Course Portfolio for PHYS 218
- Introductory Mechanics -

2004-2005 Peer Review Project

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Interaction One

Overview of PHYS 218

PHYS 218 is the first-year, calculus-based physics course for non-physics majors at Texas A&M University (TAMU). The course covers classical mechanics, where most of students are engineering majors and freshmen, followed by PHYS 208 (‘electricity and magnetism’ course). Annual enrollment is about 2000 (1200 in fall semester, 800 in spring semester). A typical class size is 100 students.

The lecture is led by faculty, while lab and recitation are led by graduate teaching assistants (TAs) with little faculty supervision and without any clear connection to the lectures. There was no rigorous grading of students’ lab reports (the score of each lab report was usually better than 90!), and TAs offered no feedback to students on how well they communicated what they were learning during the semester.

Goals for the Course

It is a challenge to train freshmen, so they can (i) read the problem and turn into a set of equations, (ii) solve the equations and (iii) evaluate the solution. This is a multi-step problem-solving skill that will be useful for any science and engineering courses.

The best impact to students will be achieved if we provide a coherent effort for this goal in lecture, recitation and lab. At Department of Physics, we have been carrying out a pilot program (Visual Physics) to improve recitation and lab. In the recitation, we use interactive engagement (IE) between TA and students along with context-rich recitation quizzes. During the lab, all experiments are designed to use a video-based data acquisition followed by an analysis by Microsoft Excel and a short lab report, called Technical Memo.

On the lecture side, it is up to each instructor so far. In the past years, my effort has been focused on providing elegant presentations (visual impacts) using PowerPoint, and providing a regular lecture style. Namely it starts with an introduction of principle, followed by a simplest example and solving a complex example problem.

However, I found the presentations less impact on students’ exam performance. This can naturally be explained by a fact that my exams have been given in a traditional way (nothing to do visual presentation). They also often said “I cannot take note.”

Therefore, I am quite interested in trying a Problem-Based Learning method. Unfortunately I haven’t had a chance to search articles on this before writing this portfolio. So, let me give you what I would like to do.

Main change in my lecture will be:
(a) Choose 4-5 problems each chapter of the textbook and convert them to context-rich problems. The context-rich problems may also come from their experiments in the lab.
(b) The problems are given to students one week in advance.
(c) Lecture will begin with one of context-rich problems, followed by a set of questions, such as “What kind of motion do you see?” and “What kind of forces do you identify?” to train them to teach how they start thinking of the problem. The question should guide them to think about the principle.
(d) Show the physics principle(s) and set up the equations.
(e) Solve the equations.
(f) Evaluate the solution.
(g) Repeat (c) – (f) for the second problem.

To assess the impact of this new lecture, I keep the same homework problems from the textbook and maintain the style of exam. I also use Force Inventory Concept (FCI) problems to test students’ conceptual learning.
**Interaction Two**

For Interaction 2, I describe the specific teaching method, compared to my regular style.

**Regular Course**

Figures 1 and 2 are common syllabus for all PHYS 218 instructors. Below are some details of my regular PHYS 218 course:

1. **Proficiency in mathematics:**
   Students will be asked to take online math quizzes that are developed by Prof. D. Toback. If I identify students who are weakly prepared, provide a review and help.

2. **Course Materials**
   a) **Textbook:** University Physics, 11th ed. Young and Freedman, Addison-Wesley
      (This is a common textbook for PHYS 218 and 208.)
   b) **Lecture notes (available online):**
      [http://faculty.physics.tamu.edu/kamon/phys218/class/class04C.htm](http://faculty.physics.tamu.edu/kamon/phys218/class/class04C.htm)
   c) **Web-based (WebCT) home work submission**
   d) **Recitation:** weekly quiz is given by TA.
   e) **Lab:** reports are required. Those reports are graded by TA.

3. **Lecture style**
   My lectures in the past provide a complete overview of theories in each chapter and then examples. As a result, I ran out of time to provide enough number of examples. Few numbers in each example seem to frustrate some students by saying they don’t learn anything from lectures.
PHYSICS 218: Mechanics (Fall 2004)

Corequisites: MATH 151. You are expected to have a working knowledge of plane geometry, trigonometry, and algebra. As the semester progresses you will also be expected to have a working knowledge of derivatives and integrals, and be proficient in the use of vectors (addition, subtraction, dot and cross products).

Instructor: Dr. Teruki Kanon
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E-mail: t-kanon@tamu.edu
Office hours: Mon: 10 to 12 PM, Tues: 10 to 12 PM, and by appointment.

Homepages:
http://physics218.physics.tamu.edu for general information
http://faculty.physics.tamu.edu/kanon/phys218/class/ for my own homepage

Textbooks:
"University Physics," 11th ed. by Young and Freedman

Rec. & Lab
Recitation meets in 118 Holdenby Hall for the first hour, and is followed by a Laboratory session the remaining two hours. No Lab sessions and Reports will be dropped. Students retaking the course should contact me immediately in order to get credit for Lab if passed in a previous semester with a grade of 80 or better. Students retaking the course do not have to repeat the Lab but they are required to attend Recitation and take weekly quizzes. Notes: There will be no recitation or lab meetings during the first week of the semester.

Quizzes/
Homework
Homework assignments and quiz quizzes will be turned in using webCT (http://webct.tamu.edu). Instructions on using webCT for Physics 218 may be found at http://faculty.physics.tamu.edu/toback/webct/. Homework assignments are for you to practice problem-solving techniques. Homework will be graded weekly by webCT. About 10 quizzes will be given in Recitation. Each quiz will test your ability to work one of the assigned homework problems. There may also be unexpected pop quizzes during Lecture.

Exams
There will be three midterm exams and one final exam: (a) Each midterm exam will be given during the regular classroom time and will last 55 minutes, while the final exam is comprehensive and lasts for 2 hours. Each exam will generally consist of problems similar in content and difficulty to the homework. The entire solution will be graded and partial credit given if merited. Your work must show the steps toward the solution; the answer alone is not sufficient. The grader will judge your performance in solving the solution. Exams may also include Examples worked in the lecture but not appearing in the text as assigned as problems. (b) Formula sheets will be provided for each exam and the final. (c) You will need to bring a calculator to the exams. (d) If you miss an exam due to an authorized excused absence as outlined in the University Regulations, then you must contact me no later than the next class meeting following the missed exam to arrange for a makeup exam. There will be a single course-wide makeup exam for those missing an exam. This makeup exam will be written by a committee of Physics 218 lecturers and administered outside normal class time within 7-10 class days following the missed exam. Note: Very few conditions qualify as an authorized excused absence, so avoid missing an exam at all costs. (e) You must bring your student ID with you to all exams for identification purposes.

Exam Grade
Exam grades may be curved depending on special conditions of a particular exam. In no case will a curve result in a lower letter grade than the standard 90-100% A, 80-89% B, 70-79% C, 60-69% D, and <60% F.

Course Grade
The total course grade consists of 700 points distributed as follows:

<table>
<thead>
<tr>
<th>Points</th>
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<tbody>
<tr>
<td>Midterm Exams</td>
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<tr>
<td>Final Exam</td>
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<tr>
<td>Laboratory</td>
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<tr>
<td>Recitation and Lecture Quizzes</td>
</tr>
<tr>
<td>WebCT Homework and Math Quizzes</td>
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<tr>
<td>Total</td>
</tr>
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NOTE: If your final exam grade is higher than your 3-exam average, then the final will count 300/700 points toward your final grade and your midterm exam average will count just 200/700. You must pass both the lecture (3 midterm exams, final exam, homework, recitation & lecture quizzes) and laboratory (≥70%) parts of the course separately in order to pass the course.

Figure 1: Common syllabus for PHY 218 (fall 2004)
### ADA Policy
The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities, in Room 126 of the Kole Building or call 845-1637.

### Honor Code

### Tentative Class Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Chapters</th>
<th>Topics/Homework Assignment</th>
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<tbody>
<tr>
<td>Aug 30 - Sep 3</td>
<td>1 (1-10)</td>
<td>Introduction: vectors</td>
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<tr>
<td></td>
<td></td>
<td>11: 1,10,13,32,35,40,41,47,50,52,56,72,74,89</td>
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<tr>
<td>Sep 6 - 10</td>
<td>2 (1-6)</td>
<td>Motion along a straight line</td>
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<td>2: 4,9,11,18,21,36,40,49,50,61,76,80,83,92</td>
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<tr>
<td>Sep 13 - 17</td>
<td>3 (1-5)</td>
<td>Motion in two or three dimensions</td>
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<td></td>
<td></td>
<td>3: 5,15,19,32,33,38,40,47,52,54,64,81</td>
</tr>
<tr>
<td>Sep 20 - 24</td>
<td>4 (1-6)</td>
<td>Newton’s laws of motion</td>
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<tr>
<td></td>
<td></td>
<td>4: 12,14,22,24,31,35,37,44</td>
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<tr>
<td>Sep 27 - Oct 1</td>
<td>Exam 1 (Chap. 1-3)</td>
<td>Sep 27 (Mon)</td>
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<tr>
<td></td>
<td></td>
<td>Further application of Newton’s laws</td>
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<tr>
<td>Oct 4 - 8</td>
<td>6 (1-4), 7 (1,2)</td>
<td>Work, kinetic energy, and potential energy</td>
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<td>Oct 11 - 15</td>
<td>7 (3-5), 8 (1,2)</td>
<td>Force and energy: Momentum</td>
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<td></td>
<td></td>
<td>7: 25,38,42,46,54,56,62,66,67,69,74</td>
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<tr>
<td>Oct 18 - 22</td>
<td>8 (3-5)</td>
<td>Momentum and collisions</td>
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<td></td>
<td></td>
<td>8: 34,36,40,43,46,47,61,70,94</td>
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<tr>
<td>Oct 25 - 29</td>
<td>Exam 2 (Chap. 4-7)</td>
<td>Oct 23 (Mon)</td>
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<td></td>
<td>10 (1-2)</td>
<td>Torque</td>
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<tr>
<td></td>
<td></td>
<td>10: 1,2,5,8,13</td>
</tr>
<tr>
<td>Nov 1 - 5</td>
<td>10 (3-7)</td>
<td>Dynamics of rotational motion</td>
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<tr>
<td>Nov 5 (Fri)</td>
<td></td>
<td>Last day to drop course with no penalty (Q-drop)</td>
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<td>Nov 8 - 12</td>
<td>11 (1-3), 12 (1-5)</td>
<td>Static equilibrium; Gravitational</td>
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<tr>
<td>Nov 15 - 19</td>
<td>13 (1-8)</td>
<td>Periodic motion</td>
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<tr>
<td>Nov 18 (Thu)</td>
<td></td>
<td>No class after 1:30 pm; Bonfire Memorial dedication.</td>
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<tr>
<td>Nov 22 - 24</td>
<td>Exam 3 (Chap. 8-11)</td>
<td>Nov 22 (Mon)</td>
</tr>
<tr>
<td>Nov 25 - Dec 3</td>
<td>15 (1-8)</td>
<td>Thanksgiving holidays</td>
</tr>
<tr>
<td>Dec 6 - 7</td>
<td>Review</td>
<td>Mechanical waves</td>
</tr>
<tr>
<td>Dec 10 (Fri), 7:30-9:30 AM:</td>
<td>Final Exam (Chap. 1-13, 15)</td>
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### Figure 2:
Common syllabus for PHYS 218 (cont’d)
Proposed Changes

As I mentioned earlier, the primary goal of this course portfolio is to test “Problem-based Learning” method in my lecture. Since I want to monitor an effect of the method, I intentionally maintain my course structure, but the lecture part.

Adding the message to students in the first class meeting

The course is based upon some problem solving skills using basic mathematics that you should have developed before taking this course. The learning experts say that for a course like this, everything must be learned three times. One must learn the material and then forget about it for three days or so. Your knowledge has largely evaporated. At that time you should re-learn everything but this process should be a little easier than the first time. After three days, this knowledge will again be gone and only after the third time learning it, will you be prepared to go into an exam and be able to work the problems without your mind “going blank.” This program of study requires time, so allocate your study time accordingly.

Memorization is a valued skill but it is not very important this course. If you find that you must memorize many things, you are missing the point. This course is designed to teach you to THINK. To further de-emphasize memorization, you will be allowed to use a formula sheet that I provide.

Since we live in a world filled with mechanical, electrical and optical things, I hope you will find this course interesting, fun, and an aid in understanding the world around you. It will be one of the most challenging courses you will ever have.

Lecture: Problem-Based Learning with Visual:

Below is an example of lecture to cover (i) energy conservation and (ii) rotational motion.

(1) Begin with a context-rich problem, followed by an introduction of “theory” and problem-solving steps. An example is shown in Figure 3. The problem may come from the textbook or lab.

(2) Show Systematic Problem Solving as Identify, Setting up, Execute, and Evaluate (ISEE) in Y&F.
   a) Begin with slides to cover “energy conservation” like in Figures 4-6.
   b) Move to more complex situation (Figure 7), which is to practice (i) energy conservation and (ii) rotational motion.
   c) Solve the problem in Figure 3.

(3) Repeat (1)-(2) for key subjects.

Howe work assignments: no change

A set of problems are chosen from the textbook as a part of large service course. I maintain to use those problems. In this way, I have main change in the lecture and can measure students’ performance through the exams and FCIs, compared to the previous exam scores.

Exams: reflections
Physics 218 Course Portfolio

The exam problems will be used as a tool to evaluate what I teach in the lectures and what they learn from recitation and lab as well as home work problems. The format of each mid-term exam that I have been using is:

Problem 1 – Multiple-choice conceptual problems
Problem 2 – Topic #1
Problem 3 – Topic #2
Problem 4 – Topic #3

The problems for Topics #1 ~ #3 can be based on the textbook problems, but modified to look like a real-world problem that students experienced in their lab or can imagine.

Problem 3 (25 points) – Riding a loop-the-loop

You are employed at Texas Aggie Flag Co (TAFCo) that operates an amusement park in College Station. One of main attractions is a new loop-the-loop. The company president Teruki Kamon wants to know the minimum height ($H_{min}$) of point A such that a car slides along the track without falling off at the top (point B). You, as Chief Engineer, have to submit a technical memo before 7 pm today. In the memo, you first state the assumptions: (i) the car slides without friction around the track; (ii) it starts from rest at point A at height $H$ above the bottom of the loop; (iii) the car is treated as a particle; and (iv) the air resistance is ignored.

a) (5 pts) Draw a free-body diagram for the car at point B when the car moves around the loop safely. Assume $H > H_{min}$.

b) (5 pts) I have covered this topic in my lecture, where I showed two key concepts to solve this problem. What were they?

c) (10 pts) Express the minimum value of height $H_{min}$ (in terms of $R$) such that the car moves around the loop without falling off at the top (point B)?

d) (5 pts) If $H = 3.50R$ and $R = 20.0$ m, compute the speed, radial acceleration, and tangential acceleration of the passengers when the car is at point C, which is the end of the horizontal diameter. Show these acceleration components in a diagram, approximately to scale.

![Diagram](image)

Figure 3: An example of a problem that will be used for problem-based learning.
Example Slide #1
“Identify”

**Figure 4:** Examples of Slides #1 to guide students to identify the principle(s).
Example Slide #2
“Setting up”

Figure 5: Example of Slide #2 to guide students to set up the equations

Example Slide #3
“Execute”

Figure 6: Example of Slide #3 to guide students to solve the equations.
Figure 7: Example of step-by-step slides to solve the problems
**Interaction Three**

I haven’t had chance to implement the proposed change during this peer-review project in 2004-05. The analysis and documentation of students’ learning/understanding/performance will be reported in future. Below is a list of key questions (taken from [http://www.tamu.edu/cte/pewcon.htm](http://www.tamu.edu/cte/pewcon.htm)) to be addressed in the report:

**A. The Nature of Student Understanding**

(1) Is there any evidence (as represented in their work samples) of students meeting the specific learning goals I selected? Where do I see such understanding (e.g., I could cite particular passages from a student paper or a short answer from a quiz that provides evidence of such understanding)? What criteria do I use to assess such understanding?

(2) How does the understanding represented by the work samples I present differ among students?

(3) Does the performance represented by student work indicate students have developed an understanding for physics that will be retained and/or that students can apply to new contexts?

(4) What does the analysis of students' work tell me about how students are learning ideas that are central to the course and to my teaching goals? Can I identify misconceptions they might have about these ideas? How might I identify and address these errors and/or misinterpretations?

**B. Distribution of Student Performance**

Given the evidence of student learning/performance documented above, how many students out of the total class population achieved a high, middle, or low range of student learning? Am I satisfied with the results? Why or why not?

**C. Student Performance and the Broader Curriculum**

(1) Overall, how well did student work meet my intellectual goals for the course? Did the distribution of student achievement meet my expectations? Why or why not?

(2) Does the evidence of student performance you've documented above indicate that students are prepared for other courses or have achieved the aims of the broader curriculum?

(3) What does my students' work tell me about the prior preparation they have received in physics study?

(4) What changes could be made to help more students achieve in the higher categories of learning? Are there particular features of the course that I would redesign? What specific changes do I plan to make in the way I teach or organize the course the next time it is offered? How do I think those changes would improve student understanding?