Welcome to Physics 101!
Lecture 01: Introduction to Forces

"I'm hoping the class is explained well and is graded easily."

"I am very excited about taking Physics 101!"

"I look forward to the demos"

"Nervous" "Anxious" "Apprehensive"

"worried about the math"

"I am excited to learn about something other than biology."

http://online.physics.uiuc.edu/courses/phys101

Physics 101 covers…

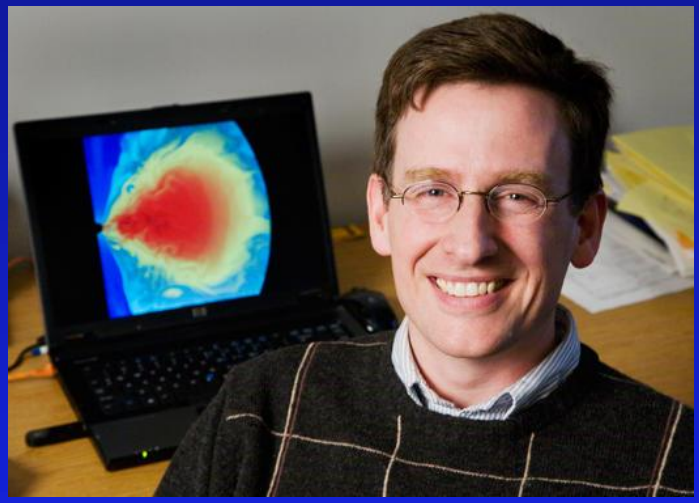
- Forces
- Kinematics
- Energy/Momentum
- Rotations
- Fluids
- Waves/Sound
- Thermodynamics

Meet the Lecturer

- Prof. Charles Gammie
  gammie@illinois.edu
- Office Hours

  Monday 10-11

  236 Loomis; start next wk
- Research
  - ➔ Astrophysics – black holes!
- P101 is one of my favorite courses!



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Course Format

(upward) Spiral Learning

• Lecture Preflights	25
• iClickers	25
• Homework	100
• Lab	150
• Discussion	100
➔quizzes; drop lowest 1	
• Hour Exams (3 x 100)	300
• Final Exam	300
	1000

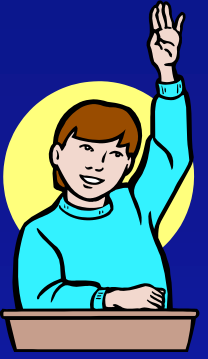
Grading Scale

- 950-1000 A+
- 920-949 A
- 900-919 A-
- 880-899 B+
- 860-879 B
- 835-859 B-
- 810-834 C+
- 780-809 C
- 750-779 C-
- 720-749 D+
- 690-719 D
- 610-689 D-
- <610 F

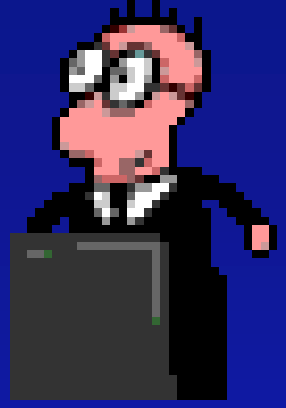
"My goal is to receive an A..."

Reading & Lecture Preflight

- Need to complete PreLecture for Preflight
- Answer preflights 25/1000 points
  - ➔Due 6:00 am day of lecture.
  - ➔1 points for honest attempt at preflight (lose points for nonsense – and I read these!).
  - ➔No EX, 28 Lectures can miss three and still get all 25 points.
- Everyone gets 1 point for today!



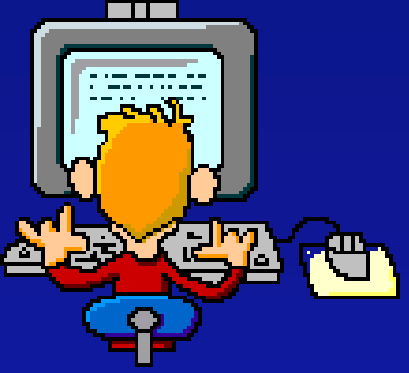
P101 Lectures



"I'm looking forward to a fun … semester"

- Participation is key!
  - ➔Come to lecture prepared!
  - ➔1 point for each lecture using iclicker
    - » No EX, 28 Lectures can miss three and still get all 25 points.
    - » Available at bookstore---*register using link on our web page*.
    - » Using multiple clickers is an academic integrity violation.

- Not everything you need for exams!
  - ➔Concepts, Connections, Motivation
  - ➔Comprehensive Text
  - ➔Calculations Homework + Discussion
  - ➔Hands-On Lab
- Taking Notes
  - ➔Lecture notes available.
  - ➔Some key pieces for you to fill in.



P101 Homework

- All web based, immediate feedback
- 100% if done before 6:00 am deadline
- 90% credit on unfinished parts until following Tuesday
- 0% after that
- Always keep 5 significant figures!
- First one is due Tues Aug 31 !

P101 Labs

"I'm looking forward to the labs because I learn better with hands-on activities."

- Director: Professor Paul Selvin

  research: biophysics, molecular motors

- First Lab is Today!
- No "dropped" labs….. Don't miss one!

Discussion Sections

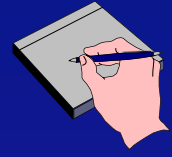
- Director: Professor Yoshi Oono

  research: statistical mechanics
- Start: tomorrow!
- Quiz during last 20 minut
- 10 minutes late ☹
- First section: math review, dimensional analysis.

Physics Philosophy

- You are too smart!
- Physics is DIFFERENT
- Describe large number of “complicated” observations with a few simple ideas:

  APPROXIMATION
- Exams don’t have same problems, but do have same IDEAS



Newton's Laws of Motion

1. If the sum of all external forces on an object is zero, then its speed and direction will not change. Inertia

2. If a nonzero net force is applied to an object its motion will change F= ma

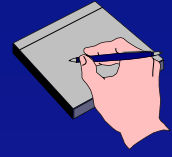
3. In an interaction between two objects, the forces that each exerts on the other are equal in magnitude and opposite in direction.

Forces in P101

- Non-Contact ---- Gravity ($|F| = G\ m\ M/r^2$)
  - ➔ $G = 6.7 \times 10^{-11}\ m^3 / (kg\ s^2)$
  - ➔ Earth: Mass = 6×10^{24} kg, radius = 6.4×10^6 m.

- Contact (fundamentally E+M)
  - ➔ Normal: Perpendicular to surface
  - ➔ Friction: Parallel to surface
  - ➔ Anything touching the object
    - » Rope: Tension
    - » Spring F = -kx

Example Weight of Object



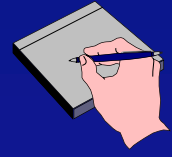
- Calculate the gravitational force on a 3 kg book held 1 meter above the surface of the earth.

$|F| = G\ M\ m / r^2$

$= (6.7\text{x}10^{-11}\ m^3 / (kg\ s^2))\ (6\text{x}10^{24}\ kg)\ (3\ kg) / (6.4\text{x}10^6 + 1)^2\ m^2$

$= 29.4\ kg\ m/s^2$

Gravitational ACT



- If the book is raised 10 meters above the surface of the earth, the gravitational force on the book will

A) 100 times stronger B) 10 times stronger

C) Nearly the same

D) 10 times weaker E) 100 times weaker

$F = G M m / r^2$

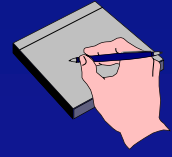
$= (6.7\text{x}10\text{-}11\ m^3 / (kg\ s^2))\ (6\text{x}10^{24}\ kg)\ (3\ kg) / (6.4\text{x}10^6 + 10)^2\ m^2$

$= 29.4\ kg\ m/s^2$

Near surface of earth $r = 6.4\text{x}10^6$ m

$|F| = m\ (G\ M / r^2) = m\ (9.8\ m/s^2)$

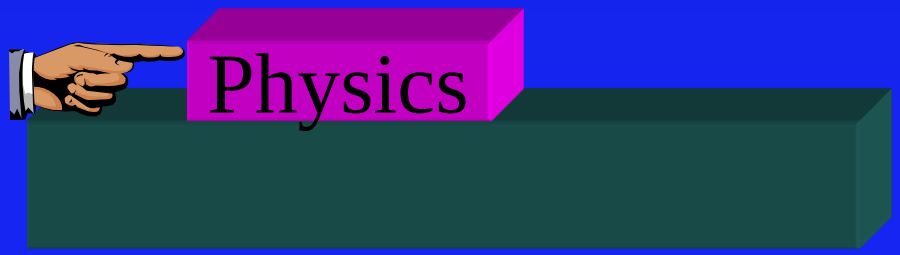
Contact Forces: Friction

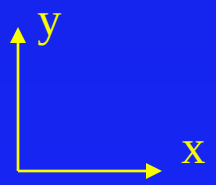


- Magnitude of frictional force (parallel to surfaces) is proportional to the normal force.
  - ➔ $f_{kinetic} = \mu_k N$ μ_k coefficient of Kinetic friction
  - ➔ $f_{static} \leq \mu_s N$ μ_s coefficient of Static friction
- Be Careful!
  - ➔ Static friction $\leq$, can be any value up to $\mu_s N$
  - ➔ Direction always opposes motion

Free Body Diagrams

- Choose Object (book)
- Label coordinate axis
- Identify All Forces
  - ➔Hand (to right)
  - ➔Gravity (down)
  - ➔Normal (table, up)
  - ➔Friction (table, left)





Summary

- Newton's Laws of Motion
  - ➔Inertia
  - ➔F=ma
  - ➔Pairs
- Forces:
  - ➔Non-Contact: Gravity
  - ➔Contact: Friction and Normal
- Free Body Diagrams
  - ➔Each direction is independent
- Friction opposes motion, parallel to surface
  - ➔Kinetic $f = \mu_k N$
  - ➔Static $f \leq \mu_s N$

To Do

- Discussions starts tomorrow,

  Labs start today.

- Do lecture preflight before 6:00 am Wednesday!

- Have a GREAT WEEK!