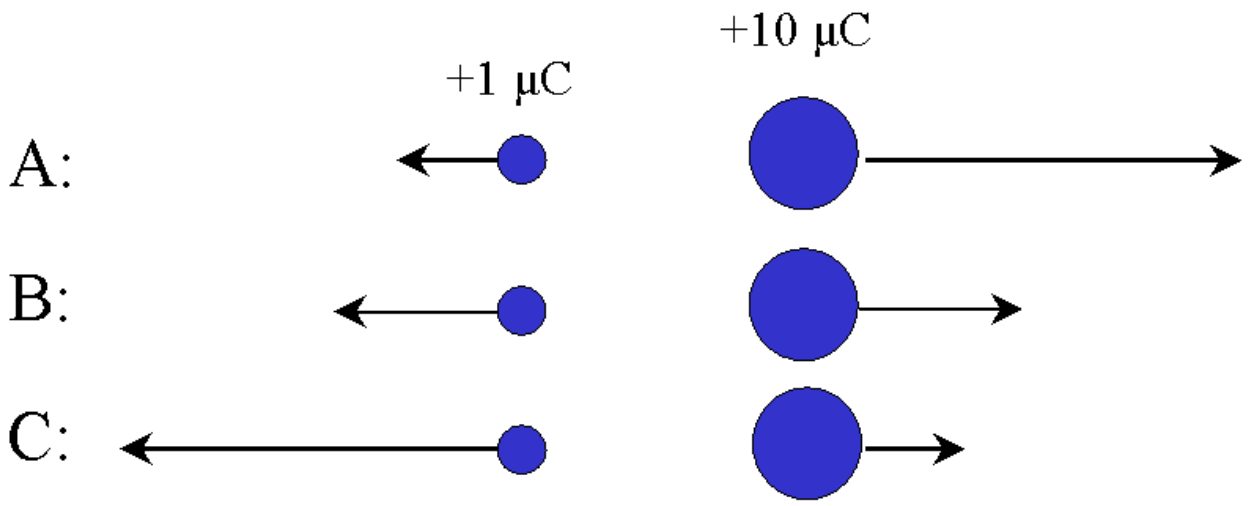
E) Mt. Everest (10^{14} kg x g)

F = 9e9 x (1.6e-19 * 1e22)^2 / 10 = 2 e 15 Newtons

Physics 212 >>> Physics 211

Check Point 1

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



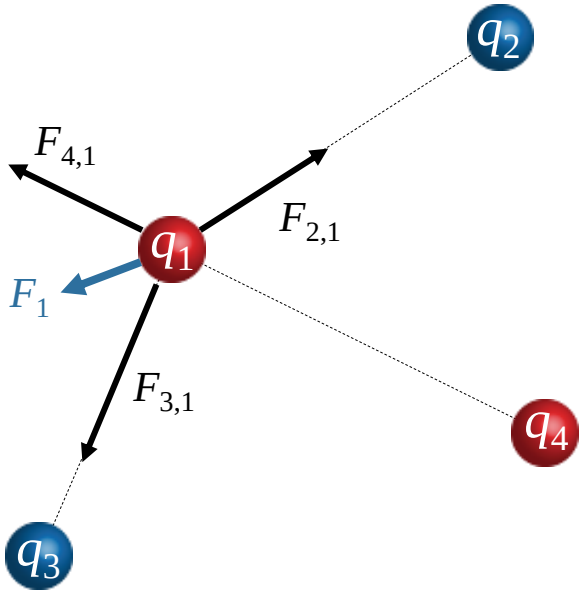
A) bigger charge experiences a bigger force

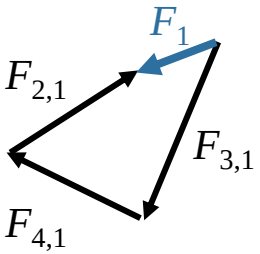
B) Newton's 3rd law says the forces must be equal and opposite.

C) Bigger charge creates a bigger force

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:





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

Check Point 2

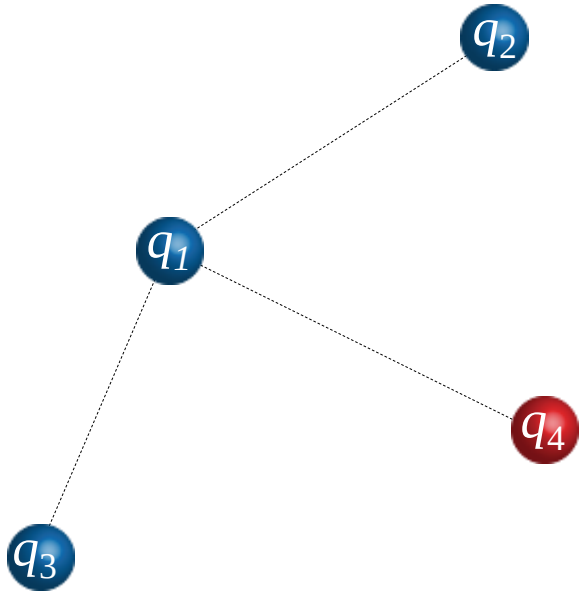
What happens to the magnitude of the Force on q_1 if its sign is changed from negative to positive?

A) $|F_1|$ increases

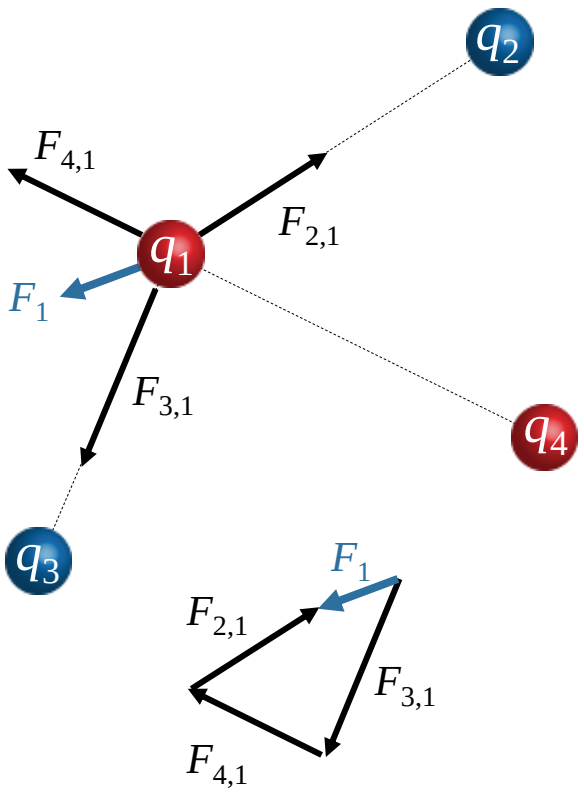
B) $|F_1|$ remains the same

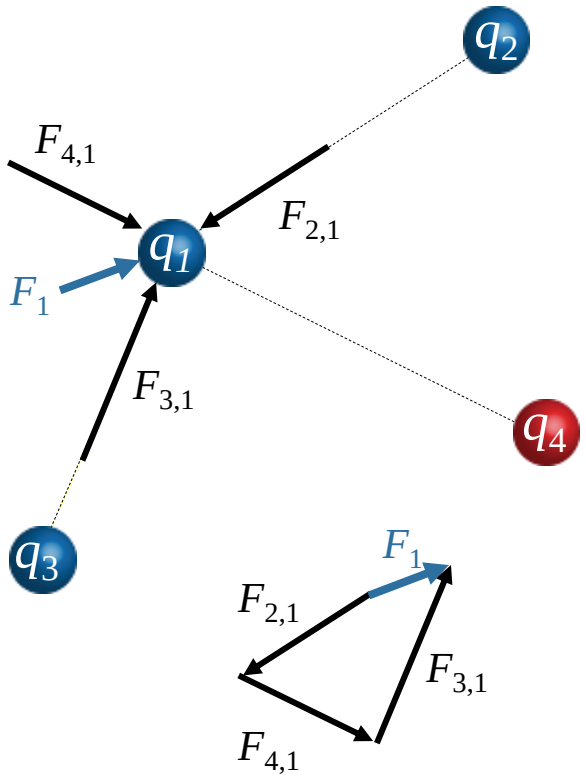
C) $|F_1|$ decreases

D) Need more information to determine



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



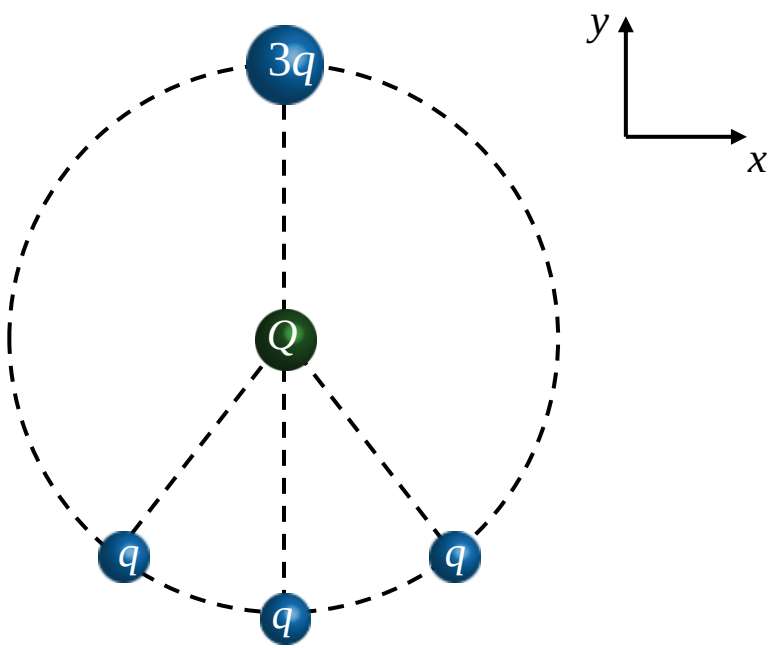


$$\vec{F}_1 = \vec{F}_{2,1} + \vec{F}_{3,1} + \vec{F}_{4,1} + \ldots$$

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

Check Point 3

Four positively charged particles are placed on a circular ring with radius 3 m as shown below. A particle with positive 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) $F_y < 0$

A) Part of the charges of the 3 q objects go towards a force in the x direction so the total force of the 3 in the y direction will be less than 3q leaving the net force of Q to point in the direction of the 3q object which is positive.

B) The magnitude of the charge on top is equal to the 3 charges on bottom so they cancel each other out.

C) The 3q charge exerts a downward force on the Q charge. The bottom three q charges exert a upward force on the Q charge. Because those bottom two q charges are exerting a diagonal force, the force in the y-direction is less than the actual force exerted. The magnitude of the downward force would be greater than the sum of the upward forces.

Takeaways!

Course logistics

Should be able to apply Coulomb's law

Determine direction and magnitude of electric force

Should be able to apply superposition of forces

Determine direction and magnetic of net electric force

Wedding: electric fields!

See you Thursday!

Discussion Sections meet this week!

Be sure to complete prelecture 1 and checkpoint 1.

Start on Homework 1 now!

will involve you in smart physics today!