**PHYSICS 105 FIRST MIDTERM EXAM**

October 27, 2005

This exam consists of **four** problems. When we begin, check to see that this copy of the exam has all four. Use the same exam booklet for all problems, continuing to another booklet if necessary. **Print** your name on **each** booklet as you start it. On the cover of your first booklet, **COPY** and **SIGN** the following pledge:

*I pledge my honor that I have not violated the Honor Code during this examination.*

At the end of the exam, indicate clearly on the cover of your first exam booklet how many booklets you used.

Some useful test-taking hints:

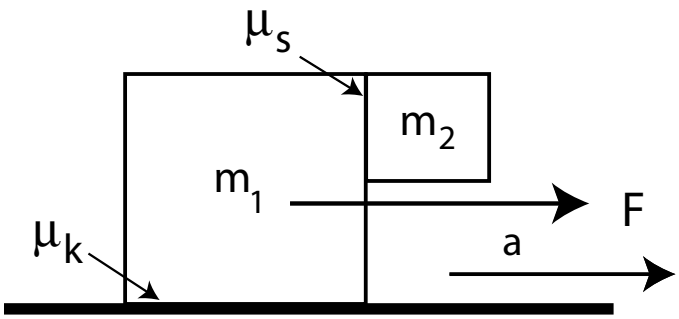
- You may not be able to complete every problem. Keep moving – do what you know first.
- Make it clear what your answer is by circling it.
- Use symbols rather than numbers wherever possible and check units.
- Whenever possible, check whether an answer or intermediate result makes sense before moving on.
- If you get stuck on an early part of a problem, check the later parts — some may be independent and doable.
- If you get stuck on an early part of a problem, and a later part depends on it, **clearly** define a symbol for the unknown answer and use it in later parts. However, keep in mind that we often give multiple parts to guide you through a problem.

- **To get full credit you need to show your work!**

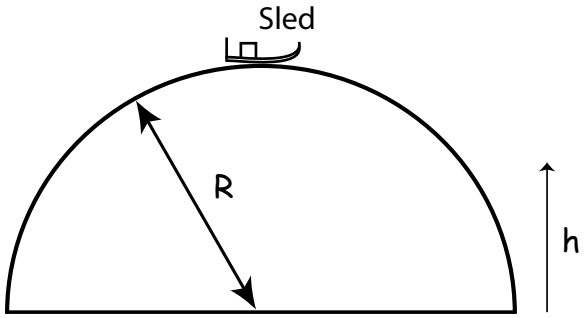
**The exam will last 1.5 hours: 7:30-9:00 PM**

**Good luck!**

**Problem 1.** [8 points] Two blocks of mass $m_1$ and $m_2$ slide along a horizontal surface. An external force $\mathbf{F}$ applied to $m_1$ from the left provides enough acceleration to keep $m_2$ from sliding down the face of $m_1$. The coefficient of kinetic friction between $m_1$ and the horizontal surface is $\mu_k$. The coefficient of static friction between $m_1$ and $m_2$ is $\mu_s$, and $\mu_s > \mu_k$. What is the smallest value of $\mathbf{F}$ required to keep $m_2$ from slipping?

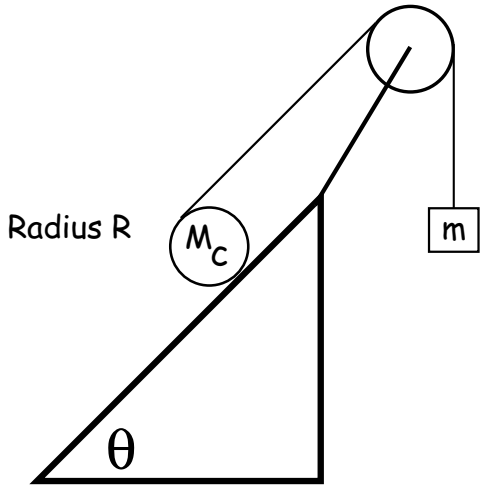



**Problem 2.** [7 points] A sled slides frictionlessly down from the top of a hemispherical hill after being given a slight nudge. At what height $h$ does the sled leave the hill?




**Problem 3.** [15 points] A car of mass M with a vertical back is free to move frictionlessly. To get it moving, you stand behind it and throw balls straight at its back at a rate of $b$ kg/sec. Each ball is thrown with velocity $u$ and bounces elastically off the car. If the car starts at rest, what is its speed as a function of time? [Hint: You will need to account for the rate of arrival of the balls at the moving car.]

**Problem 4.** A string wraps around a uniform cylinder of radius $R$ and mass $M_C$ ($I = M_C R^2/2$), runs over a frictionless and massless pully, and down to another mass $m$. The cylinder *rolls without slipping* on the inclined plane and the string does not interfer with its motion. The string from the top of the cylinder is parallel to the surface of the plane.




(a)[5 pts] Draw a free body diagram for the cylinder on the plane and the mass $m$.

(b)[5 pts] What is the relation between the center of mass acceleration of the cylinder, $a_{cyl}$, and the acceleration, $a_m$, of the mass $m$?

(b)[10 pts] What is the acceleration of $m$?