**Physics 8A, Lecture 2 (Speliotopoulos)**
**Second Midterm Fall 2016**
**Berkeley, CA**

***Rules:*** *This midterm is closed book and closed notes. You are allowed two sides of one sheet of 8.5" x 11" paper on which you can write whatever notes you wish. You are* **not** *allowed to use calculators of any type, and any cellular phones must remain off and in your bags for the duration of the exam.* ***Any violation of these rules constitutes an act of academic dishonesty, and will be treated as such.***

***Numerical calculations:*** *This exam consists of four problems, and each one is worth 25 points. two of the problems ask you to calculate numbers. I have chosen the parameters in these two problems so that the answers can be expressed in terms of rational and irrational numbers. If you find that in your calculation of these problems you end up with an expression which you cannot evaluate numerically—such as one containing an irrational number—simplify the expression as much as you can and leave it.*

***We will give partial credit on this midterm****, so if you are not altogether sure how to do a problem, or if you do not have time to complete a problem, be sure to write down as much information as you can on the problem. This includes any or all of the following: Drawing a clear diagram of the problem, telling us how you would do the problem if you had the time, telling us why you believe (in terms of physics) the answer you got to a problem is incorrect, and telling us how you would mathematically solve an equation or set of equations once the physics is given and the equations have been derived. Don't get too bogged down in the mathematics; we are looking to see how much physics you know, not how well you can solve math problems.*

***If at any point in the exam you have any problems, just raise your hand, and we will see if we are able to answer it.***

*Name:* ______________________________ *Disc Sec Number:*______________________

*Signature:* ___________________________ *Disc Sec GSI:*_________________________

*Student ID Number:* ___________________ *Disc Sec Time:*_________________________

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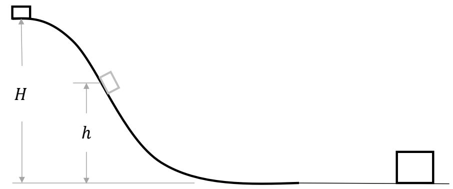
***You must show your student ID when you hand in your exam!***

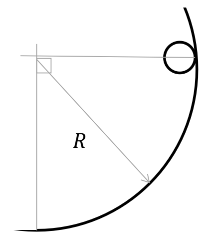



1. The figure to the right shows a block with mass $m$ sliding down a hill with height $H$. This block collides ***elastically*** with a second block with mass $2m$ that is initially at rest. All surfaces are frictionless.
   a. What is the velocity of the small block right before the collision? Express it in terms of $H$ and $g$.

   b. What is the velocity of the small block right after the collision? Express it in terms of $H$ and $g$. (To cut down on the algebra, you can use the following result we obtain from lecture: For elastic, one-dimensional collisions $v_A + v'_A = v'_B$ (yes, this is all the information you get). It is not necessary to use this to solve the problem, however.)

c. After the collision the first block travels back up the hill until it reaches maximum height $h$. What is $h/H$? (You will get simply a number.)

2. The figure to the right shows a *sphere* with mass $M$, and radius $r$ rolling up a section of a circle with velocity $v_0$. The radius of the circle is $R = (7)(9.8)$ m. The sphere rolls without sliding. Take $r$ to be small so that $R - r \approx R$.



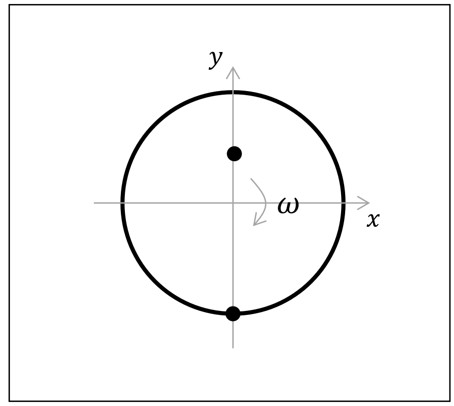

   a. Draw the free body diagram for the sphere when it is at the position shown.

   b. The acceleration of the center of mass $a$ of the disk depends on its angular acceleration $\alpha$ and $R$. What is this dependence? Write down the equation that relates the two, and give a short, physical explanation for this dependence.

   c. What is $a/g$ for the sphere at the position shown?

d. Remember that $f_s \leq \mu_S N$. If the coefficient of friction between the sphere and the ramp is $\mu_S = 1/2$, what is the smallest that $v_0$ can be at the position shown if the sphere does not slide?

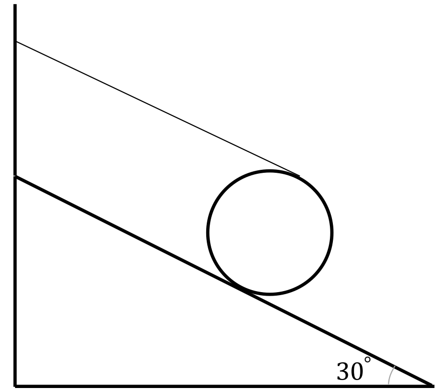
3. The figure on the right shows disk with mass $M = 4.0$ kg and radius $R = 0.5$ m rotating clockwise on a *frictionless* table about its center with angular velocity $\omega = 3.0$ rad/s. On the disk are two fleas, each with mass $m = 1.0\ kg$. One flea is at the outer rim of the disk, with the other is half way between the center of the disk and its rim. The fleas jump off with the *same speed* $v$, but in *opposite directions* along the $x$-axis (horizontal axis) only at the position shown in the figure.



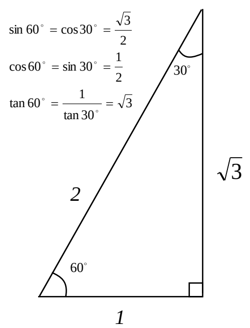

   a. What is rotational inertia $I$ of the disk and the flees before they jump?

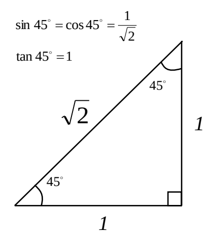
   b. If the disk stops rotating after the flees jump, what is $v$? Should the top flea jump to the right or to the left at the instant shown in the figure?

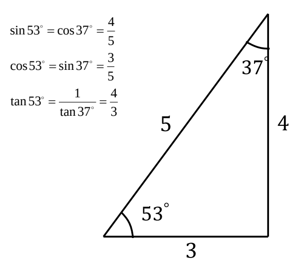
4. A disk with mass $M$ and radius $R$ is placed on a $30^\circ$ incline. A string is wrapped around the outer edge of the disk, and attached to the incline (see figure). The coefficient of static friction between the disk and the incline is $\mu_S$. If the sphere does not move, what is the smallest that $\mu_S$ can be?

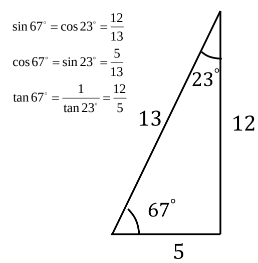


# Physics 8A Math Info Sheet




*Quadratic Equations:*

The solution of the quadratic equation $ax^2 + bx + c = 0$ is

$$x = \frac{1}{2a}\left(-b \pm \sqrt{b^2 - 4ac}\right)$$

Derivatives:

$$\frac{d(x^n)}{dx} = nx^{n-1}$$

Integrals:

$$\int x^n \, dx = \frac{x^{n+1}}{n}$$

Rotational Inertias: