Printed Name: _____

Section: ☐ 1 (8AM) ☐ 2 (9AM)

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PHYSICS 221 EXAM 3

November 16, 2009

Do not open this booklet until instructed. The exam will end promptly at 50 minutes after the hour.

Instructions: When you are told to begin, check that this examination booklet contains all the numbered pages from 2 through 7. Page 8 contains equations. You may remove it.

Read each problem carefully so that you are certain what it is asking. Do not panic or be discouraged if you cannot do every part of every problem. If a part of a problem depends on a previous answer you have not obtained, define a symbol for it and proceed to maximize your credit. Keep moving to finish as much as you can!

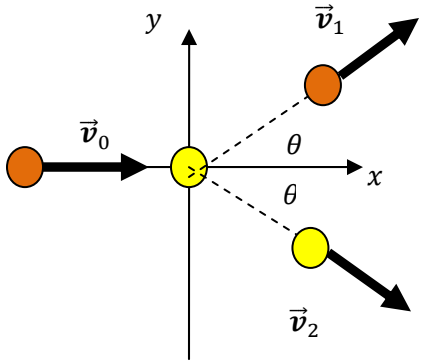
You must show your work. The purpose of this exam is to show how well you understood the material we have covered. You must include an adequate explanation, including correct equations where applicable, for full credit. A number with no explanation will not get credit. **Show your answer's units**, and give an adequate number of significant digits. Completely numerical solutions showing no equations are not eligible for partial credit. Do not use scratch paper. Indicate any work on the backs of the pages that you wish to be considered.

Box your answers.

This examination is administered under the Cadet Honor Code. All suspected violations must be reported appropriately. The seat next to you must be unoccupied. No talking is permitted during the examination, apart from questions to the instructor. You may use a scientific calculator, but may not use "advanced features", including graphing, solving, derivatives, integrals, symbolic manipulation, or equation storage capabilities. Any other electronic devices, including headphones, cell phones, PDAs, and MP3 players, may not be used during the exam in any way. You may use the equation sheet distributed with the exam. No other notes or textbooks may be open during the exam.

Problem 1: [17pt]

Two shuffleboard disks of equal mass, one orange and the other yellow, are involved in a glancing collision. The yellow disk is initially at rest and is struck by the orange disk moving with a speed of 8.00 m/s. After the collision, both disks move along directions that make an angle of $\theta = 36.9°$ with the orange disk's initial direction of motion, as shown.

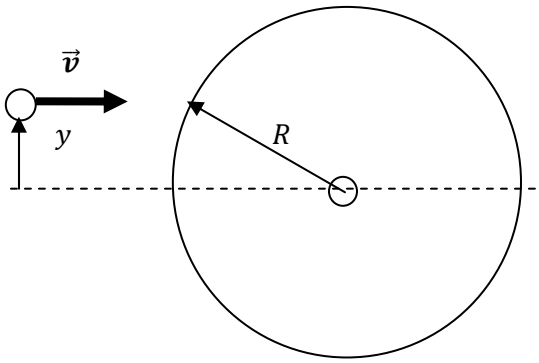


(a) [6pt] If the mass of each disk is m, and the final speeds of the orange an yellow puck are v_1, v_2, explicitly write the two equations expressing momentum conservation in the x and y directions. Use θ for both angles, not the numerical values. Write one equation for each direction. Do not combine them or skip steps, even if they seem obvious to you.)

(b) [6pt] Calculate the final speed of each disk.

(c) [5pt] How much (if any) energy was converted to internal energy (spinning, heat, vibrations, …) in the collision if $m = 0.400$ kg?

Problem 2: [17pt] A cannonball of mass $m = 200$ kg is fired at a velocity of 125 m/s toward a large wooden disk of mass $M = 500$ kg with a radius of $R = 1.20$ m, mounted on a central axis about which it is free to spin. The cannonball gets embedded in the rim a height $y = 0.30$ m above the axis, and the wheel starts to spin with the cannonball attached.

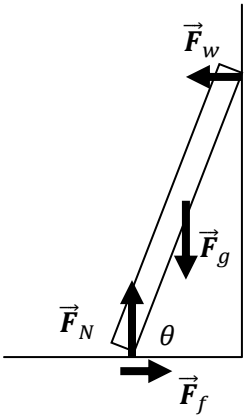


(a) [5pt] What is the magnitude and direction of the cannonball's angular momentum **vector** about the axis of the wheel just before it strikes?

(b) [6pt] If the moment of inertia of the wheel about its axis is $I = \frac{1}{2}MR^2$, what is the moment of inertia of the wheel with the embedded cannonball? Give a numerical result.

(c) [6pt] What is the angular velocity of the wheel with the embedded cannonball after the collision?

Problem 3: [10pt] A uniform ladder of length $L = 15.0$ m and mass $m = 10.0$ kg rests against a frictionless wall. The floor is not frictionless, however. The ladder can be set at an angle of at most $\theta = 60°$ before it starts to slip.



(a) [4pt] What is the torque due to **each** of the four forces shown in the diagram about the bottom edge of the ladder? Express it in terms of the symbolic magnitudes of the forces, the length L and the angle θ. (Do not use the numerical values in this part.) Use the convention that counterclockwise torques are positive. Do not add the torques.

$\vec{F}_f$:

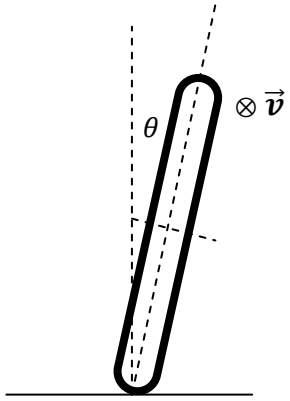
$\vec{F}_N$:

$\vec{F}_g$:

$\vec{F}_w$:

(b) [6pt] Find the coefficient of friction of the ladder against the floor.

Problem 4. [6pt] A wheel is rolling away from you as shown in the figure. It is tilted toward the right as it rolls away. (The velocity vector is into the page.)



(a) [2pt] What is the direction of its angular momentum vector?

(You can draw on the figure if it helps explain your answers.)

(b) [2pt] What is the direction of the net torque vector acting on the wheel about its center of mass?

(c) [2pt] Explain briefly in words what effect this torque has on the motion of the wheel. Be specific about any directions involved.