8.012 Physics I: Classical Mechanics
Fall 2008

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Physics

Physics 8.012: Physics (Mechanics) I **Fall Term 2008**

PROBLEM SET 6

Collaboration policy: You are encouraged to freely discuss homework problems with other 8.012 students and teaching staff. However, **you must write up your solutions completely on your own**—do not simply copy solutions from other students. You are **forbidden from consulting solutions from previous years or from the web.** Violations of this policy may result in disciplinary action.

Reading: Kleppner & Kolenkow, Chapters 5 & 6

8.012 Project Proposal: The 8.012 Project is a design-your-own project to explore some of the concepts we've been learning in class. It is free-form in the sense you can design any kind of (reasonable) project you can think of related to the class, but in the spirit of Newton should nevertheless be experimental in design. The project itself will be due on **Wednesday, November 26th** in your recitation section, and is worth 5% of your total grade.

Here are the ground rules for the 8.012 project (see also the 8.012 webpage):

- The project must an experiment based on principles we have learned in 8.012.
- The project should test an idea (such as the conservation of momentum), verify a result from the psets (such as confirming the properties of the capstan), demonstrate a physical concept (similar to the classroom demos) or examine a unique mechanical situation (such as examining the motion of coupled-pendulum system).
- The project can be mechanical (i.e., building something), purely experimental (i.e., measuring the motion of a simple system) or numerical (i.e., simulating a physical problem on computer).
- Each project is to be accompanied by a 3-5 page write-up, as well as any accompanying media (e.g., pictures, video or computer simulation).
- You may work in groups of up to 4 people.
- Each project will be graded according to its description of the physics underlying the experiment, design and execution of the experiment and analysis/description of the results. <u>Creativity will be rewarded!</u>

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The objective here is to draft up a project proposal which you will hand in during your recitation section on **Wednesday, October 29th**. The proposal must include:

- A title and name(s) of those working on the project;
- A brief description of the project itself (general idea, design, goals);
- A description of how the project is specifically related to the physical principles discussed in 8.012;
- A description of the resources you may need to complete the project and how you aim to obtain those resources;
- The proposal must be no longer than one (1) page, single-spaced, 12-point font.

The instructors will assess your project idea and either give you/your group the go-ahead or suggest a revised project plan. **No 8.012 project can be done without an accepted proposal, and no late proposals will be accepted**, so be sure to get your proposals in on October 29th. Only one proposal per group needs to be turned in; if your group spans multiple recitations, please designate one (responsible!) member of your group to hand in the proposal.

Some examples of last year's projects are on the 8.012 website. Have fun brainstorming ideas!

Homework Problems:

0. **Collaboration and discussion.** Please list the names of all the students with whom you discussed these homework problems. Also be sure to write down your name and recitation section clearly on the first page.
1. Kleppner & Kolenkow, Problem 5.4 [10 points]
2. Kleppner & Kolenkow, Problem 5.7 [10 points]
3. Kleppner & Kolenkow, Problem 6.1 [10 points]
4. Kleppner & Kolenkow, Problem 6.2 [10 points]
5. Kleppner & Kolenkow, Problem 6.4 [10 points]
6. Kleppner & Kolenkow, Problem 6.6 [10 points]

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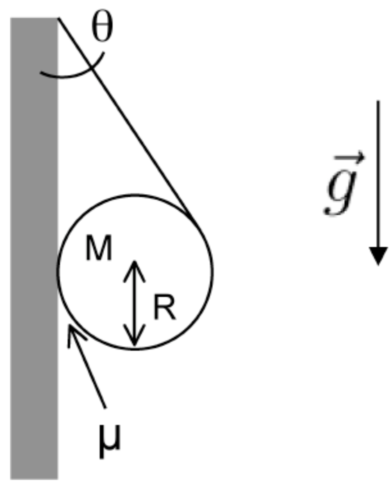
7. **Hanging Cylinder.** [10 points]



A cylinder of mass M and radius R is suspended at one side by a length of rope, while the other side rests against a vertical wall. The coefficient of friction between the wall and cylinder surfaces is μ. The rope extends off at an angle θ relative to the vertical wall. The whole system remains at rest. Constant gravity acts downward.

What is the minimum angle θ for which this setup remains stationary? Explain why this is a minimum angle and not a maximum angle (i.e., explain what happens if the ball is placed higher or lower on the wall).