Name, Surname:	Student ID Number:
Exam Room:	Signature:

KOÇ UNIVERSITY

College of Sciences

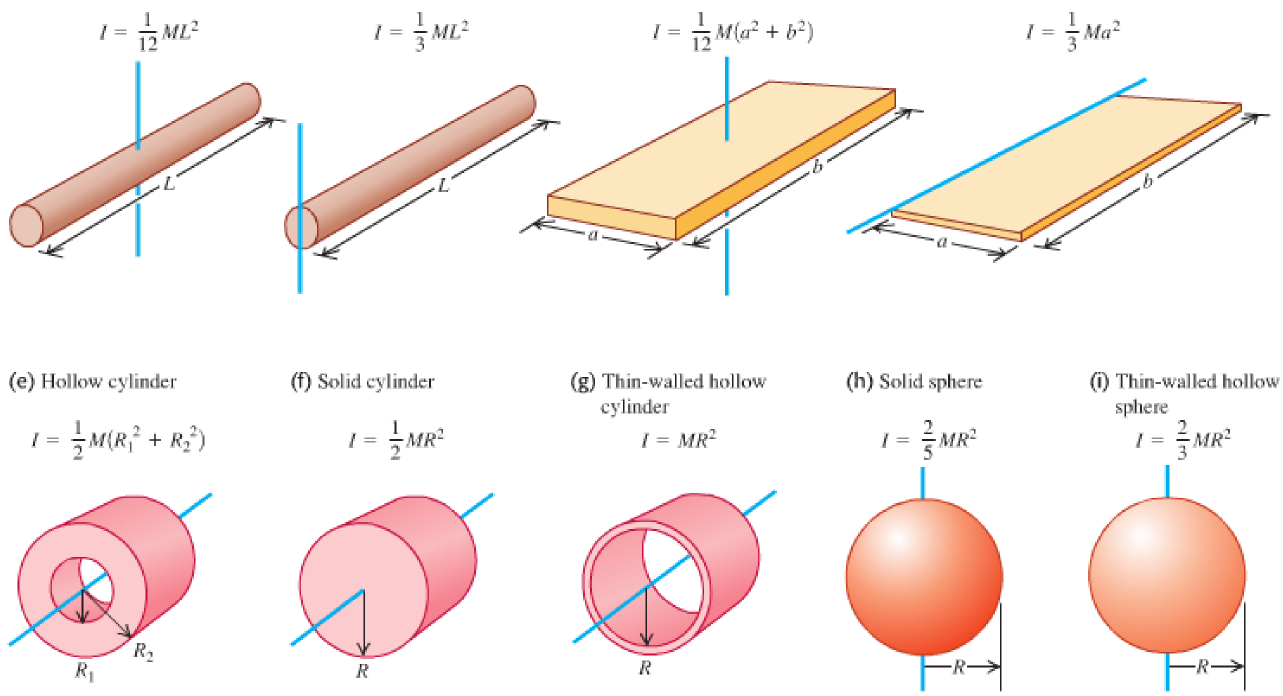
PHYS 101 General Physics 1

Fall Semester 2021, Midterm 2 Exam

December 11, 2021 Saturday, 15:00-17:00

Please read.

- Please turn off mobile phones and stow away your belongings. Have your student ID ready for attendance check. Only exam booklet, pencil and eraser are allowed throughout the exam.
- Check that there are 4 question sheets in this question booklet.
- Use only black pencil for writing.
- Write your **name, number, on front page, and student ID on each page.**.
- Write neatly and clearly; unreadable answers will not be given any credit.
- Any final answer not backed by a reasonable, consistent solution attempt on the exam paper may get no credit even if it coincides with the correct answer.
- The mathematical expressions in the result must be simplified as possible.
- Use the back pages in case you need more blank space. **IMPORTANT: Do not continue the solution of a question on a different question sheet!**
- If applicable, make sure to include units in your final answer.
- In graphing questions, use proper scaling, label the axes and indicate units.
- Using calculators is not allowed.
- Leaving/entering the exam room within the last 10 minutes of the exam session is not allowed. Please wait until the exam session is over.



P101_Index:

1	2	3	4	Total

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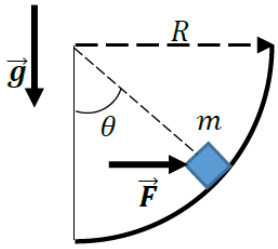
Q1-(25 pts) A block of mass m is moving on a frictionless circular track of radius R acted upon by a horizontal force F as shown. Magnitude of the force F is adjusted so that the block moves up the circular track with constant speed v.

(a) (5 Pts.) Draw a free-body diagram of the block.



(b) (5 Pts.) What is the magnitude F of the applied force as a function of which makes the block move up the circular track with constant speed?

(c) (5 Pts.) What is the work done by the gravitational force as the block moves from θ=0 to θ=θ_f (θ_f <π/2)?

(d) (5 Pts.) What is the work done by the force F as the block moves from θ=0 to θ=θ_f?

(e) (5 Pts.) What is the average power delivered to the block by the force F as it moves from θ=0 to θ=θ_f?

 Solution continues on the back side of the page **Yes** □ **No** □

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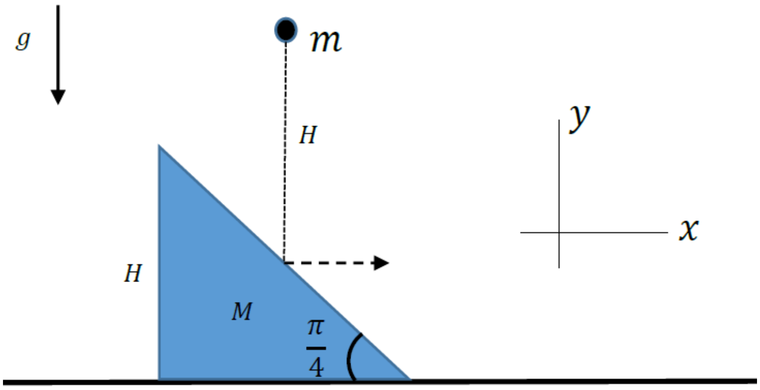
Q2-(25 pts) A right-angle triangular wedge of mass M, side length H, and angle $\pi/4$ can slide on a horizontal floor without friction. Initially, the inclined plane is at rest. A ball of mass m is dropped onto the inclined plane's midpoint from a height H, as shown in the figure. The collision is completely elastic, and the ball's velocity is horizontal just after the collision. Gravitational acceleration is g.

a)(15 Pts.) Find the velocity vector for the triangular wedge after the collision.



b)(10 Pts.) If the ball sticks to the surface of the triangular wedge instead of elastically bouncing off, what is the final velocity of the combined object? How much energy is lost in this collision?

 Solution continues on the back side of the page **Yes** □ **No** □

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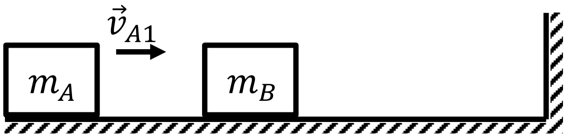
3-(25 Points) A block of mass m_A sliding on a frictionless horizontal track with velocity $\vec{v}_{A1}$ hits a stationary block of mass m_B. To the right of block B, the track is terminated by a vertical wall. **Formulate your solution in terms of the given parameters only. Parts a and b are unrelated.**



a) [10 pts.] Given $m_A < m_B$, and assuming all collisions are elastic, determine the condition that A will hit B twice.

b) [10 pts.] Given $m_A = m_B = m$, suppose that when A hits stationary B, 20% of the initial kinetic energy is lost (that is, converted to some other form of energy). Determine the speed of B after this collision.

c) [5 pts.] For the collision given in part (b), determine the kinetic energy of the center of mass $K_{CM} = \frac{1}{2} m_{total} v_{CM}^2$ before and after the collision in the ground reference frame. Is it conserved? If yes, why? If not, why?

Solution continues on the back side of the page **Yes** □ **No** □

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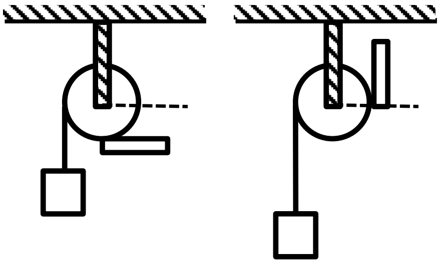
4-(25 Points) A block of mass $3m$ is suspended by a rope over a solid disk-shaped pulley of mass $2m$ and radius R. A thin rod of length $2R$ and mass $2m$ is fixed on one end tangent to the edge of the pulley. The system is released from the position in the left figure where the rod is parallel to the ground. The pulley rotates without friction, the rope moves without slipping around the pulley and the block moves only vertically. During rotation, the rod does not hit anywhere or other objects. Gravitational acceleration is g. **Formulate your result in terms of the given parameters only.**



Initial position   Position for parts (c), (d)

a) [6 pts.] Determine the total moment of inertia of the pulley and the rod about the center axis of the pulley. (Hint: Use parallel axis theorem)

b) [3 pts.] A point of the rod has a tangential acceleration twice the acceleration of the block. Determine the distance of this point from the fixed end of the rod.

c) [10 pts.] Calculate the speed of the block at the instant the rod becomes vertical the first time (as shown in the right figure).

d) [4 pts.] Calculate the radial acceleration of the center of mass of the rod at the instant the rod becomes vertical the first time (as shown in the right figure).

 Solution continues on the back side of the page **Yes** □ **No** □