TEAL
Technology Enhanced Active Learning
Interactive online homework
Group problem solving
Personal Response System
Peer Instruction

NOT
Uninterrupted Lectures
Lecture demonstrations
Textbook reading to introduce material
Gain on the MIT Final Exam

\[ \text{Normalized Gain of MIT Final} \]

\[ r=0.045, \ p-value=0.69 \]

\[ r=0.32, \ p-value=0.01 \]

Written Homework

CyberTutor
Gain on Force Concept Inventory
- data C. Ogilvie 2000

FCI gain=0.41 for course

- Small Tutorial Sessions
- PIVOT Multimedia
- Written Homework
- Group Problems
- CyberTutor

P-value
0.854
0.807
0.198
0.087
0.015
Overview

- Lecture/presentations
- In-class experiments
- Expert problem solving
- Schedule
- Grading
- WWW page
Lecture/Presentations: Mon./Wed. first hour

- Like lectures, but less formal (discussion, PRS questions, interruption encouraged).

- Notes usually available on server.

- Personal response system (PRS) questions: to stimulate discussion & indicate how concepts are going over.

- In-class problem solving for class/group discussion. There will usually be five people in the room to help out (instructor, grad & two undergrad TAs, and demo-group member).
Experiments: Wed. second hour

- Pre-experiment question part of problem set.
- Carried out by groups of three, in class.
- Laptops with DataStudio and other software; most experiments will interface to laptops.
- Conceptual Report due at end of experiment.
- Post-experiment data analysis part of problem set.
Expert Problem Solving

• **Mon**: In class problem solving session, basics.

• **Tues**: Problem Set due at 4 pm.

• **Thurs**: Mastering Physics assignment (due at 10pm) advanced problem solving.

• **Fri**: In class problem solving session, advanced.

• **Sun 1-5 pm**: Tutoring.

• **Sun**: Mastering Physics assignment (due at 10pm) introduction to weekly material.
<table>
<thead>
<tr>
<th></th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
<th>Sunday</th>
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<tbody>
<tr>
<td><strong>Morning</strong></td>
<td><strong>Hour1 (10-11): Lecture</strong></td>
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<td><strong>Hour1 (10-11): Lecture</strong></td>
<td><strong>Hour1 (11-12): Advanced problem solving</strong></td>
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<td></td>
<td><strong>Hour2 (11-12): Problem</strong></td>
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<td><strong>Hour2 (11-12): Experiment</strong></td>
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<td><strong>Afternoon</strong></td>
<td><strong>Problem set due by 04:00pm</strong></td>
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<td><strong>Evening</strong></td>
<td><strong>Mastering Physics due: 22:00</strong></td>
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Grading policy: Weighting scheme

- Tests + Final Exam 45%+20% Individual
- Homework PS 10%
- Mastering Physics 10%
- Experiments 5%
- In class work and PRS 10%
## Grading policy: Breakpoints

<table>
<thead>
<tr>
<th>Grade</th>
<th>Minimum Score</th>
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<tr>
<td>A+</td>
<td>( A+ \geq 95 )</td>
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<tr>
<td>A</td>
<td>( A \geq 90 )</td>
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<tr>
<td>A-</td>
<td>( A- \geq 85 )</td>
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<tr>
<td>B+</td>
<td>( B+ \geq 81 )</td>
</tr>
<tr>
<td>B</td>
<td>( B \geq 77 )</td>
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<tr>
<td>B-</td>
<td>( B- \geq 73 )</td>
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<tr>
<td>C+</td>
<td>( C+ \geq 69 )</td>
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<tr>
<td>C</td>
<td>( C \geq 66 )</td>
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<tr>
<td>C-</td>
<td>( C- \geq 63 )</td>
</tr>
<tr>
<td>D</td>
<td>( D \geq 60 )</td>
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<tr>
<td>F</td>
<td>( F &lt; 60 )</td>
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</table>
A cannonball is shot straight up (not recommended). At the top of its trajectory:

1. It’s acceleration is zero, but not its velocity
2. It’s velocity is zero as well as its acceleration
3. Neither its velocity nor its acceleration is zero
4. It’s velocity is zero, but not its acceleration
5. Both its acceleration and its speed are zero
Pre-Class Diagnostic Test

- 50 minutes for diagnostic test, interrupted by lab tours of 25 min (so 75 min total)
Tours of BEC Experiments

- Students from 3 tables (at a time) will go upstairs to look at Bose-Einstein Condensate experiments at the Center for Ultra Cold Atoms

http://www.rle.mit.edu/cua/default.htm

- Video of Prof. Wolfgang Ketterle Lecture on BEC

http://mitworld.mit.edu/video/77
What is % difference in temperature between summer and winter?

15 % (Kelvin!)

i.e. - not much!

Ratio of hottest to coldest?
What is Bose-Einstein condensation (BEC)?

High Temperature $T$:
- thermal velocity $v$
- density $d^{-3}$
- "Billiard balls"

Low Temperature $T$:
- De Broglie wavelength $\lambda_{dB} = \frac{h}{mv} \propto T^{-1/2}$
- "Wave packets"

$T = T_{crit}$:
- Bose-Einstein Condensation
  - $\lambda_{dB} \approx d$
  - "Matter wave overlap"

$T = 0$:
- Pure Bose condensate
  - "Giant matter wave"
Two condensates ...
Interference of two Bose-Einstein condensates

Andrews, Townsend, Miesner, Durfee, Kurn, Ketterle, Science 275, 589 (1997)