MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Physics

Physics 8.01 Fall 2003

MAKE-UP EXAM 3
Tuesday, December 2, 2003

FAMILY (Last) NAME

GIVEN (First) NAME

Student ID Number

Your Recitation (check one)

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Instructions:

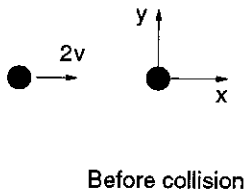
1. SHOW ALL WORK. All work must be done in this booklet. Print your name on each sheet.
2. One 8 ½ x 11 sheet of notes allowed.
3. This is a closed book exam.
4. CALCULATORS, BOOKS, COMPUTERS and CELL PHONE are NOT ALLOWED.
5. Do all FOUR (4) problems.
6. Extra pages provided.
7. Exams will be collected 5 minutes before the hour.

Problem	Maximum	Score	Grader
1	15		
2	15		
3	15		
4	15		
TOTAL	60		

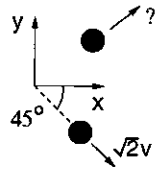
R17	TR 12:00		Maria Chan
R23	TR 11:00		Maria Chan
R12	TR 1:00		Min Chen
R13	TR 2:00		Min Chen
R14	TR 3:00		Min Chen
R01	MW 1:00		Bruno Coppi
R05	MW 2:00		Bruno Coppi
R09	MW 1:00		Qudsia Ejaz
R06	MW 2:00		Paul Joss
R07	MW 3:00		Paul Joss
R08	MW 4:00		Paul Joss
R02	MW 2:00		Young Lee
R03	MW 3:00		Young Lee
R15	TR 10:00		Hong Liu
R16	TR 11:00		Hong Liu
R21	TR 2:00		David Pritchard
R22	TR 3:00		Gunther Roland
R25	TR 1:00		Gunther Roland
R04	MW 1:00		Brian Ross
R19	TR 10:00		Brian Ross
R10	MW 2:00		Senthil Todadri
R11	MW 3:00		Senthil Todadri
R18	TR 9:00		Vladan Vuletic
R24	TR 12:00		Vladan Vuletic
R20	TR 11:00		Xiao-Gang Wen

Problem 1: 2D collision (15 pts)

A particle of mass m collides with a second particle of mass m. Before the collision, the first particle is moving in the x-direction with a speed $2v$ and the second particle is at rest. After the collision, the second particle is moving in the direction 45° below the x-axis and with a speed $\sqrt{2}v$.



Before collision



After collision

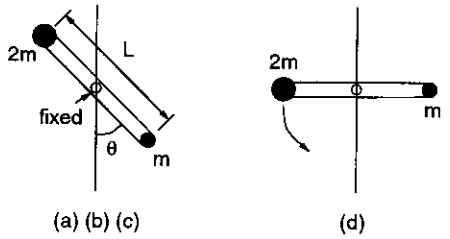
(a) Find the velocity of the first particle after the collision. (*ie* find the x- and y-components of the velocity.)

(b) Find the total kinetic energy of the two particles before and after the collision.

(c) Is the collision elastic or inelastic?

Problem 2: Dynamics (15 pts)

Two balls of mass m and $2m$ are connected by a rod of length L. The mass of the rod is small and can be treated as zero. The size of the balls can also be neglected. We also assume the center of the rod is fixed, but the rod can rotate about its center in the vertical plane without friction.



(a) Find the center of mass of the two balls. That is find the distance between the center of mass and the ball of mass $2m$.

(b) Find the moment of inertia of the two balls about the rotation axis.

(c) Find the gravity induced angular acceleration of the rod when the angle between the rod and the vertical line is θ as shown.

(d) If the rod starts its swing from the horizontal position, what is the angular velocity of the rod when it reaches the vertical position?

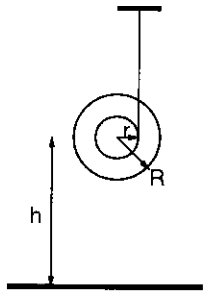
Problem 3: Dynamics (15 pts)

A yo-yo can be treated as a solid disk of mass m, radius R and thickness d. A string is wrapped around a small axis of radius r in the center of the yo-yo. The mass of the string can be ignored. Before we release the yo-yo, the string is stretched in the vertical direction. Initially, the yo-yo is at rest and is a distance h above the ground.
After the yo-yo is released:

(a) Find the angular acceleration of the yo-yo.

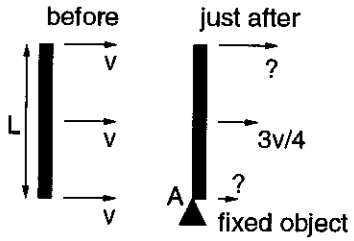
(b) Find the acceleration of the center of the yo-yo.

(c) Find the tension in the string.



Problem 4: Collision (15 pts)

Initially, a rod of mass m and length L moves without rotation on a frictionless surface in a direction perpendicular to the rod. The speed of the rod is v. At time $t = 0$, one end of the rod collides with (or brushes over) a fixed object. Just after the collision, the rod is still parallel to the rod before the collision and the center of the rod still moves in the same direction as before. But the speed of the center of the rod is reduced to $\frac{3}{4}v$



(a) Find the angular velocity ω of the rod just after the collision. (Hint: the total angular momentum about the collision point A is conserved during the collision.)

(b) Find the total kinetic energy of the rod after the collision.

(c) Find the speeds of the two ends of the rod just after the collision.