Physics 206 – Exam III

Spring 2019 (all UP sections) **April 15, 2019**

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 beforethe exam starts. You may *not* use any other formula sheet.
3. Check to see that there are 8 numbered (4 double-sided) pages in addition to the scantron-like coverpage. **Do not remove any pages**.
4. If you run out of space for a given problem, the last two pages have been left blank and may beused for extra space. Be sure to indicate *at the problem under consideration* that the extra space is being utilized (and also on the extra sheets, which problem the work refers to) so the graders know to look at it!
5. Calculators of any type are **not allowed**. In the case of questions with numerical values, the math should be simple enough you will not need a calculator. For purely symbolic questions, ensure that all your answers are in terms of the known variables given in the question.
6. Cell phone use during the exam is strictly prohibited. Please turn off all ringers as calls during anexam 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. Unless explicitly stated otherwise in the question, all of the free-response problems in this exam 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 these rules.

Name: ______________________ UIN: ______________________
(printed *legibly*)

Signature: ______________________ SectionNumber: ______________

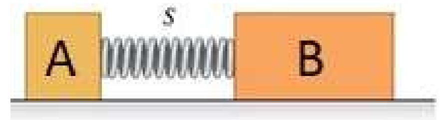
Instructor: (circleone)

Allen	Eusebi	Kocharovsky	Kubik
Mahapatra	McIntyre	Saslow	Wu

PHYS 206: Exam 3 – Spring 2019

Short Problems:

A) Block *A* on the left has mass ***m***. Block *B* on the right has mass ***3m***. The blocks are forced together, compressing the massless spring. Then the system is released from rest on a level, frictionless surface. After the blocks are released, the two blocks spring apart.



a) Is the momentum of the system conserved between the instants before and after release? Why?

Ans:______________________

b) Is the total mechanical energy of the system conserved for the same scenario? Why?

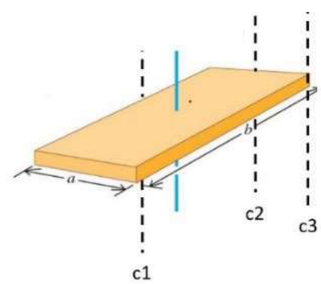
Ans:________________

c) Find the ratio of K_A (the kinetic energy of block A) to K_B (the kinetic energy of block B) right after the blocks have separated from the spring.

Ans:________________

LO	S	U
48.1		
50.1		
48.2		
34.1		
3.1		

B) A thin rectangular sheet rigid body has mass *M*. The length of the two sides are *a* and *b* as shown. The solid vertical line represents an axial that is perpendicular to the sheet, passing through the center of mass of the sheet. Calculate the moment of inertia of this rigid body for rotation about the following three axes that are perpendicular to the sheet (no need to simplify your answer):



a) about axis c1 that passes through the middle of the long side

Ans:______________________

b) about axis c2 that passes through the middle of the short side

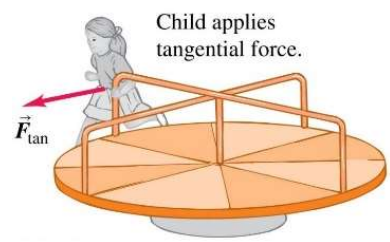
Ans:______________________

c) about axis c3 that passes through the corner

Ans:______________________

LO	S	U
51.1		
52.1		
51.2		
52.2		
51.3		
52.3		

C) A playground merry-go-round has a radius of *R* and a moment of inertia of *I* about a vertical axis through its center. The merry-go-round is initially at rest. A child pushes the edge of the merry-go-round with force of F_{tan} tangential to the edge for a time t seconds. *For the following questions, express all solutions using the given variables.*



a) What is the angular speed of the merry-go-round after the child's push?

Ans:______________________

b) What is the total angle traversed by the child during this motion?

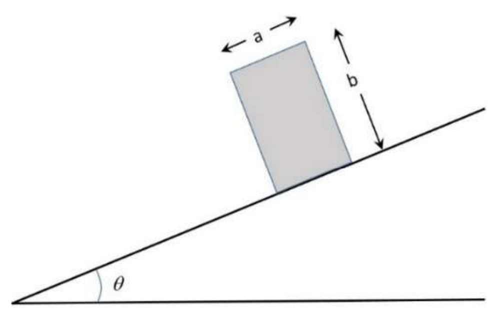
Ans:______________________

c) How much work did the child do?

Ans:________________

LO	S	U
54.1		
55.1		
3.2		
14.1		
14.2		
56.1		

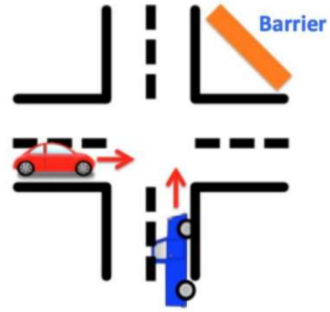
D) This sketch shows a uniform rectangle box of weight W resting on an inclined surface. The sides of the box have known lengths a and b as shown. The incline angle θ can be varied. Assume that the box does not slip. As you increase the incline angle starting from a small value, at what angle will the box tip and lose balance? *Draw the free body diagram just at the moment of tipping and consider the torque produced about the bottom left corner as the pivot point.*



Ans:______________________

LO	S	U
9.1		
23.1		
26.1		
45.1		
3.3		

Long Problems:



Problem 1 A car of mass *1800 kg* is traveling east at *60 km/hr* approaching an intersection. A large truck of mass *2400 kg* is approaching the same intersection traveling north at *60 km/hr*. After the collision, the car and the truck become tangled and move as a single object. Assume that it's a very slick road so that there is no friction between the vehicles and the ground. Use only MKS units.

(a) Is the collision between the cars elastic or inelastic?

Ans:______________________

(b) Calculate the momentum of the car and the momentum of the truck just before the collision, and, sketch the momentum vector for each.

Ans:______________________

(c) Calculate the magnitude and the direction of the momentum vector of the car + truck after the collision.

Ans:______________________

(d) After the collision, the stuck together car + truck collide with a roadside barrier and come to a complete stop. What is the impulse experienced during this collision with the barrier? Is this an elastic or inelastic collision?

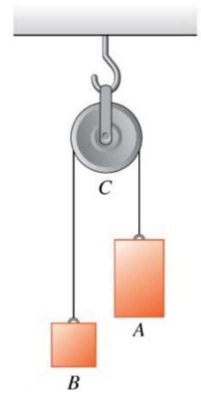
Ans:______________________

(e) What is the average magnitude of the net force on the car/truck system while it is in contact with the barrier, if it comes to a complete stop in *0.1 second*?

Ans:______________________

LO	S	U
50.2		
46.1		
10.1		
46.2		
10.2		
46.3		
48.3		
3.4		
2.1		
49.1		
50.3		
49.2		

Problem 2 Consider an Atwood's Machine consisting of two blocks and one pulley as shown. Block A has a mass MA = 5.00 kg. Blok B has a mass MB = 4.00 kg. The pulley is a uniform solid disk with a mass m = 2 kg and a radius R = 0.20 m. The cord connecting the blocks are massless and non-stretchable. There is no slipping between the cord and the pulley. The system is initially at rest. Once it is released, block A drops a vertical distance of h = 0.5 m before it hits the floor. Let gravitational acceleration g = 10 m/s2.



(a) Use the conservation of mechanical energy to calculate the speed of the blocks just before block A hits the floor.

Ans:______________________

(b) Use your result from part (a) to calculate the magnitude of the acceleration of the blocks as well as the angular acceleration of the pulley.

Ans:______________________

(c) Calculate the angular displacement the pulley makes in this process.

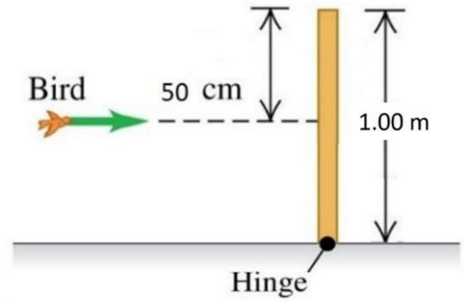
Ans:______________________

(d) Write Newton's second law equation for block A, calculate the tension force $\boldsymbol{T_A}$ that the cord exerts on block A, the torque it exerts on the pulley, and the work this torque does on the pulley.

Ans:______________________

LO	S	U
38.1		
34.2		
35.1		
51.4		
16.1		
3.5		
14.3		
16.2		
16.3		
21.1		
24.1		
54.2		
56.2		

Problem 3 A bird (mass m = *500 gram*) is flying horizontally at a speed of v_0 = *4.00 m/s*, when it suddenly hits a stationary vertical bar at *50 cm* below the top end of the bar. The bar is uniform with a mass M = *1.5 kg* and a length l = *1.00 m*. The bar is hinged at the bottom end and is free to rotate about this pivot point. The collision stuns the bird, which then drops vertically to the ground.



(a) Is the angular momentum conserved in this collision? Why?

Ans:_______________________

(b) What is the angular momentum of the system before and after the collision?

Ans:_______________________

(c) What is the angular velocity of the bar just after it is hit by the bird?

Ans:_______________________

(d) After the collision, the bar rotates about the hinge and falls to the ground. What is its angular velocity just before it hits the ground?

Ans:_______________________

LO	S	U
59.1		
57.1		
57.2		
51.5		
59.2		
3.6		
38.2		
45.2		
35.2		
35.3		
51.6		
3.7		