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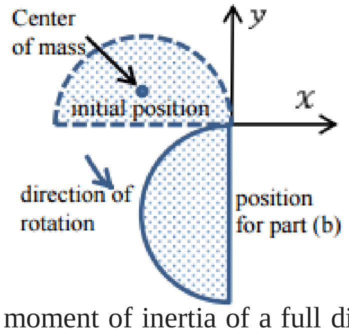

4-[25 pts.] A thin uniform half disk having mass m, radius R is in the x-y plane and it can rotate about the z-axis as shown in the figure (z-axis is out of page). Initially, the half disk is positioned as shown by the dotted lines. The center of mass coordinates are $(-R, \frac{3R}{4\pi})$. The gravitational acceleration ($\vec{g}$) is in the –y direction.

a) Calculate the moment of inertia of the half disk about the z-axis. (The moment of inertia of a full disk of mass m and radius R about its center axis is $I_{cm} = \frac{mR^2}{2}$. You know that a full disk is just two-half disks together ;)

Note for part (b) and (c): <u>If you did not solve part (a)</u>, take the moment of inertia of the half disk about the z-axis as a parameter $I_z = cmR^2$ where c **is a constant.**

b) Which point (give coordinates) has the maximum radial acceleration at the instant the disk has rotated by $\frac{\pi}{2}$ from its initial rest position as shown in the figure? Find the magnitude of this radial acceleration in terms of relevant given parameters.

c) Calculate the maximum angular speed the half disk gains when it is released from its initial position using $m = 1kg$, $R = \frac{5}{\pi}m$, $g = 10m/s^2$ and take $\pi \cong 3$. (Caution: This does not happen at the position for part (b)!)

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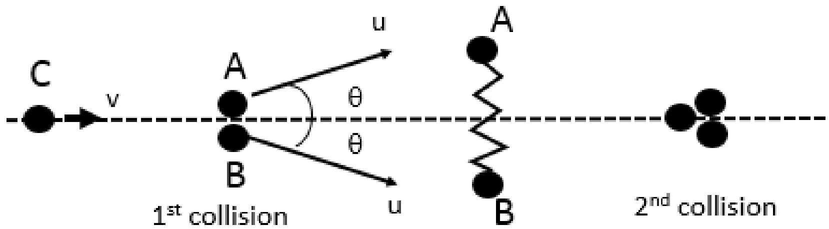
3-[25 pts.] A, B and C are three balls of equal mass ***m*** on a horizontal table. A and B are initially stationary and connected by a spring of spring constant ***k*** which has zero equilibrium length. C is initially moving in the *x* direction with speed ***v***, and hits A and B at the same time. The collision is elastic, and there is no friction on the table. Immediately after the collision, we know that A and B move symmetrically with respect to the *x*-axis with the same speed as in the figure. We also know that A, B and C collide all together again for a second time after a while from the initial collision.



a) Knowing that all three objects collide again a second time, what is the relationship between the *x* components of the velocities of A, B, C immediately after the first collision?

b) Find the velocities (magnitude and direction) of A, B, C after the first collision.

c) Find the maximum distance between A and B during the time between the two collisions. What are the velocities (magnitude and direction) of A and B at this moment?

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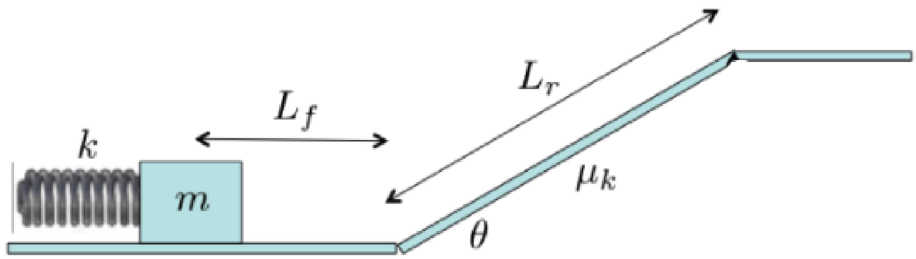
2-[25 pts.] You are building a spring device that pushes boxes across a floor a distance L_f and then up a ramp of length L_r. Your spring has spring constant k, the mass is m, and there is a coefficient of sliding **friction** between the box and the ground **everywhere** including the flat floor and the ramp. Note that the spring is initially unstretched in the figure.



(i) Write down an expression for how much the distance "x" must you compress the spring so that the box gains just enough energy to make it to the top of the ramp. **You do not need to solve the resultant quadratic equation.**

(ii) When the box slides across the floor and up the ramp, calculate its change in gravitational potential energy.

(iii) As the box slides across the floor and up the ramp, calculate the energy that is lost to friction.

(iv) As the box slides across the floor and up the ramp, calculate the work done by the normal force.

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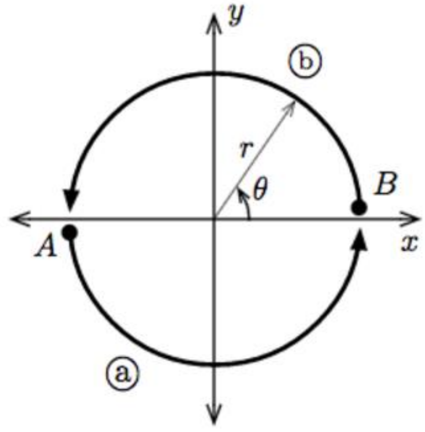

1-[25 pts.] Consider the force F whose component along the radial direction from the origin is given by $F_{rad} = Ar$ and whose component along the tangential direction to the circular paths is given by $F_{tan} = B$, where A and B are positive constants. Note that radial and tangential directions are always perpendicular to each other.

(i) Find the work done by this force through the semi-circular path from point A to point B through path *(a)*.

(ii) Find the work done by this force through the semi-circular path from point B to point A through path *(b)*.

(iii) Is F a conservative force? Explain it using your answers in parts (i) and (ii).

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PHYS 101 General Physics I – MT2 Exam
December 09, 2016 Friday 17:30-19:10

Please read!

- Count to make sure that there are 5 pages in the question booklet
- Check your name and surname on front page, and student ID number on each page, and sign each page.
- This examination is conducted with closed books and notes.
- Put all your personal belongings underneath your seat and make sure that pages of books or notebooks are not open.
- Absolutely no talking or exchanging anything (like rulers, erasers) during the exam.
- You must show all your work to get credit; you will not be given any points unless you show the details of your work (this applies even if your final answer is correct!).
- Write neatly and clearly; unreadable answers will not be given any credit.
- If you need more writing space, use the backs of the question pages and put down the appropriate pointer marks.
- Make sure that you include units in your results.
- Make sure that you label the axis and have units in your plots.
- You are not allowed to use calculators during this exam.
- Only the answers in the boxes will be graded and NO partial credit will be given. No points will be given to unjustified answers. Incomplete calculations will not be graded.

Signature: