Chapter 1

Units and Significant Figures

Course website: [http://faculty.uml.edu/Andriy_Danylov/Teaching/PhysicsI](http://faculty.uml.edu/Andriy_Danylov/Teaching/PhysicsI)
Everything you need to know about the course can be found on the course website or Blackboard:

http://faculty.uml.edu/Andriy_Danylov/Teaching/PhysicsI.aspx

There are two Blackboards (BB). How to find the right one?

Course Organization

• **Lectures**: 9:00-9:50 MW, Olney 150
  Lecture slides will be posted on-line
  Lecture recording (video and audio)
  will be posted on Blackboard:

• **Recitation Sections**
  Various times (M/W or Tu/Fr) and locations.

**Text**: The textbook for the course is “*Physics for Scientists and Engineers, a Strategic Approach*,” Fourth Edition by Randall Knight (Pearson, 2017).

*Bookstore options*

1) Stand-alone Modified Mastering Physics Access code for Knight PSE 4e with etext: 9780134110561. $103.59 net

2) Loose-leaf full text package with Modified mastering access card: 9780134454016. $171.40 net.
   “Physics for Scientists and Engineers: A Strategic Approach”, (Chs 1-36), 4th Edition, Knight

3) Volume 1, bound text packaged with modified mastering access card (contains full etext): 9780134588872. $160.40 net
# Course table

Problems from the textbook which will be solved in class with your recitation instructor

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<tr>
<th>Monday Lecture</th>
<th>Tuesday(Mon) Recitation</th>
<th>Wednesday Lecture</th>
<th>Thursday(Wed) Recitation</th>
<th>Sunday HWs (done in midnight)</th>
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<td>PHYS.1410</td>
<td>FALL 2016</td>
<td>31</td>
<td>1 Math Test</td>
<td>4</td>
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<td>5 Labor Day</td>
<td>6 Sin, Cos, Tan Converting Units</td>
<td>7 Ch1. SigFig, Units, Converting Units</td>
<td>8 Ch1: 23,24,28,29</td>
<td>11 Ch: 1: 23,25,28</td>
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<tr>
<td>12 Ch2: 1D motion (accel, velocity, distance)</td>
<td>Ch2:1,5,6,33</td>
<td>14 Ch2: Motion with const accel. Free fall (2.4; 2.5)</td>
<td>15 Ch2:9,14,22,27</td>
<td>18 Ch.2: 2.4,8,35, 11,17,21,26,29</td>
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<tr>
<td>19 Ch3: Vectors</td>
<td>20 Ch3: 1,7,16,19</td>
<td>21 Ch4: 2D Kinematics</td>
<td>22 Ch4:11,15,50</td>
<td>25 Ch3: 2.6,15,19, Ch4: 13,15,57</td>
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<tr>
<td>26 Rel. Motion(4.3); Non/Uniform circ. Motion (4.4,4.6)</td>
<td>27 Ch4:20,23,33,68</td>
<td>28 Ch5: Forces. Newton’s 1st and 2nd laws</td>
<td>29 Ch5: 15,17,24,35-39</td>
<td>2 HW4 Ch: 21,35,40, 69 Ch5: 14,18,23</td>
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<tr>
<td>3 EXAM 1 Ch: 1-4</td>
<td>More N. 2\textsuperscript{nd} law problems</td>
<td>Ch6: Using N. 2\textsuperscript{nd} law (6.1,6.2)</td>
<td>Ch6: 1,6,13,19</td>
<td>9 Ch6: 2,12,18</td>
</tr>
<tr>
<td>10 Columbus day</td>
<td>11 MonSch Lec: Friction(6.3) 25,29,56</td>
<td>12 Ch7 N.3\textsuperscript{rd} law, Tension</td>
<td>Ch7:9,14,16,25</td>
<td>16 Ch6: 24,27,57, Ch7: 9,24,36</td>
</tr>
</tbody>
</table>

Online HW (done in MasteringPhysics)
Clicker registration

Clicker registration must be done through Blackboard.
1) Find Physics I course in BB
2) Click on

[Link to "Lowell Day Turning Account Registration"

Link to "Turning Technologies" to register a clicker and join "Physics I clicker class" (PHYS1410 F17)

3) Follow a guidance.
You need to have a clicker ID number and a license number

Channel Number of a clicker: 61

http://student.turningtechnologies.com/
Weekly Homework

- **Online HW** is on [www.masteringphysics.com](http://www.masteringphysics.com) but you can reach Mastering Physics (MP) through your Blackboard page.
  - MP Course name: **PHYS1410Fall2017**
  - MP Course ID: **danylov20777**

- The online HW is typically due midnight on Sunday (You are penalized 25% for each day late)

**Mastering Physics registration must be done through Blackboard.**

1) Find the Physics I course in BB
2) Click on any of Mastering Physics Links
3) Follow a guidance.
   You need to have an access number, which comes with a book or you can buy it with a credit card during your registration.

*PHYS.1410  Lecture 1  Danylov*
Department of Physics and Applied Physics
EXAMS

3 Mid-Term (in-class) Exams
Each worth 100 pts.

Covers incremental material from previous exam
No rescheduling
(Extra time available for students with note from Student Disability Services)

Final Exam 200 pts (in-class).
Date/Time/Location To Be Announced
# Course Grading

<table>
<thead>
<tr>
<th>Item</th>
<th>Points</th>
<th>Range</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attendance</td>
<td>50</td>
<td>&gt;80%</td>
<td>A</td>
</tr>
<tr>
<td>HW</td>
<td>100</td>
<td>75-80%</td>
<td>A-</td>
</tr>
<tr>
<td>Quizzes</td>
<td>100</td>
<td>70-75%</td>
<td>B+</td>
</tr>
<tr>
<td>Exam 1</td>
<td>100</td>
<td>65-70%</td>
<td>B</td>
</tr>
<tr>
<td>Exam 2</td>
<td>100</td>
<td>60-65%</td>
<td>B-</td>
</tr>
<tr>
<td>Exam 3</td>
<td>100</td>
<td>55-60%</td>
<td>C+</td>
</tr>
<tr>
<td>Final Exam</td>
<td>200</td>
<td>50-55%</td>
<td>C</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>750</strong></td>
<td><strong>45-50%</strong></td>
<td>C-</td>
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<tr>
<td></td>
<td></td>
<td><strong>40-45%</strong></td>
<td>D+</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>35-40%</strong></td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;35%</td>
<td>F</td>
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</tbody>
</table>
Physics I Resources

- Get help early and often.

- The first person to contact with problems in Physics I is your Recitation Instructor!!

- Recitation Instructors will have office hours each week during which they can be met.

- Physics Department Tutoring Center:
  Tutors are available free of charge in the Physics Department tutoring room (9 am-5 pm), located adjacent to the Department office on the 1st floor of Olney Hall.
Let’s start
Today we are going to discuss:

Chapter 1:

- Uncertainty: Section 1.8
- Significant figures: Section 1.8
- Units: Section 1.8
- Unit Conversion: Section 1.8
Measurement and uncertainty

There are 3 parts to a measurement:

1) The measurement  (13.2)
2) The unit         (g)
3) The uncertainty  (±0.4)

(No measurement should be written without all three parts)

NO measuring device can give perfect measurements without experimental uncertainty.

Convention: If uncertainty is not mentioned,

13.2 g is said to have an absolute uncertainty of ±0.1 g

(Which means we are reasonably sure the actual weight is somewhere between 13.1 and 13.3)

13.20 g (absolute uncertainty ±0.01g)
13.200 g (absolute uncertainty ±0.001g)
Significant Figures (SF)

The accurately known digits in a number plus one uncertain digit are called its **significant figures**.

- **13.4 g**
  - Two accurately known digits
  - One uncertain digit
  - $SF = 2 + 1 = 3$

- **13.40 g**
  - Three accurately known digits
  - One uncertain digit
  - $SF = 3 + 1 = 4$
Number of SF rules

1. **All nonzero digits are significant**
   - 1.234 m  SF=4
   - 3.07 m  SF=3

2. **Leading zeros to the left of the first nonzero digit are not significant**
   - 0.001 m  SF=1
   - 0.012 m  SF=2

Reason? 0.001 m = 1*10^{-3} m = 1 mm (definitely SF=1)

3. **Trailing zeros that are after the decimal point are significant**
   - 3.20 m  SF=3
   - 0.0320 m  SF=3
4. When a number ends in zeros that are not to the right of a decimal point, the zeros are not necessary significant. Here, there is an ambiguity:

length = 2950 m, SF may be 3 and 4?

To avoid ambiguity powers-of-10 notation is used (reasonable convention):

If you mean that SF = 3, write $2.95 \times 10^3$ m
If you mean that SF = 4, write $2.950 \times 10^3$ m
**ConcepTest**

What is the number of significant figures in the following numbers?

- 0.430
- 4.321\times10^{-10}

<table>
<thead>
<tr>
<th>Option</th>
<th>Significant Figures</th>
</tr>
</thead>
<tbody>
<tr>
<td>A)</td>
<td>2 and 3</td>
</tr>
<tr>
<td>B)</td>
<td>3 and 4</td>
</tr>
<tr>
<td>C)</td>
<td>4 and 4</td>
</tr>
<tr>
<td>D)</td>
<td>2 and 4</td>
</tr>
</tbody>
</table>

**Answer:** B) 3 and 4
Addition/Subtraction/Multiplication/Division

- In addition/subtraction, the final result is no more precise than the least precise number used to get the answer.

  \[
  \begin{align*}
  \text{82 kg} &+ 0.13 \text{kg} = 82.13 \text{kg} = 82 \text{ kg} & \text{82 kg} + 0.93 \text{kg} = 82.93 \text{kg} \approx 83 \text{ kg} \\
  \text{Least certain} & \quad \text{82.0 kg} + 0.13 \text{kg} = 82.13 \text{kg} = 82.1 \text{ kg} \\
  \text{Least certain} & \quad \text{82.00 kg} + 0.13 \text{kg} = 82.13 \text{kg} \\
  \text{Both equally certain} & \quad \text{82.000 kg} + 0.13 \text{kg} = 82.13 \text{kg} \\
  \text{Least certain} & 
  \end{align*}
  \]

- In multiplication/division, any number of the problem with the least number of SF determines the number of SF in the answer.

  \[
  \begin{align*}
  3.0 \times 12.60 &= 37.80 &= 38 \\
  \text{(SF=2)} & \quad \text{(SF=4)} & \quad \text{(SF=2 should be)}
  \end{align*}
  \]
SI (Système Internationale) units

- Length: meters [m]
- Time: seconds [s]
- Mass: kilogram [kg]
- Temperature [K]

For very small or very large numbers, use prefixes:

- \( G \rightarrow \text{giga} \rightarrow 10^9 \)
- \( M \rightarrow \text{mega} \rightarrow 10^6 \)
- \( K \rightarrow \text{kilo} \rightarrow 10^3 \)
- \( m \rightarrow \text{milli} \rightarrow 10^{-3} \)
- \( \mu \rightarrow \text{micro} \rightarrow 10^{-6} \)
- \( n \rightarrow \text{nano} \rightarrow 10^{-9} \)

- 100,000m can also be written as 100 kilometers (km)
- 0.0001s could be written as 100 microseconds (\( \mu s \))
Converting units

Very often we have to convert a quantity in a certain unit to its equivalent in a different unit of the same kind.

In this case, we use the fact that multiplying anything by 1 doesn’t affect its value:

\[
12 \text{ in} = 1 \text{ ft}, \quad \text{so} \quad \frac{12 \text{ in}}{1 \text{ ft}} = 1
\]

\[
4 \text{ ft} = 4 \text{ ft} \times 1 = 4 \text{ ft} \times \left( \frac{12 \text{ in}}{1 \text{ ft}} \right) = 48 \text{ in}
\]

**Example:** Convert 30 mile/h to m/s

\[
30 \frac{\text{mile}}{\text{hour}} = 30 \frac{\text{mile}}{\text{hour}} \cdot \frac{1.61 \text{ km}}{1 \text{ mile}} \cdot \frac{1000 \text{ m}}{1 \text{ km}} \cdot \frac{1 \text{ ft}}{1 \text{ km}} \cdot \frac{1 \text{ in}}{1 \text{ ft}} \cdot \frac{1 \text{ in}}{1 \text{ inch}} \cdot \frac{1 \text{ hour}}{60 \text{ min}} \cdot \frac{1 \text{ min}}{60 \text{ sec}}
\]

\[
= 13.33 \frac{\text{m}}{\text{sec}} \approx 13 \frac{\text{m}}{\text{sec}}
\]
Percentage uncertainty

The percent uncertainty is the ratio of the uncertainty to the measured value, multiplied by 100

\[
\text{% uncert.} = \frac{\text{absol. uncert.}}{\text{meas. value}} \times 100\%
\]

\[
\frac{0.1g}{13.2g} \times 100\% = 0.7\
\]

SO, the uncertainty in the measurement can be provided

- either in absolute numbers: e.g. 0.1g
- or as a percentage: 13.2g +/- 0.7%