Physics 272

Electricity
Magnetism
Geometric Optics

Spring 2015

Prof. Philip von Doetinchem
philipvd@hawaii.edu
\[ \oint \vec{E} \cdot d\vec{A} = \frac{Q_{\text{encl}}}{\epsilon_0} \]

\[ \oint \vec{B} \cdot d\vec{A} = 0 \]

\[ \oint \vec{B} \cdot d\vec{l} = \mu_0 \left( i_C + \epsilon_o \frac{d\Phi_E}{dt} \right) \]

\[ \oint \vec{E} \cdot d\vec{l} = -\frac{d\Phi_B}{dt} \]
Organization

Instructor
Prof. Philip von Doetinchem, Watanabe 430
email: philipvd@hawaii.edu
phone: 808-956-3719

Lecture
9:00-10:15am, Tuesday, Thursday in Watanabe 112

Office hours
10:30-11:30am, Tuesday, Thursday in Watanabe 430
or other times by arrangement
→ Please do not just show up in my office and always send me an email to philipvd@hawaii.edu before coming

Text
(We will cover chapters 21-34)

Prerequisites
Physics 151 or 170 and Math 242 or 252A. Math 216 may be substituted with consent.
Organize

Reading
Reading is assigned every week, and the assignment should be completed before the lecture so that you may ask questions and participate in class discussion. Fulfilling the reading assignments will help you during iClicker quizzes that will happen during nearly every lecture.

Clickers
Nearly every lecture will ask conceptual questions on the material that was just covered. You will receive a point for each correct i>clicker response.

Registration of i>clickers:

i>clicker ID is found on the backside of your i>clicker

i>clicker GO users (iOS, Android) find the ID in the following way:
open the app → my account → i>clicker GO credentials → hex code in the first line

Register your i>clicker ID on https://laulima.hawaii.edu/iclicker

You have to register your i>clicker during the first two weeks or I will not count your points.
Organization

- Working problems is central to learning physics.
- New problem sets will be given out each Thursday unless specified otherwise.
- Parts of the homework have to be completed by using Mastering Physics.
- Some fraction of the problems will have to be worked on with pen and paper (hand-in).
- Mastering Physics problems are due before the lecture on Thursdays one week after the assignment unless specified otherwise.
- Hand-in problems have to be submitted during the break of the lecture on Thursdays one week after the assignment unless specified otherwise. Hand-in problems can be worked on in groups of two. These groups have to be registered with me at the beginning of the semester and cannot be changed during the semester. Both group members will get the same number of points.
- I will try to spend half a lecture per week to explain homework problems.
Organization

- **Hand-in Problems**
  - Papers should be stapled. Letter size. Write all of your group's names, student IDs, and homework set number on each page. Show all steps in solving your problem and place a box around your final answer.

- **Mastering Physics Problems**
  - Some problem sets will be worked and graded using [www.masteringphysics.com](http://www.masteringphysics.com). You will have to create a Mastering Physics account and register for the course. To access the problems and receive credit, you will need a registration code, which comes along with a new textbook or can be purchased separately.

ID: DOETINCHEMMPHYS272SPRING15
Organization

• Midterms
There will be two exams during the regular course hours in WAT112 (February 19th & April 2nd). Midterm 1 will cover chapters 21-25 and midterm 2 chapters 26-29. They will consist of conceptual questions (similar to the i>clicker questions during the lecture, but no multiple choice) and problems similar to those occurring on the problem sets. Please just bring your calculator and paper. No further materials will be allowed.

• Final
  – May 12th, 9:45am-11:45am, WAT112
  – The final will focus on chapters 30-34, but will also have conceptual questions concerning chapters 21-29. It will consist of conceptual questions (similar to the i>clicker questions during the lecture, but no multiple choice) and problems similar to those occurring on the problem sets. Please just bring your calculator and paper. No further materials will be allowed.

Make accommodations in your schedule for the exams well before. I will not arrange for make-up exams if you are traveling or have other non-emergency or health related obligations.
Organization

Grading

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>final</td>
<td>35%</td>
</tr>
<tr>
<td>midterm 1:</td>
<td>25%</td>
</tr>
<tr>
<td>midterm 2:</td>
<td>25%</td>
</tr>
<tr>
<td>homework:</td>
<td>15%</td>
</tr>
<tr>
<td>in-class clicker quizzes:</td>
<td>5%</td>
</tr>
</tbody>
</table>

in-class clicker quizzes: 5% (extra credit)

Final grades will be determined based on your scores in final, midterms, homework, and i>clicker. The final score translates into the following final grade:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Score Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>A+</td>
<td>95% ≤ score &lt; 95%</td>
</tr>
<tr>
<td>A</td>
<td>90% ≤ score &lt; 95%</td>
</tr>
<tr>
<td>A-</td>
<td>85% ≤ score &lt; 90%</td>
</tr>
<tr>
<td>B+</td>
<td>80% ≤ score &lt; 85%</td>
</tr>
<tr>
<td>B</td>
<td>75% ≤ score &lt; 80%</td>
</tr>
<tr>
<td>B-</td>
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</tr>
<tr>
<td>C+</td>
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</tr>
<tr>
<td>C</td>
<td>60% ≤ score &lt; 65%</td>
</tr>
<tr>
<td>C-</td>
<td>55% ≤ score &lt; 60%</td>
</tr>
<tr>
<td>D+</td>
<td>50% ≤ score &lt; 55%</td>
</tr>
<tr>
<td>D</td>
<td>45% ≤ score &lt; 50%</td>
</tr>
<tr>
<td>D-</td>
<td>40% ≤ score &lt; 45%</td>
</tr>
<tr>
<td>F</td>
<td>score &lt; 40%</td>
</tr>
</tbody>
</table>

To pass the class only one out of the written examinations (midterm 1, midterm 2, final) is allowed to be F.
Website

www.phys.hawaii.edu/~philipvd/pvd_15_spring_272_uhm

- I am not going to use Laulima for the upload of materials and announcements, but will upload all my lecture slides to this website.

- Most of the time the slides will be available within a few hours after the lecture. The website will also announce reading assignments, homework, important dates, and any other changes or updates.

- Please always check the website first before asking organizational questions. I will not answer questions that are already answered on the website.
Study suggestions

- Keep good notes. Use the text to fill in lecture material.
- Work problems: this is how you learn physics.
- Discuss in study groups!
- Try to get a grasp of the physical problem before going to the mathematics.
- When you learn something new, check that you know how to apply it.
- There are many equations. Don't try to remember all of them. **Learn the fundamental equations.** Keep a summary sheet of these. This will be useful at test time. It is not the memorizing Olympics. The formulas actually do make sense.
- Study every day. Don't get behind
Homework instructions

- Neatness counts. The grader can't give partial credit if he/she can not read your paper.

- Follow the steps below when doing problems:
  - Paraphrase the problem (briefly). **Don't work the wrong problem!**
  - Consider what physics concepts are involved.
  - How do the physics concepts apply specifically to this problem?
  - **Draw a diagram and label it. Diagrams are crucial; points are given for careful sketches or diagrams.**
  - Write down the main formulas. **Use only symbols at this stage!**
  - Write down what is given and what is unknown.
  - Manipulate your formula(s) to get the desired unknown on the left of the equal sign and the known quantities on the right. **Do not plug in numbers at this stage!**
  - Rewrite the equation with numbers and units inserted.
  - Use a reasonable number of significant figures for your numerical answers. You will be graded down for ridiculous accuracy. Rule of thumb: round to the two last digits.
  - Write the solution with units and put a box around it.
  - Check to see if your answer and units make sense.
  - Be sure that you use vectors and scalars properly when writing your final results.
Code of conduct

- Academic dishonesty
- Threats and verbal/physical altercations
- Theft
- Disorderly/disruptive conduct

Please avoid all of these popular student conduct code violations (and also all the others!)
Advice

- This is going to be a tough class for most of the students. Don't get behind or you will quite likely not be able to catch up. The difficulty level is increasing throughout the course.

- Ask a lot of questions to yourself, to your fellow students, and to me. Make use of office hours. Don't worry about asking naive questions. These are typically the best and most likely others have the same questions.

- Problems in the exam will be extremely similar to the homework.

- Copying solutions from others does not help you learn physics. You have to really understand the homework. Then you should have no problem to get a good grade. Deciding to not spend a lot of time on understanding the homework because it is only 15% of the grade is a bad idea.
Homework vs. total score

High homework grade does not necessarily result in a high total score.
Don't do that:

• I do not want to receive emails like that:

  “Hey yo, can I get more credit.”

I will ignore these type of emails!
Suggestions on how to improve the lecture?
Let me know early on. I will try to listen to your concerns.

Email: philipvd@hawaii.edu

Office hours:
10:30-11:30am, Tuesday, Thursday in Watanabe 430
(or other times by arrangement)
Learning outcomes

- Charge and currents
- Electric and magnetic fields
- Field determination for various configurations of charges and currents
- Forces on charges and currents due to fields
- Potential energy and potential
- Electrical circuits (AC and DC) composed of resistors, capacitors, and inductors
- Energy transfer in electric circuits
- Maxwell's equations of electricity and magnetism
- Electromagnetic waves
- Properties of light
- Reflection and refraction
- Mirrors and lenses
Mathematics recap
## Greek letters important for the lecture

<table>
<thead>
<tr>
<th>Greek Letter</th>
<th>Lower Case</th>
<th>Upper Case</th>
<th>Lower Case</th>
<th>Upper Case</th>
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</thead>
<tbody>
<tr>
<td>alpha</td>
<td>α</td>
<td>μ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>beta</td>
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<td>π</td>
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<td>φ</td>
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<tr>
<td>lambda</td>
<td>λ</td>
<td>χ</td>
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</table>
# Prefixes for units

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Exponent</th>
<th>Symbol</th>
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</thead>
<tbody>
<tr>
<td>pico</td>
<td>$10^{-12}$</td>
<td>p</td>
</tr>
<tr>
<td>nano</td>
<td>$10^{-9}$</td>
<td>n</td>
</tr>
<tr>
<td>micro</td>
<td>$10^{-6}$</td>
<td>μ</td>
</tr>
<tr>
<td>milli</td>
<td>$10^{-3}$</td>
<td>m</td>
</tr>
<tr>
<td>kilo</td>
<td>$10^{3}$</td>
<td>k</td>
</tr>
<tr>
<td>mega</td>
<td>$10^{6}$</td>
<td>M</td>
</tr>
<tr>
<td>giga</td>
<td>$10^{9}$</td>
<td>G</td>
</tr>
<tr>
<td>tera</td>
<td>$10^{12}$</td>
<td>T</td>
</tr>
</tbody>
</table>
Sketch functions

Sketch a graph of the given functions

(a) \( y = \frac{1}{2}x \), \( y = x \), \( y = 2x \), \(-4 \leq x \leq 4\)

(b) \( y = \frac{1}{4}x^2 \), \( y = x^2 \), \( y = 4x^2 \), \(-4 \leq x \leq 4\)

(c) \( y = \frac{1}{2} \sin x \), \( y = \sin x \), \( y = 2 \sin x \), \( y = \sin(2x) \)

(d) \( y = \frac{1}{2} \cos x \), \( y = \cos x \), \( y = 2 \cos x \), \( y = \cos(2x) \)

(e) \( y = e^x \), \( y = e^{-x} \), \( y = \ln(x) \), \( y = \ln(-x) \), \(-4 \leq x \leq 4\)
Sketch functions a)

- $y = x$
- $y = 0.5x$
- $y = 2x$
Sketch functions b)

\[ y = x^2 \]

\[ y = 0.25x^2 \]

\[ y = 4x^2 \]
Sketch functions c)

- $y = \sin(2x)$
- $y = 2\sin(x)$
- $y = \sin(x)$
- $y = 0.5\sin(x)$
Sketch functions d)

- $y = \cos(x)$
- $y = 2\cos(x)$
- $y = 0.5\cos(x)$
- $y = \sin(x)$
- $y = \cos(2x)$
Sketch functions e)

- $y = e^{-x}$
- $y = e^x$
- $y = \ln(-x)$
- $y = \ln(x)$
Calculate the derivatives

\[ y = 3x^5 + 2x^2 - x + 4 \]

\[ y = \frac{2x^2 + x}{x + 1} \]

\[ y = \ln(3x) \]

\[ y = e^{\sin x} \]

\[ y = \sin(3\theta) \]

\[ y = \cos(3\theta) \]

\[ y = \cos^2(3\theta) \]
Calculate the derivatives

\[ y(x) = 3x^5 + 2x^2 - x + 4 \]

\[ \frac{d}{dx} y(x) = y' = 3 \cdot 5 \cdot x^4 + 2 \cdot 2x - 1 \]

\[ = 15x^4 + 4x - 1 \]

\[ y = \frac{2x^2 + x}{x+1} \]

\[ y' = \frac{(2 \cdot 2x + 1)(x+1) - (2x^2 + x) \cdot 1}{(x+1)^2} \]

\[ = \frac{4x^2 + 4x + x + 1 - 2x^2 - x}{(x+1)^2} \]

\[ = \frac{2x^2 + 4x + 1}{(x+1)^2} \]
Calculate the derivatives

\[ y = \ln (3x) \]

\[ y' = 3 \cdot \frac{1}{3x} = \frac{1}{x} \]

\[ y = e^{\sin x} \]

\[ y' = \cos x \cdot e^{\sin x} \]
Calculate the derivatives

\[ y = \sin(3\theta) \]
\[ y' = 3 \cdot \cos(3\theta) \]

\[ y = \cos(3\theta) \]
\[ y' = -3 \sin(3\theta) \]

\[ y = \cos^2(3\theta) \]
\[ y' = 2 \cdot \cos(3\theta) \cdot (-\sin(3\theta)) \cdot 3 \]
\[ = -6 \cdot \cos(3\theta) \cdot \sin(3\theta) \]