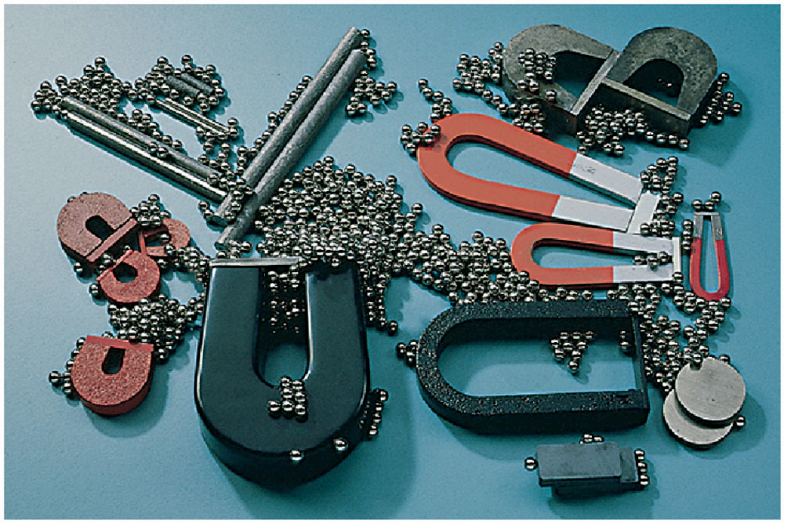
Physics 1B: Electricity & Magnetism

Dr. Alex Markowitz

(UCSD/CASS)

Fall 2010



Logistical+Administrative Info.

Lectures: Tu & Th 09:30-10:50 a.m., 2722 York Hall

TA: Grigor Aslanyan

You must also be concurrently enrolled in Physics 1B-LAB -- completely separate course/grading

Textbook: Serway & Jewett, Physics I: Volume II -- Principles of Physics.

Course website:
http://physics.ucsd.edu/students/courses/fall2010/physics1b/

Our Office Hours:

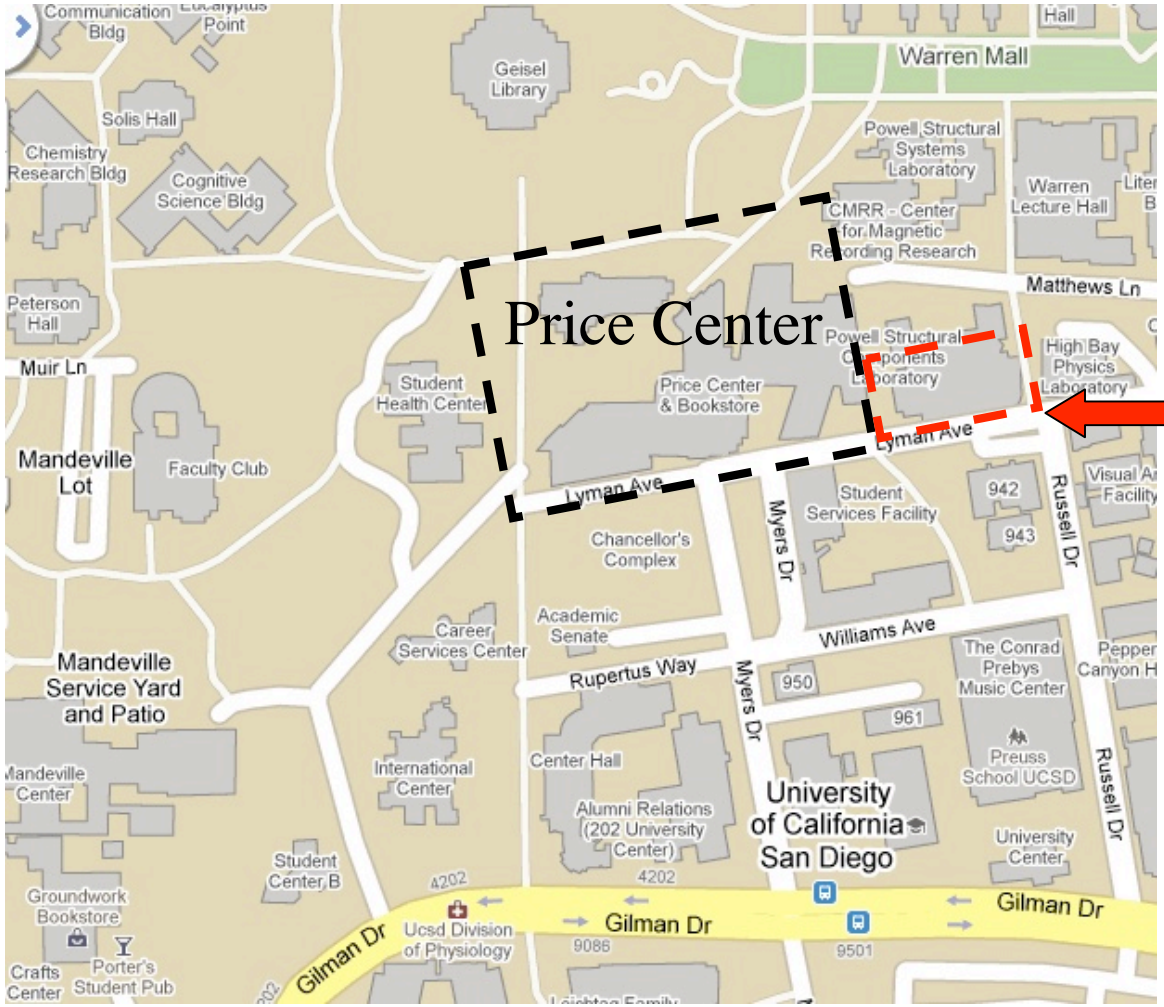
My Office Hours: Mon 11:30-12:30 & Thur 11:30-12:30

My Office Location: 412 SERF Bldg.

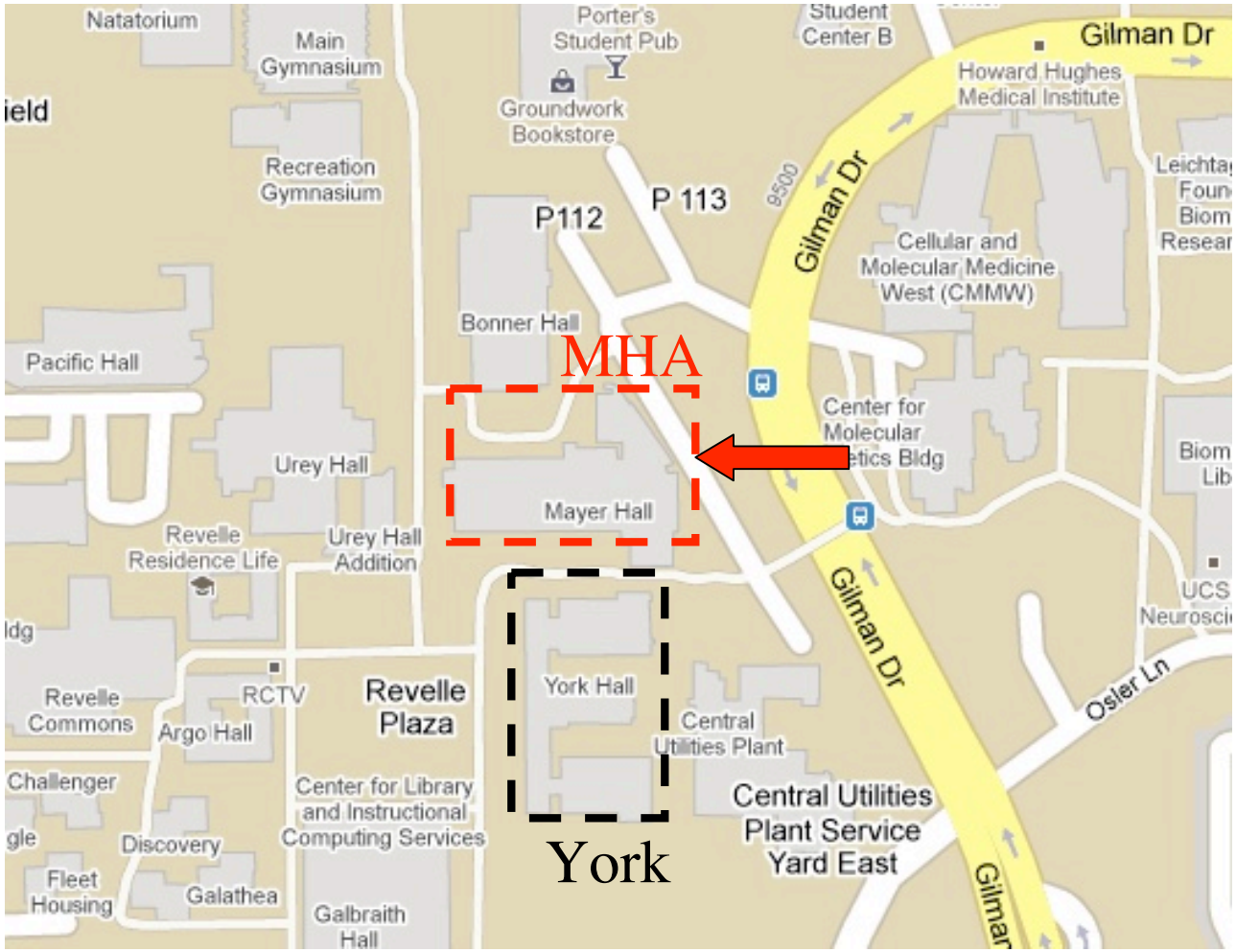
Grigor's Office Hours: Mon 2-3 & Thur 2-3

Grigor's office: 4514 Mayer Hall Addn.

My Office Location



Grigor's Office Location



Mayer Hall Addition,

Office #4514

Discussion / Problem Sessions: Every Monday evening, 6:00-7:50 p.m., in 2622 York

EXAMS:

4 QUIZZES in lecture:

Tues. Oct 5, Tues. Oct 19, Tues. Nov 2, and Thurs. Nov 18. (45 mins each)

FINAL EXAM:

Final Exam: Thursday, December 9, 08:00-11:00, location TBA

Grading:

Final Exam = 37%

Quizzes = 63% (top three quiz grades are 18% each; lowest quiz grade is 9%).

There will be no make-up exams. Please plan ahead for the exams accordingly!

Bring your own scantron forms (X-101864-PAR only!) and #2 pencils!

Scientific calculators: okay (but no iPhones, etc.!)

HOMEWORK -- Will not be collected/graded, but are the best way to practice for the quizzes/final.

Do all the text's 'Quick Quizzes' and try as many conceptual questions as you can.

Physics Tutorial Center, 2702 Mayer Hall Addition. Days/Hours of operation (tentative as of 9/22): Sun through Thurs, 3-8 pm

More administrative info.

Deadlines:
Last day to add a class: Friday, 10/8
Last day to drop a class without a W and change grade option: Friday, 10/22
Last day to drop a class WITH a W but without an F: Monday, 11/29

See the Physics Dept. Student Affairs Office, 2521 Mayer Hall Addition, for additional info.

More administrative info.

ACADEMIC DISHONESTY: Please read the "UC Policy on Integrity of Scholarship" in the UCSD General Catalog. Cheating, including knowingly allowing a peer to copy your quizzes or tests, will result in an F in this course and referral to the Dean for disciplinary action. See http://senate.ucsd.edu/manual/Appendices/app2.htm & http://www.ucsd.edu/catalog/front/AcadRegu.html

Some recommendations

Keep a running list of equations for quick reference (an ‘equation toolbox’)

Commit to studying and reviewing notes consistently -- Do not wait until the night before an exam (cramming never helps).

Online notes are meant to augment, not be a substitute for, attending lectures and problem sessions

All quizzes/exams are cumulative!

General overview of course:

19: Charges, electrostatic forces, electric fields

20: Electric potential, electrical energy, energy storage

21: Electrical Currents (moving charges), DC Circuits, Time-dependent Circuits

22: Magnets, magnetism, magnetic forces

23: Induced currents from magnetism; AC Currents; inductive circuits

24: Electromagnetic radiation

Why is E+M important?

In this course, applications covered include:

Electric Motors and Generators; Power Line Transmission & Distribution; Household Circuits; Batteries

Magnets & Magnetism: Electromagnets, Computer Drives & Data Storage, Planetary Magnetic Fields

Medical Diagnostic Imaging (X-rays)

Medical Devices (Defibrillators)

EM Radiation (visible light, radio, TV, cell phones)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Ch. 19: Electric Forces & Electric Fields

Properties of electric charges & how they interact with each other -- on both macroscopic and microscopic scales

Electric Charges & Conservation of Charge

Nature of Matter

Insulators & Conductors

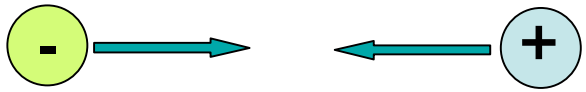
Charging by Induction

Electrical Charges

Two kinds of charges: positive & negative

Like charges repel

Unlike charges attract



Electrical Charges

Charge is a quantized quantity ("e")

Proton: $e = +1.6 \times 10^{-19}$ C  $m_p = 1.67 \times 10^{-27}$ kg

Electron: $e = -1.6 \times 10^{-19}$ C  $m_e = 9.11 \times 10^{-31}$ kg

Units = Coulomb

An object may have a total charge of 0, ±1e, ±2e, ±3e,…

CONSERVATION OF CHARGE: Total amount of charge is conserved in any interaction

Electric Charges & Conservation of Charge

Nature of Matter

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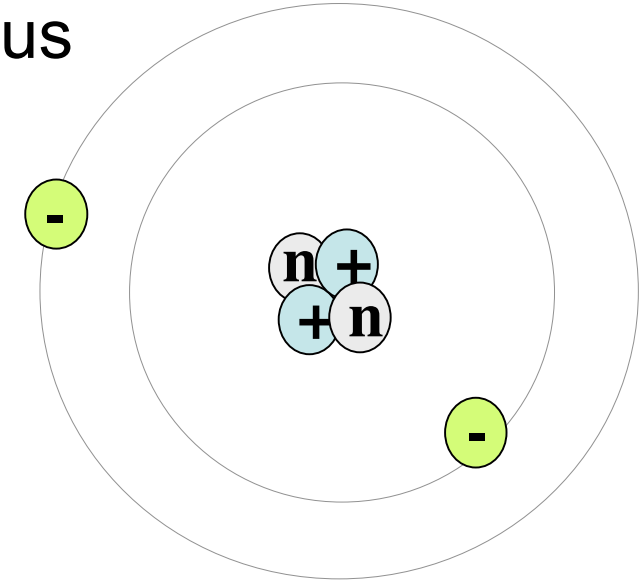
Nature of Matter

Review: Atoms contain nuclei with protons and neutrons; e^-'s orbit around nucleus



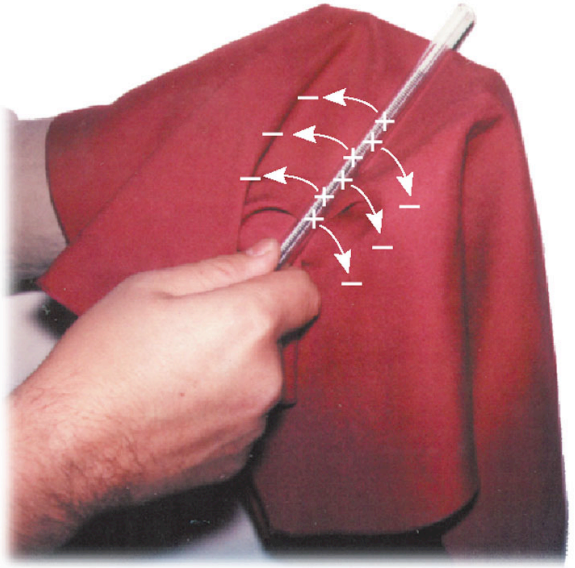
Most matter is neutral: equal numbers of +, – charges (sum of all charges is zero)

Charge transfer is usually due to movement of electrons

Charging by Rubbing

Examples: Glass + silk;
Rubbing a balloon against your hair

Negative charges are transferred from glass to silk



Application: static electricity

Electric Charges & Conservation of Charge

Nature of Matter

Insulators & Conductors

Charging by Induction

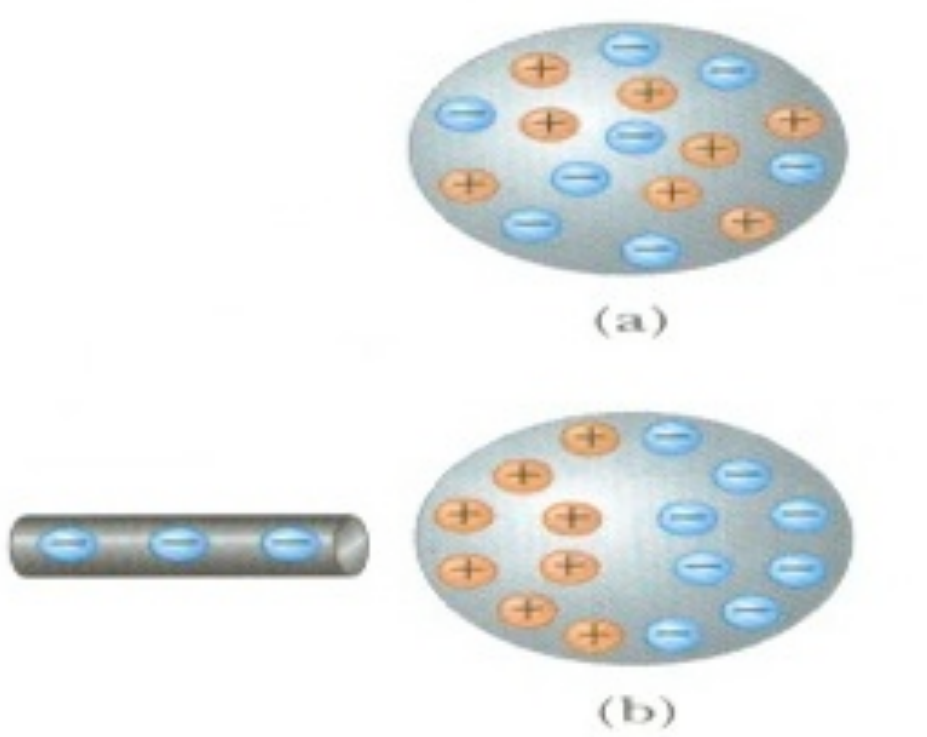
Insulators & Conductors

Insulators: do not conduct charges: glass, rubber, paper, plastic

Conductors: Charges can move freely. Most metals. Density of charge carriers in Cu: $10^{29}/m^3$

Semi-conductors: intermediate conduction properties -- silicon, germanium. Density of charge carriers in Si: $10^{16}/m^3$

In conductors, charges can move freely



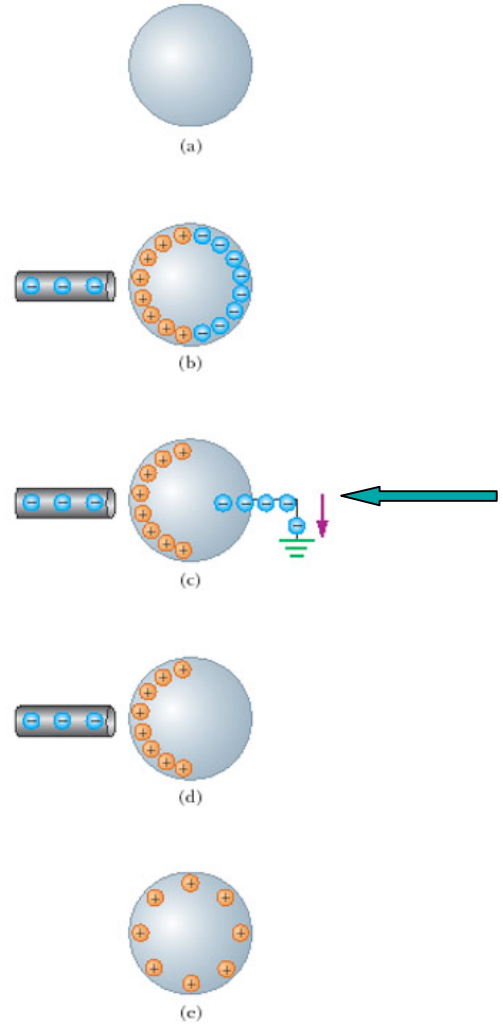
Electric Charges & Conservation of Charge

Nature of Matter

Insulators & Conductors

Charging by Induction

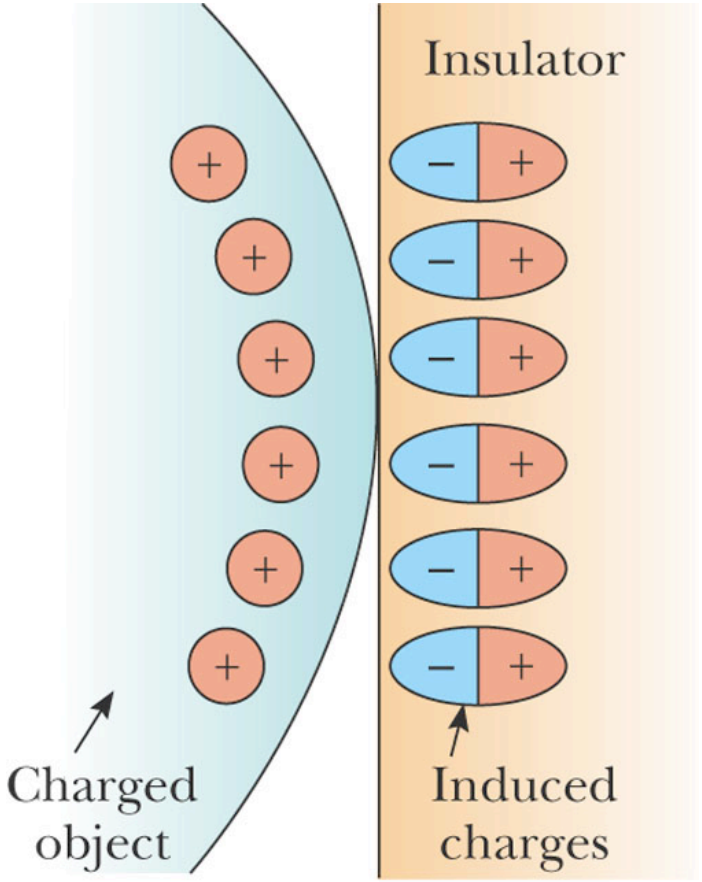
Charging by Induction



Conducting wire = Connection to ground: a “sink” or for negative electrical charge

Question - why do only negative charges ‘jump ship’?

Charging by Induction



(a)

In insulators: centers of +,– charges separate slightly: POLARIZATION

Ex.: rubber balloon sticking to neutral wall

19.4–19.6

Electrostatic Forces; Coulomb's Law

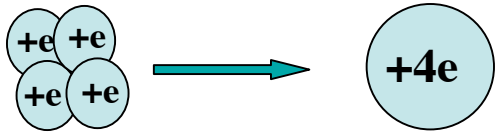
Electrostatic Forces from multiple charges

Electric Fields: point charges

Electric Fields: multiple point charges, continuous charge distributions

Electric Field Lines

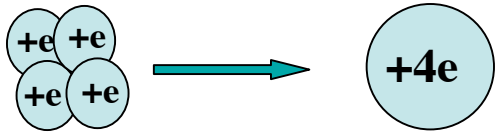
Electric Force



A collection of 4 charges, each with +1e…

…equivalent to “a charge” with +4e

Electric Force



A collection of 4 charges, each with +1e…

…equivalent to "a charge" with +4e

Given two objects with charges q_1 & q_2:

Coulomb's Law: $|F_e| = \dfrac{k_e |q_1| |q_2|}{r^2}$

Coulomb constant $k_e = 8.99 \times 10^9$ N m^2 / C^2 = $1/(4\pi\varepsilon_0)$

Permittivity of free space $\varepsilon_0 = 8.85 \times 10^{-12}$ C^2 /(Nm^2)

Electric vs. Gravitational Forces

Consider a hydrogen atom: One proton, one electron, r = 5.3×10^{-11} m

$$F_e = \frac{k_e q_1 q_2}{r^2} = \frac{8.99\times10^{9}\,Nm^2/C^2\,(1.6\times10^{-19}\,C)^2}{(5.3\times10^{-11}\,m)^2}$$

$$= 8.2\times10^{-8}\,N$$

$$F_g = \frac{G m_1 m_2}{r^2} = \frac{6.67\times10^{-11}\,Nm^2/kg^2\,(1.67\times10^{-27}\,kg)(9.11\times10^{-31}\,kg)}{(5.3\times10^{-11}\,m)^2}$$

$$= 3.6\times10^{-47}\,N$$

Both forces are prop. to $1/r^2$, but gravity is **much** weaker!