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

Rules: *This midterm is closed book and closed notes. You are allowed two sides of one-half 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. Three of the problems ask you to calculate numbers. I have chosen the parameters in these three 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.

Before the exam begins, fill in the following information on your bluebook:

Name: ______________________________ *Disc Sec Number:*

Signature: ___________________________ *Disc Sec GSI:*

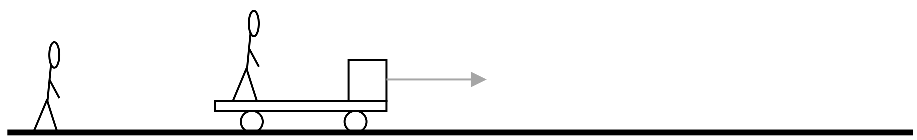
Student ID Number: ___________________ *Disc Sec Time:*

Write the following grading table on the front of your bluebook:

1	
2	
3	
4	
Total	

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

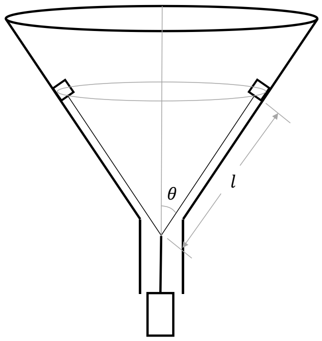
1. Louise is standing *on the back of a pick up truck* driving down the road with speed, $v_T = 5\ \mathrm{m/s}$, and she throws a rock up. Her friend Thelma is *standing on the side of the road* (see figure below), and she sees this rock go straight up to a height $h = (9.8)/8\ \mathrm{m}$, and then fall straight down again. What is the velocity, $\vec{v}_0$, of the rock when it leaves Louise's hand ***that Louise sees***? (Once you specify your reference frame, you can give me the two components of the velocity or its magnitude and direction.) You don't have to take into account Louise's height or the height of the truck.



2. In Figure A a small block $m = 1.0\ kg$ *sliding* on top of a large block with mass $M = 2\ kg$, and a force $F = 9.8\ N$ is being applied to the top block. In Fig. B we have the same two blocks and they are still sliding, but now the same force F is being applied to the bottom block. The table on which the blocks sit is frictionless.
   a. If the acceleration of the top block a_A^{Top} in Fig. A is the same as the acceleration of the top block a_B^{Top} in Fig. B, what is the coefficient of kinetic friction μ_K between the two blocks?
   b. What is the acceleration of the bottom block for Figs. A and B in this case?

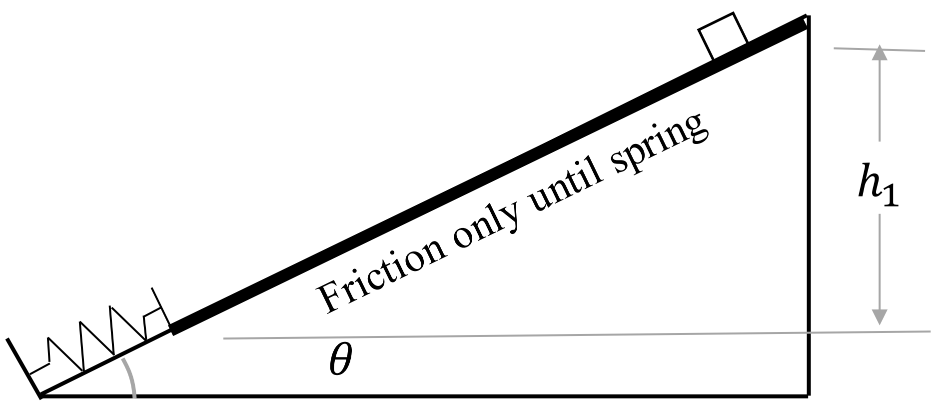
Fig. A

Fig. B



3. The figure on the left shows two blocks with mass m sliding in a circle on the inside of a *frictionless* funnel. They are attached to a third block with a mass, $M = 7m$, through a series of strings. The length of the string between the small blocks on the knot connecting them M is $l = 9.8/\sqrt{2}$ m, and they are parallel to the funnel surface. The opening of the funnel has an angle $\theta = 45^{\circ}$. What is the speed, v, of the two small blocks if the large block does not move?

4. The figure below shows a block with mass m on an incline. The block starts at height, h_1, above the spring, slides down the incline, compresses the spring with spring constant k at the bottom of the incline and then slides back up the incline until it reaches a height h_2. If the coefficient of kinetic friction between the block and the incline before the block hits the spring is μ_k, what is h_2/h_1? Express your answer in terms of μ_k and θ. *The part of the incline below the spring is frictionless.*

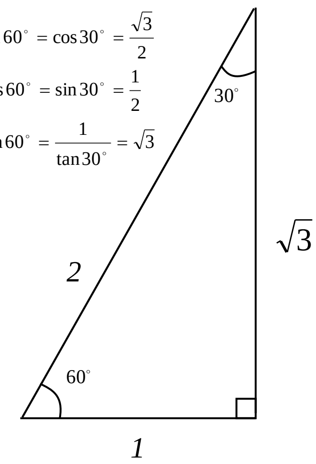


Physics 8A Math Info Sheet

$\sin 60^\circ = \cos 30^\circ = \frac{\sqrt{3}}{2}$

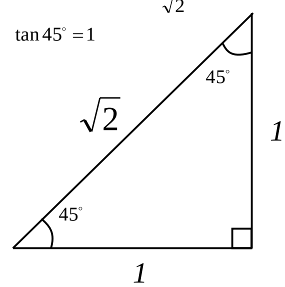
$\cos 60^\circ = \sin 30^\circ = \frac{1}{2}$

$\tan 60^\circ = \frac{1}{\tan 30^\circ} = \sqrt{3}$



$\sin 45^\circ = \cos 45^\circ = \frac{1}{\sqrt{2}}$

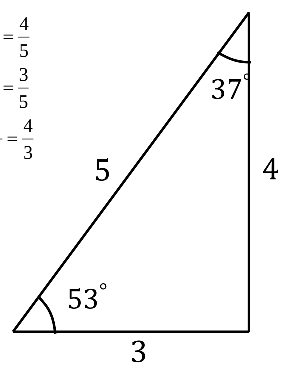
$\tan 45^\circ = 1$



$\sin 53^\circ = \cos 37^\circ = \frac{4}{5}$

$\cos 53^\circ = \sin 37^\circ = \frac{3}{5}$

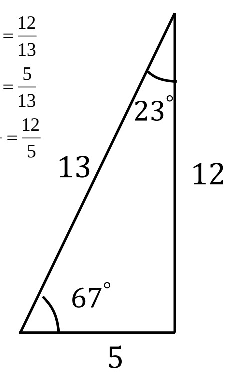
$\tan 53^\circ = \frac{1}{\tan 37^\circ} = \frac{4}{3}$



$\sin 67^\circ = \cos 23^\circ = \frac{12}{13}$

$\cos 67^\circ = \sin 23^\circ = \frac{5}{13}$

$\tan 67^\circ = \frac{1}{\tan 23^\circ} = \frac{12}{5}$



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:

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