Physics 218 – Comprehensive Exam

Fall 2016 (all sections) **December 2nd, 2016**

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 120 minutes (2 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 10 numbered (five 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 $\boxed{\text{final answer(s)}}$ 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 Mahapatra Melconian Rapp Rogachev Webb
(**circle one**)

Short Answers:

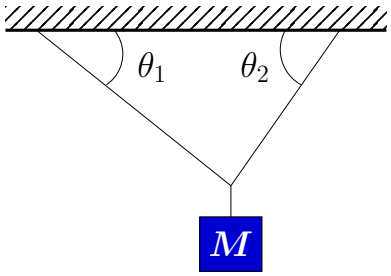
A) A flywheel (a uniform solid cylinder of radius 0.25 m and mass 80 kg) is initially at rest, but free to rotate about the axis through its center. A belt wrapped around it is pulled off horizontally, providing a tangential force of 45 N to the outer rim of the flywheel for 2.00 s. Calculate the final kinetic energy of the wheel.

LO	S	U
14.1		
39.1		
60.1		

B) A thin rod (mass $M = 15$ g, length $l = 20$ cm) is rotating freely on a frictionless pivot in a horizontal plane about one of its ends at 0.50 revolutions per second. A point-like bug of mass $m_{\text{bug}} = 4.00$ g, originally sitting at rest at the fixed end of the rod (the pivot point), crawls to the loose end of the rotating rod and stops there. Calculate the translational speed of the bug when it reaches the loose end of the rod.

LO	S	U
3.1		
55.1		
63.1		

C) In terms of the quantities given, find the tension in the two massless cables used to support the mass, M, as shown in the figure below.

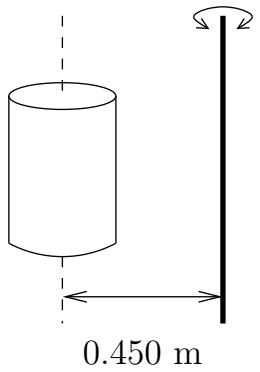


LO	S	U
4.1		
22.1		
34.1		
35.1		

D) A girl of mass 35 kg is standing on a scale inside and elevator which is accelerating upward at 1.50 m/s^2. What is the reading of her weight on the scale in Newtons?

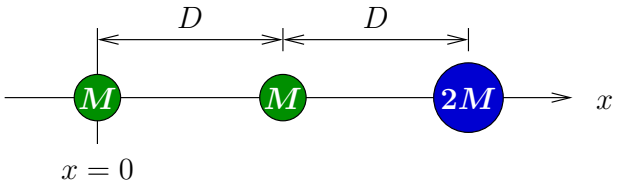
LO	S	U
22.2		
23.1		
24.1		

E) What is the moment of inertia of a cylinder of mass 2.00 kg and radius 0.150 m about an axis that is parallel to the axis of symmetry of the cylinder and is 0.450 m away from it?



LO	S	U
55.2		
56.1		

F) Three masses, M, M and $2M$ are spaced an equal distance, D, apart along the x-axis. Relative to the mass M furthest to the left, find the location of the center of mass of this system.



LO	S	U
50.1		

Prob 1 An explorer team lands on a thus far uncharted planet. The planet's radius is determined to be 8475 km, and a free fall experiment on the surface shows an object of 1.00 kg falls through 3.00 m in 0.700 s (starting from rest).

(a) Determine the gravitational acceleration on the planet's surface.

(b) What force does the falling object exert on the planet?

(c) Determine the mass of the planet and express it in units of Earth's mass, $M_\oplus = 5.97 \times 10^{24}$ kg.

LO	S	U
14.2		
23.2		
24.2		
64.1		

Prob 2 One end of a rod of mass m and length L is attached to a frictionless hinge and hung vertically. If the rod is displaced from equilibrium a small distance and released, it swings back and forth as a physical pendulum. Answer the following in terms of the quantities given (m, L, g).

(a) Prove that the system will move in simple harmonic motion (by showing $a \propto -x$), and use the result to find the period of oscillation.

(b) What is the maximum angular velocity of the rod if it was initially displaced by 0.100 rad?

(c) The general solution of the oscillation is given by $\theta(t) = A\cos(\omega t + \phi)$. State the physical meaning of A, ω and ϕ in this expression.

LO	S	U
7.1		
39.2		
43.1		
59.1		
69.1		
69.2		
70.1		

Prob 3 At time $t = 0$ a car had a speed of 60.0 km/h. It covered 2.00 km at that constant speed. The driver then applies the brakes and stops the car with a constant acceleration. The total distance covered by the car from time $t = 0$ to a complete stop is 3.00 km.

(a) How much time does it take for the car to come to a complete stop starting from $t = 0$?

(b) What is the acceleration of the car during the time the brakes were applied?

LO	S	U
10.1		
14.3		
14.4		

Prob 4 A point mass, $m = 0.0900$ kg, moves along the x-axis where the only force acting on it is a conservative force with a potential energy function given by $U(x) = -\alpha x^2 + \beta x^3$, with $\alpha = 2.00$ J/m^2 and $\beta = 0.300$ J/m^3. The object is initially at rest near $x = 0$. To get it moving from this point of unstable equilibrium, a negligibly small force is applied in the $+\hat{x}$ direction (*i.e.* just enough to get it moving, not enough to warrant inclusion in answering the question).

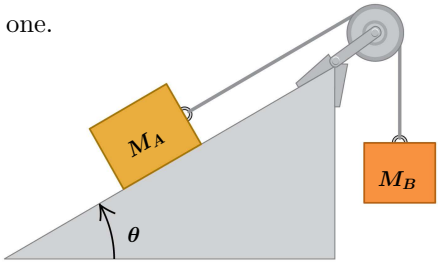
(a) When the object reaches the point of $x = 4.00$ m what is its speed?

(b) How much work was done by this force as the object moved this 4.00 m distance?

LO	S	U
3.2		
42.1		
43.2		
44.1		

Prob 5 Two boxes are connected by a massless cord running over a massless frictionless pulley. Box A has mass M_A and is initially at rest on an incline that makes an angle θ with respect to the horizontal. The coefficient of kinetic friction between the box and the incline is μ_k. The mass of box B is M_B. The system begins to move just after it is released. Answer the following in terms of the quantities given.

(a) Draw a free-body diagram for each box, identifying the forces acting on each one.



(b) Determine the acceleration of each box.

LO	S	U
4.2		
22.3		
26.1		
34.2		
35.2		
36.1		

Extra Space: