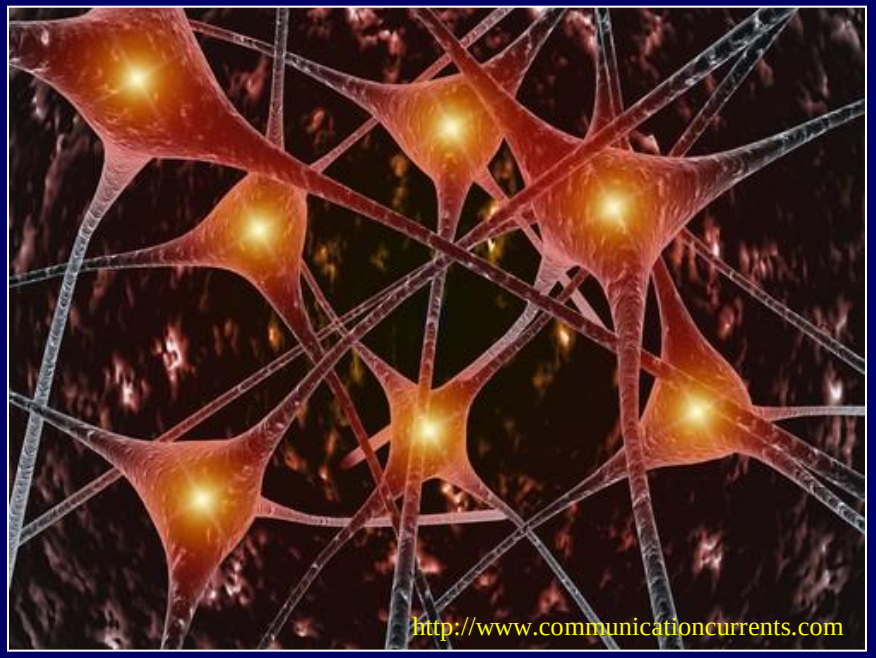
Welcome to Physics 102!

- Electricity + Magnetism

(at the heart of most processes around us:
…in atoms & molecules; living cells)

- Optics
- Atomic Physics
- Nuclear Physics
- Relativity



Introduce yourself to person you are sitting next to!

Please turn off cell phones and laptops

Meet your classmates

The quickness of going through the material. But, this is nice because I have to know it all for the MCAT.

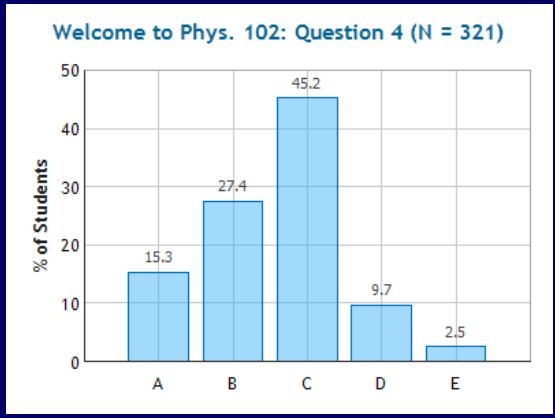
No more Tom :(...now we have Tim.

Fearing getting a bad grade.

I fear most everything in physics, it is my weakest subject.

Cool demos

I'm worried about not being able to visualize concepts



I am most looking forward to learning some very interesting topics. I am most nervous about the amount of time the class is going to require, especially studying for exams.

Applicable stuff to my life and future careers. I am looking to applying this stuff.
I fear falling behind due to to speed of the course.

Meet the Lecturer

- Tim Stelzer

  tstelzer@illinois.edu
- Research:

  Particle Physics

  Physics Education Research
- Office Hours: Monday 4-5 307 Loomis

When emailing me:

- Email must be sent from @illinois.edu
- Subject line should begin with "PHYS102 question:"
- Message should contain:

  your full name, netID, discussion section, TA name

- Questions about physics:

  Do not use email, use office hours (see course website)

- Before emailing:
- Verify information is not already on the course website
- The course directors reserve the right to penalize your HW score if you ask questions via email that are answered on the website
- If I don't reply within 24 hours please send again!

(correct) Course Website

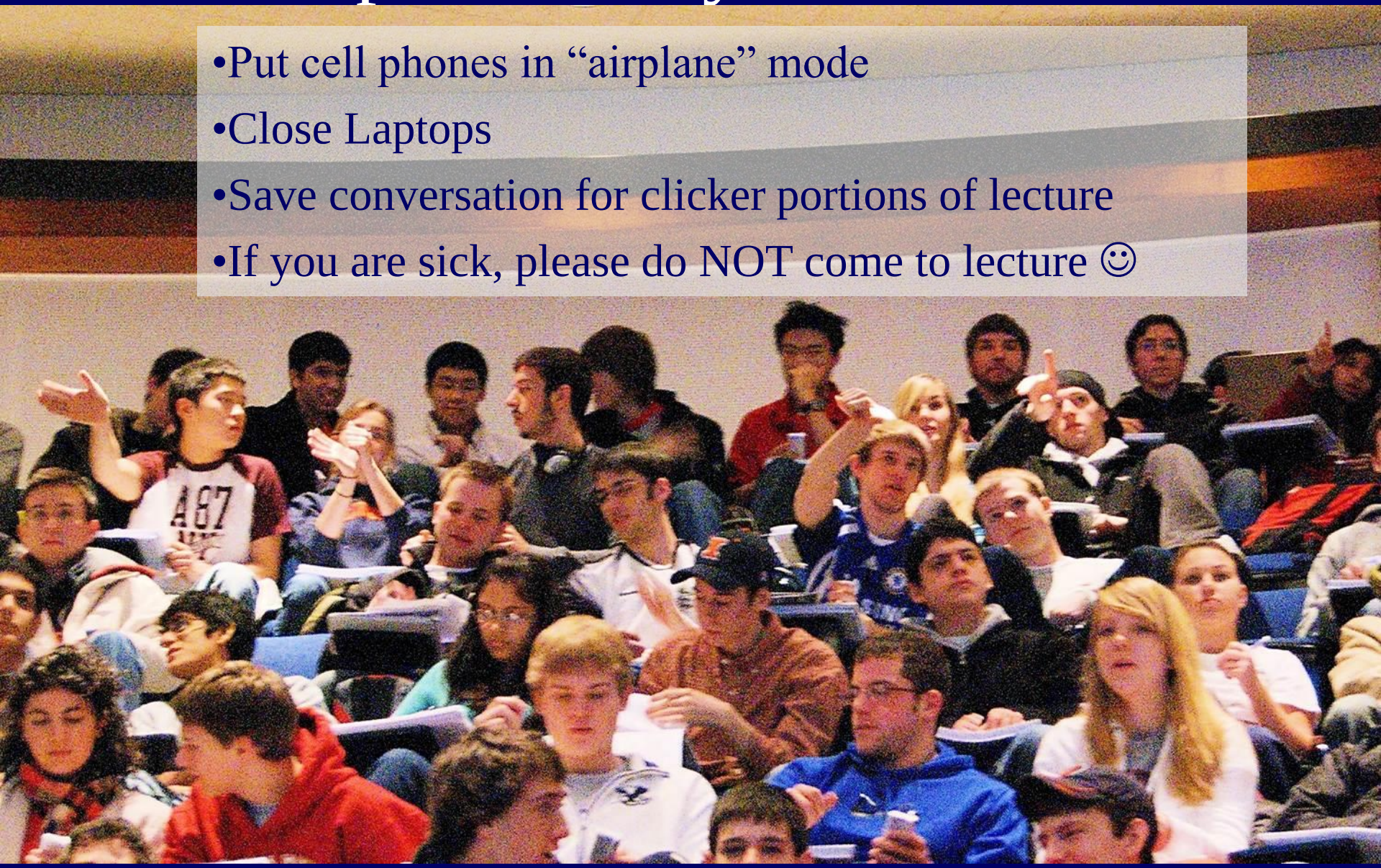
- http://courses.physics.illinois.edu/phys102/
- Syllabus
  - what you should be doing and when you should be doing it
  - Lectures posted after they are given
- Course Description / Excused Absences
- Required Materials
  - Be sure to register your i-Clicker
- First Discussion: 1/21 (Yesterday!)
- First Lab: 1/29
- Exam dates : Monday 2/24, Tuesday 4/1, Monday 4/21 at 7 pm

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 Teammates



- 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 Philosophy

- Read about it (textbook & checkpoint)
- Untangle it (lectures)
- Play with it (labs)
- Challenge yourself (homework)
- Close the loop (discussion/quiz)

The order is important!

Grading

• CheckPoints & Lectures	50
• Homework	150
• Lab (Prelab due at start of lab)	150
• Discussion	100
– in-class quizzes; drop lowest 1	
• Hour Exams (3 x 100)	300
• Final Exam	250
	1000

Physics Department letter grades:

A+(950), A(920), A-(900), B+(880), B(860), B-(835), C+(810), C(780), C-(750), D+(720), D(690), D-(610), and F(<610).

"Grading scale. It is not fair."

CheckPoints & ACTS

- Answer CheckPoints 50/1000 points
  - 1 point for attempt at Checkpoint.
- ACTS: use iClicker in class
  - 1 point for answering the questions

- 2 points/lecture x 25 lectures = 50 points
- Note that there are 28 lectures, so you have some free ones

Register i-Clicker : gradebook

Iclicker Test

Change your frequency to BB at the beginning of every lecture

- Has the person next to you heard the rumors about physics 102?

A) Yes
B) No
C) I forgot my iclicker
D) I am confused
E) I am unpredictable

Prerequisite!

Content

Physics 101

Macroscopic

- Kinematics
- Forces
- Energy
- Fluids
- Waves (Sound)

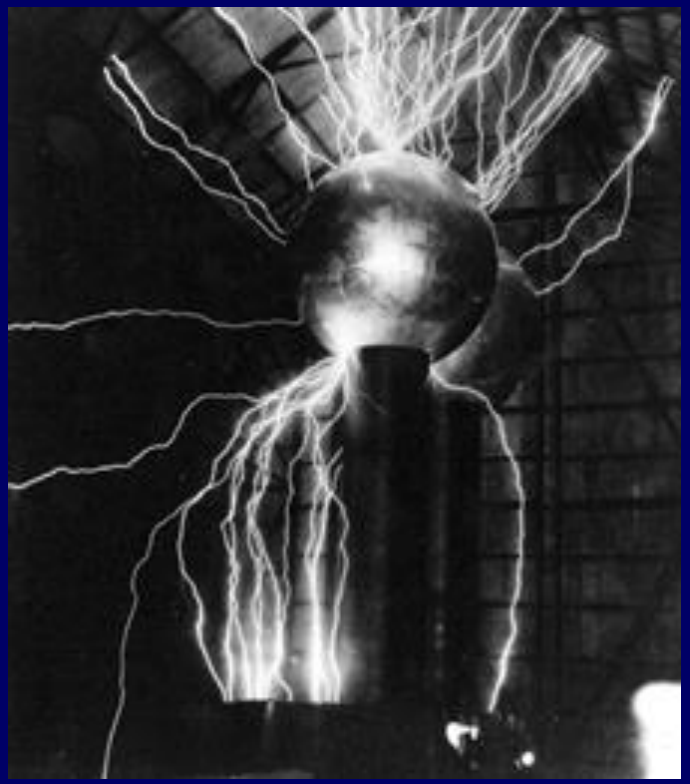
Physics 102

Microscopic

- Electricity+Magnetism
- Circuits
- Optics
- Modern
  - Atomic
  - Nuclear
  - Relativity

Physics 102: Lecture 01

Electric charge & Coulomb's Law

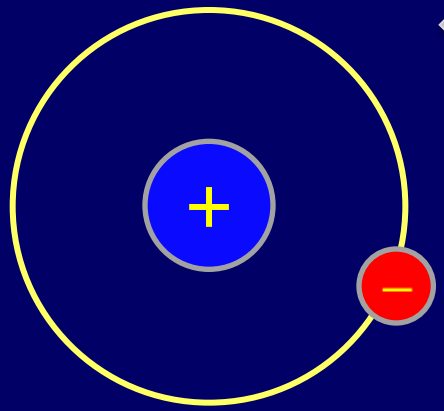


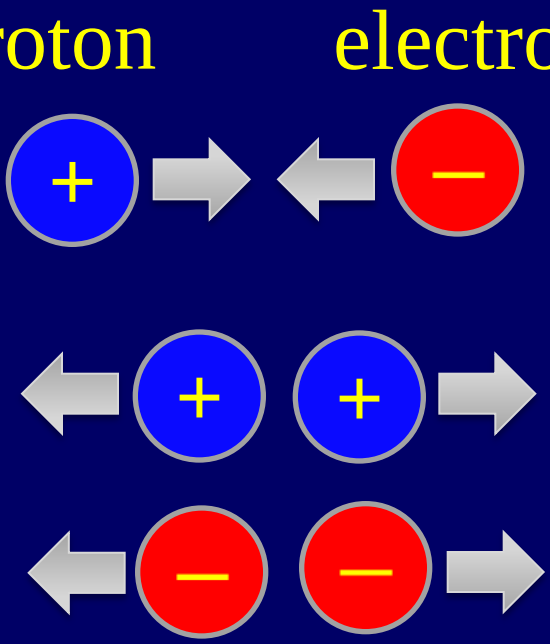
Origin of Charge

Charge is an intrinsic property of matter

- Two types:
  - Positive Charge
  - Negative Charge
  - Opposite charges attract, like charges repel.
  - The electric force is what holds stuff together
- Atoms are neutral

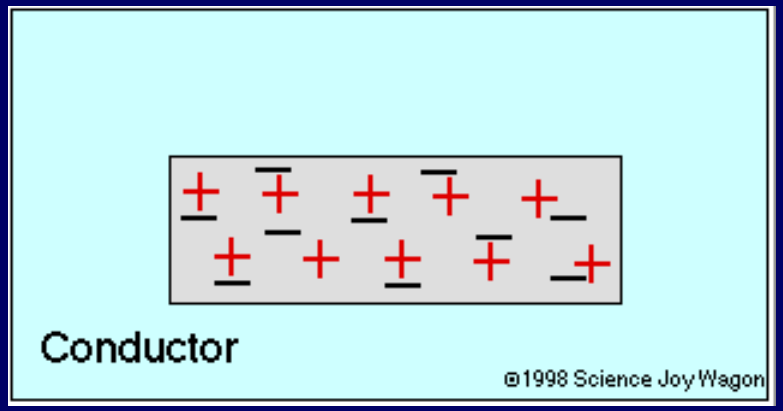
  electron "orbits" the positive nucleus



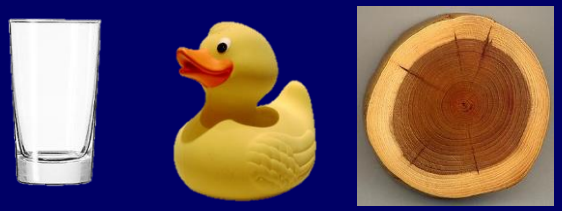


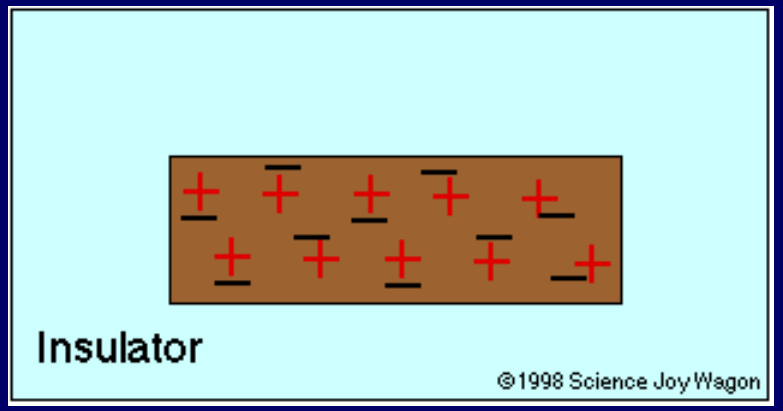
Conductors and Insulators

Q: How do electrons behave in a perfect conductor?



Q: How do electrons behave in a perfect insulator?

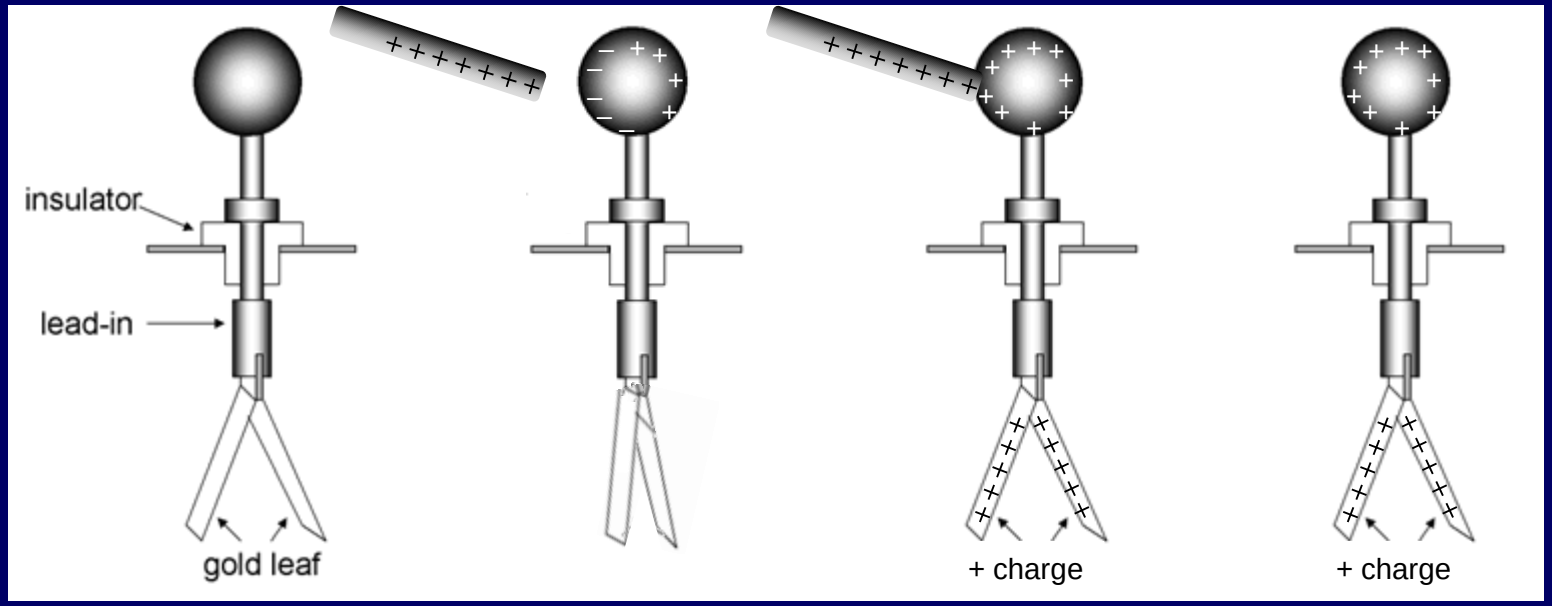




Most things are in between perfect conductor / insulator

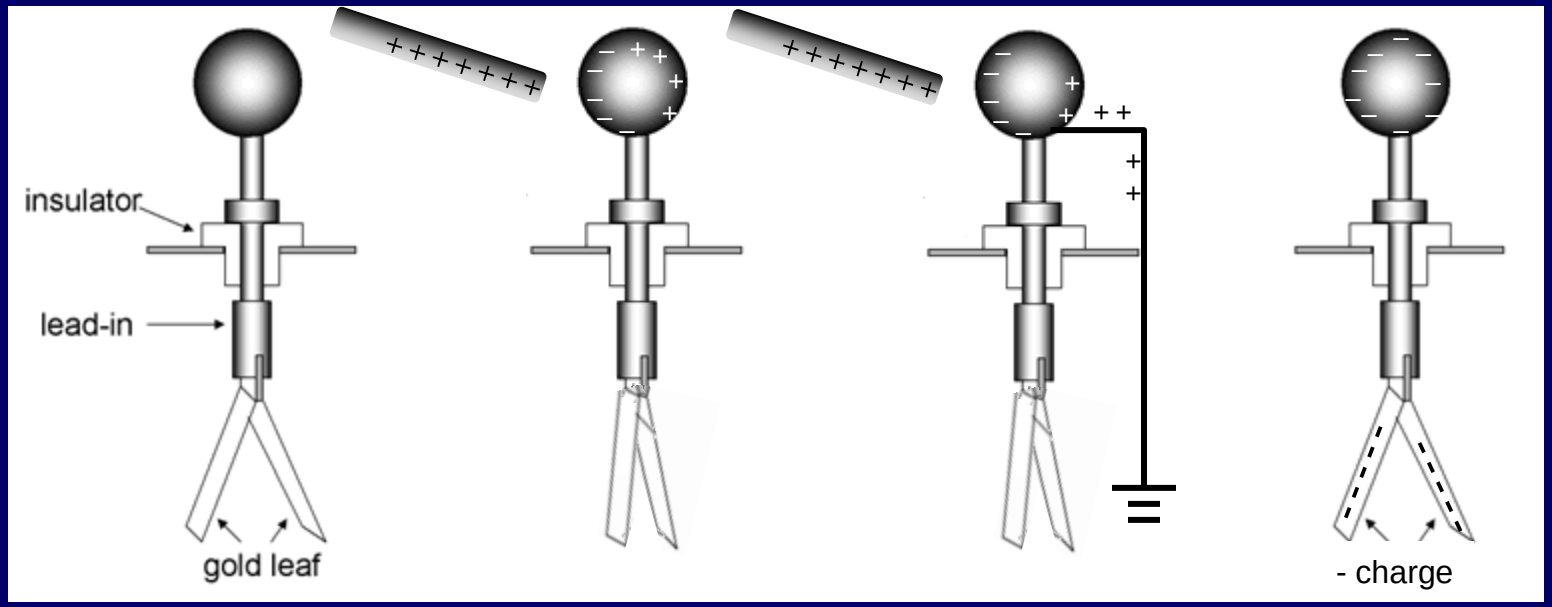
Electroscope (demo)

- Conduction
  - Charged rod is brought near scope
  - Charged rod touches scope transferring some charge
  - Scope is left w/ same charge as rod



Electroscope (demo)

- Induction
  - Charged rod is brought near scope
  - Scope is briefly grounded allowing charge to flow on (or off) scope
  - Scope is left w/ opposite charge as rod



ACTS

- A negatively charged rod is used to charge an electroscope by induction. What is the resulting net charge on the electroscope?

A) positive **B) zero** **C) negative**

- If the conducting electroscope were replaced by an insulating ball and then charged by induction as above, what would be the net charge on the ball.

A) positive **B) zero** **C) negative**

Coulomb's Law

Force between charges q_1 and q_2 separated a distance r:

Magnitude

$$F = k\frac{q_1 q_2}{r^2}$$

"Coulomb constant"

$$k = 9 \times 10^9 Nm^2/C^2$$

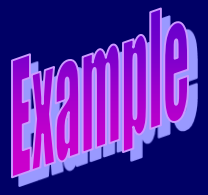
Or: $$F = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r^2}$$

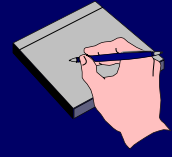
"Permittivity of free space"

$$\epsilon_0 = 8.85 \times 10^{-12} C^2/Nm^2$$

Direction

Opposite charges attract, like charges repel

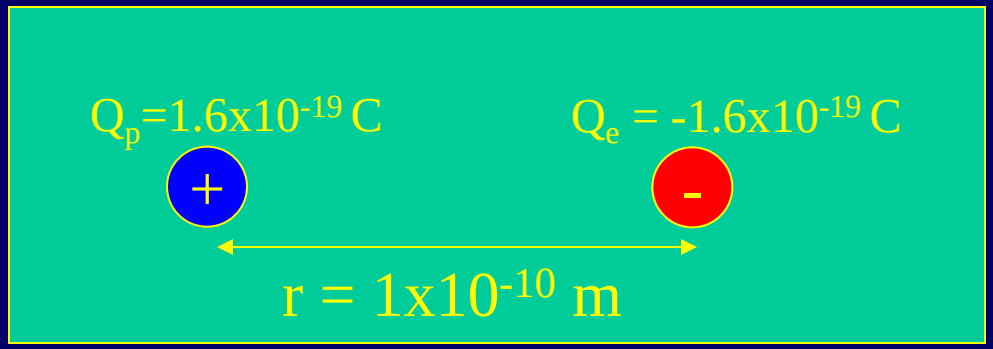




Coulomb's Law

- What is the magnitude of the force on the proton due to the electron in hydrogen?

$F = k\, q_1 q_2 / r^2$ $\qquad$ $k = 9 \times 10^9\ Nm^2/C^2$

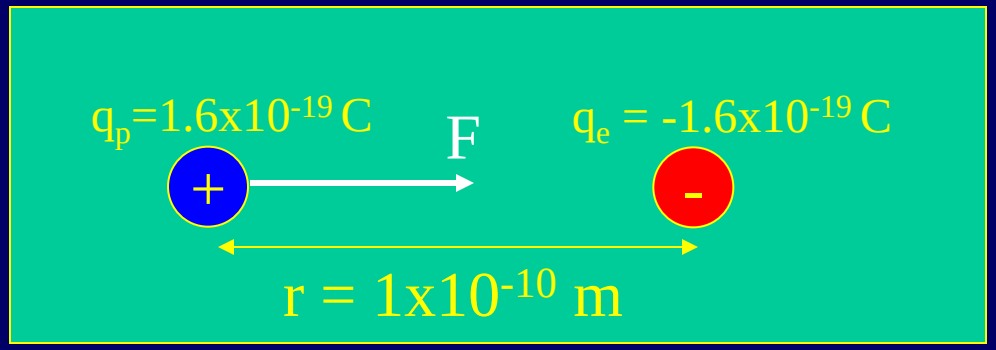


$$F = 9 \times 10^9 \frac{Nm^2}{C^2} \quad \text{——————————} \quad = 2.3 \times 10^{-8} N$$

ACT: Coulomb's Law

- What is the direction of the force on the proton due to the electron?

(A) Left (B) Right (C) Zero

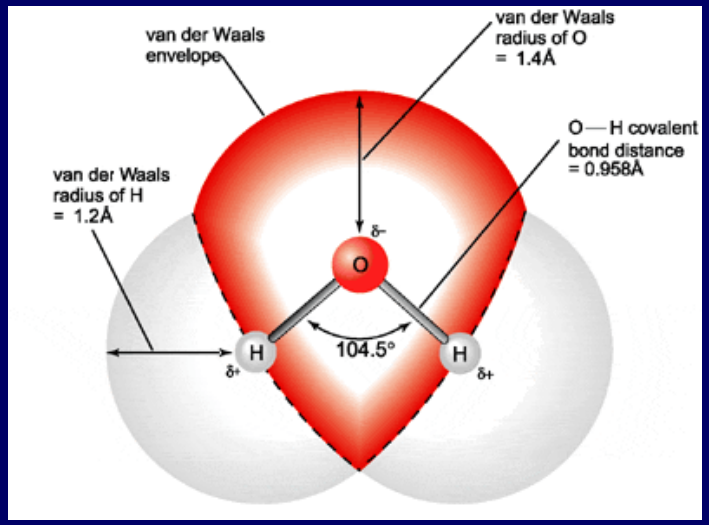


- What is the direction of the force on the electron due to the proton?

Electric dipole

A positive and negative charge of equal magnitude separated by a (usually small) distance

Ex: water



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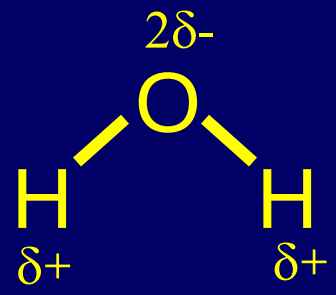

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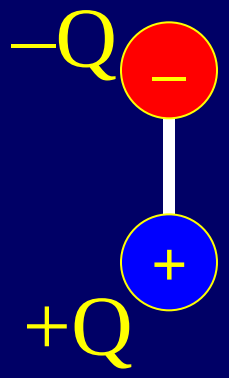
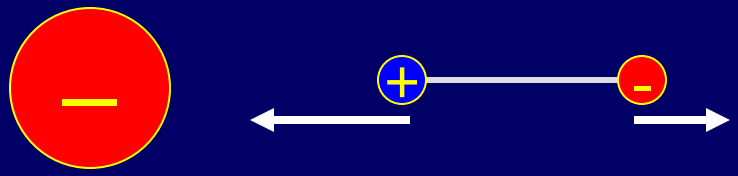
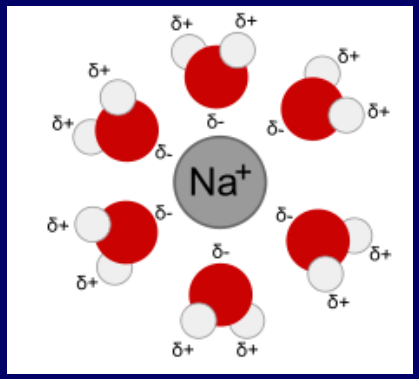


ACT

An electric dipole is placed near a large negative charge. What is the net force on the two connected charges?

A) Left B) Zero C) Right





Positive charge is attracted (force to left)

Negative charge is repelled (force to right)

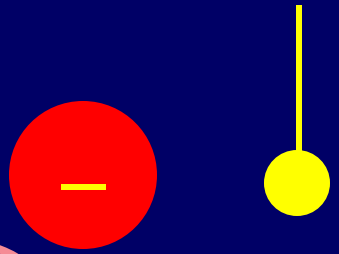
Positive charge is closer so force to left is larger.

$$F = k\frac{q_1 q_2}{r^2}$$

ACT: Induced Dipole

- An uncharged conducting sphere is hung next to a charged sphere. What happens when the uncharged sphere is released?

1) Nothing
2) Attracted to charged sphere.
3) Repelled from charged sphere.



Induced Dipole

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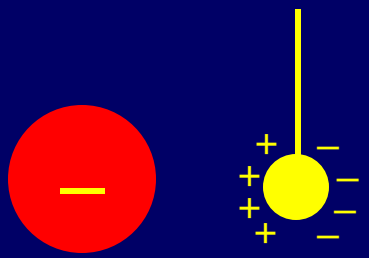
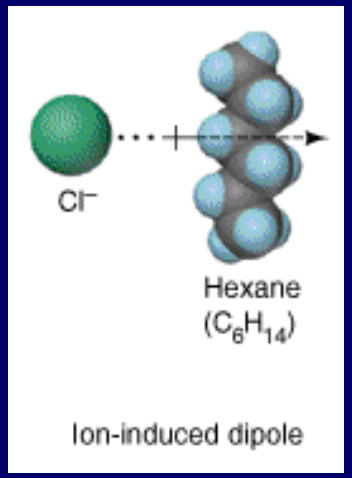
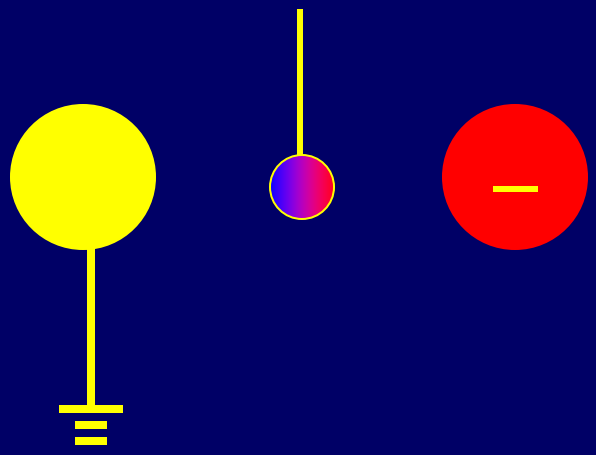




1) Negative charge attracts + repels –
2) A dipole is induced in the uncharged sphere
3) Since + is closer, attractive force is strongest

Demo: Induced Dipole

- An uncharged conducting sphere is hung between a charged sphere and a grounded sphere and held midway between the two. What happens when the uncharged sphere is released?



Summary of Today's Lecture

- The concept of charge
- Conductors and insulators
- Coulomb's Law for the force between charges

$$F = k\frac{q_1 q_2}{r^2}$$

  - Much more on Coulomb's Law in next lecture
- Electric dipoles (permanent & induced)

Prior to next lecture….

- Do your CheckPoint
  before 8:00 AM on the day of lecture.