Physics 218 – Exam III

Spring 2017 (all sections) **April 17th, 2017**

Please fill out the information and read the instructions below, but **do not open the exam** until told to do so.

Rules of the exam:

1. You have 90 minutes (1.5 hrs) to complete the exam.
2. Formulae are provided to you with the exam on a separate sheet. Make sure you have one before the exam starts. You may not use any other formula sheet.
3. Check to see that there are 8 numbered (four double-sided) pages in addition to the scantron-like cover page. **Do not remove any pages**.
4. If you run out of space for a given problem, the last page has been left blank and may be used for extra space. Be sure to indicate at the problem under consideration that the extra space is being utilized so the graders know to look at it!
5. You may use any type of handheld calculator. However, you **must** show your work. If you don't show how you integrated or how you took the derivative or how you solved a quadratic of system of equations, etc., you will **not** get credit.
6. Cell phone use during the exam is strictly prohibited. Please turn off all ringers as calls during an exam can be quite distracting.
7. Be sure to put a box around your final answer(s) and clearly indicate your work. Credit can be given **only** if your work is legible, clearly explained, and labelled.
8. All of the questions require you show your work and reasoning.
9. Have your TAMU ID ready when submitting your exam to the proctor.

Fill out the information below and sign to indicate your understanding of the above rules

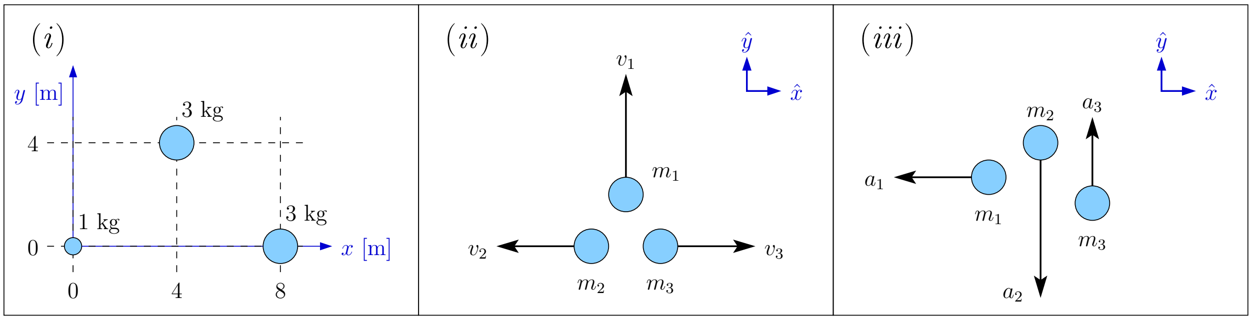
Name: ______________________________ UIN: ______________________________
(printed legibly)

Signature: ______________________________ Section Number: ____________________

Instructor: Akimov Eusebi Dierker Kocharovsky Mahapatra Teizer Rapp Ulmer
(**circle one**)

Short Problems:

A) For the systems shown, compute the $\hat{x}$ and $\hat{y}$ components of the center-of-mass (*i*) position, (*ii*) velocity, and (*iii*) acceleration.



i) $x_{\text{cm}} =$

$y_{\text{cm}} =$

ii) $v_{x,\text{cm}} =$

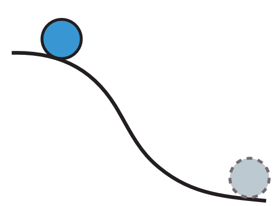
$v_{y,\text{cm}} =$

iii) $a_{x,\text{cm}} =$

$a_{y,\text{cm}} =$

LO	S	U
45.1		
45.2		
45.3		

B) A solid homogenous disk is initially at rest on the side of a hill and starts falling down. In the following cases, answer if the mechanical energy (ME) and the angular momentum of the disk around its center (L) are conserved or not during the fall.



Case	Is ME conserved?	Is L conserved?
There is static friction and the disk falls while rolling without slipping	**Y N**	**Y N**
The disk is slipping as it falls down and there is no friction.	**Y N**	**Y N**
The disk is slipping as it falls down and there is kinetic friction.	**Y N**	**Y N**

LO	S	U
40.1		
40.2		
40.3		
59.1		
59.2		
59.3		

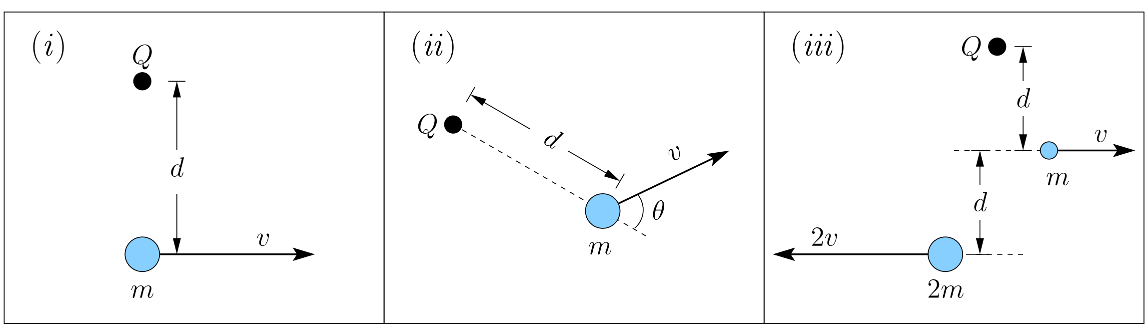
C) In a game of curling, a stone is pushed along a frictionless ice surface toward a number of other stones at the other end which are initially at rest.

i) Is the linear momentum of the thrown stone (just this stone) the same before and after the collision with the other stones? Explain why or why not.

ii) Is the linear momentum of the system of all stones conserved before and after the collision? Explain why or why not.

LO	S	U
48.1		
48.2		

D) The point-like particles shown in the systems below are moving in the plane of the paper. For each system, find the angular momentum in terms of the given masses and velocities with respect the axis of rotation at point Q. Take positive to be out of the page, and negative to be into the page.



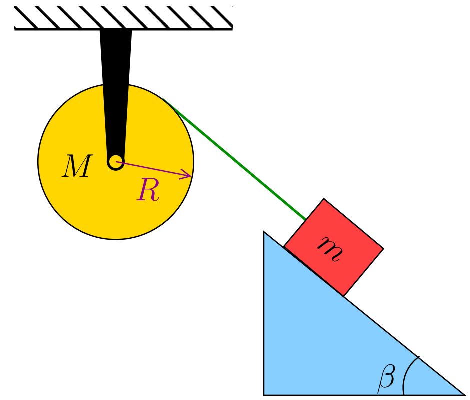
i) $L =$

ii) $L =$

iii) $L =$

LO	S	U
57.1		
57.2		
57.3		

Prob 1 A box of mass m is at the top of a frictionless incline which makes an angle β with the horizontal. The box is attached to a solid uniform cylindrical pulley of mass M and radius R via an ideal rope wrapped around the pulley. The pulley is free to rotate (without friction) about a fixed axis through its center, with a stationary rotation axle affixed to the ceiling, as shown in the figure below. The system is initially at rest and then released.



(a) Draw free-body diagrams for the pulley and box.

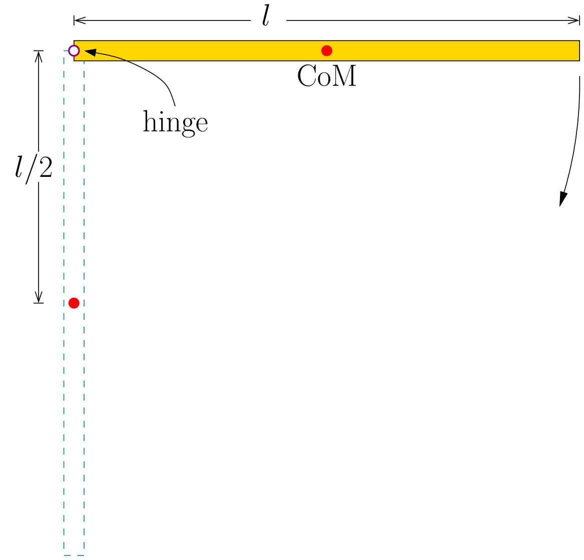
(b) What is the acceleration of the box on incline?

(c) What is the vertical component of the force that the pulley exerts on the axle?

LO	S	U
23.1		
24.1		
26.1		
17.1		
21.1		
51.1		
54.1		
55.1		
21.2		
22.1		

Prob 2 A "one-dimensional" rod (no width to consider) of mass $M = 3.2$ kg and length $l = 0.18$ m is nailed to a wall at one end, having a moment-of-inertia of $I = 0.035\ \mathrm{kg\,m^2}$ about that axis. The rod is free to pivot about the nail which acts as a frictionless hinge. The rod is held at rest horizontally and then released, at which point gravity accelerates it downward as indicated in the figure.

(a) What is the magnitude of the net torque acting on the rod as soon as it is released?



(b) Using conservation of energy, calculate the angular velocity, ω, of the rod when it reaches the lowest (vertical) position.

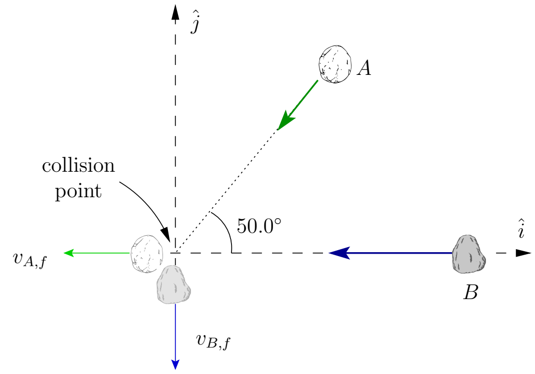
(c) Calculate the angular momentum, L, of the rod when it reaches the vertical position.

(d) Is angular momentum conserved in the motion? If so, why? If not, why not? (In one short sentence, concisely explain the relevant physical concept).

LO	S	U
54.2		
35.1		
38.1		
40.4		
57.4		
59.4		

Prob 3 Two flat objects are sliding across the frictionless surface of a frozen lake and approach one another as shown in the figure. They move in such a way as to collide at the origin of the coordinate system shown. After the collision, object A moves off along the $-\hat{\imath}$ direction and object B moves off along the $-\hat{\jmath}$ direction. The objects have masses $m_A = 1.0$ kg and $m_B = 0.25$ kg and initial kinetic energies $K_A = 1.0$ J and $K_B = 10$ J.

(a) What are the initial velocities (magnitude and direction, or $\hat{\imath}$ and $\hat{\jmath}$ components) of the two objects?



$\vec{v}_{A,i} =$

$\vec{v}_{B,i} =$

(b) What is the initial momentum (magnitude and direction, or $\hat{\imath}$ and $\hat{\jmath}$ components) of the system of the two objects?

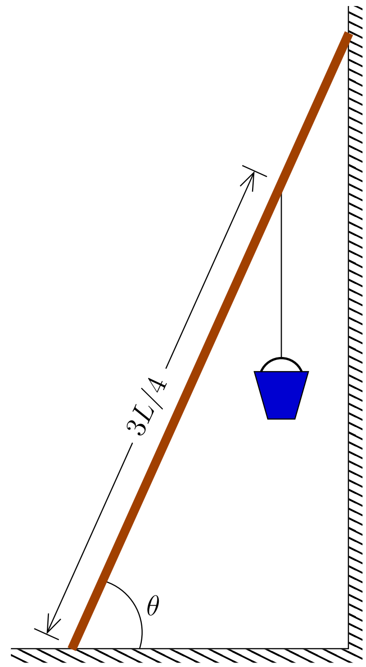
$\vec{p}_{\text{tot}} =$

(c) Find the speeds of the two objects after the collision.

(d) Quantitatively determine whether this collision is elastic or inelastic.

LO	S	U
1.1		
34.1		
46.1		
46.2		
48.3		
34.2		
50.1		

Prob 4 A uniform ladder of mass M and length L is placed against a frictionless vertical wall and makes an angle θ with respect to the horizontal as shown in the figure. The base of the ladder rests on a rough horizontal floor where friction keeps the ladder from sliding. A bucket of mass m is suspended from a rung that is 3/4 of the way up the ladder.



(a) Use the figure to make a free-body diagram of the ladder, clearly labelling all forces acting on it at the correct position.

(b) What is the magnitude of the normal force that the wall exerts on the top of the ladder? Be sure to specify your reference point for calculating the torques.

(c) What is the minimum value that the coefficient of static friction between the ladder and the floor can be such that the ladder is still in equilibrium?

LO	S	U
23.2		
26.2		
29.1		
1.2		
21.3		
21.4		
54.3		
29.2		

Extra Space: