Spring 2025 **Physics 1135** Print LAST Name: _____

Rec Sec Number ____ **TEST 3 (4 pages)** and First Name: _____

For questions on this page, write the letter which you believe to be the best answer in the underlined space provided **to the left of the question number**. For problems on subsequent pages: your solution to a question with *OSE* in front of it must begin with an *O*fficial *S*tarting *E*quation. The expression for the final result must be in system parameters and simplified as far as possible. Draw a box around your answer to each question. Neglect air resistance. Calculators and notes cannot be used during the test. If you have any questions, ask the proctor. **You must put your name on each page.**

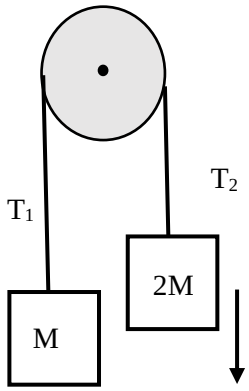
Test Total =_____ / 200

____1. (10 points) A rigid object is rotating with some angular velocity $\vec{\omega}$. If the net torque acting on it is in the same direction as the angular velocity, then angular acceleration will be:

A) zero. B) perpendicular to $\vec{\omega}$

C) in the direction of $\vec{\omega}$ D) in the direction opposite to $\vec{\omega}$

____ 2. (10 points) Two blocks, of masses *M* and 2*M*, are attached to opposite ends of a massless string that passes over a pulley with moment of inertia *I*. The heavier block is accelerating downward. The string does not slip on the pulley. Which statement about the tensions in the string is true?



A) $T_1 = T_2$ B) $T_2 > T_1$ C) $T_2 > 2Mg$ D) $T_2 < T_1$

____3. (10 points) An object is undergoing simple harmonic oscillations with amplitude *A*. When its displacement is half its maximum value, what is the ratio of its kinetic energy to its potential energy?

A) 3/4 B) 1/3 C) 3/16 D) 3

____4. (10 points) In simple harmonic motion, the speed is greatest at the point in the cycle when

A) the magnitude of the acceleration is a maximum.

B) the displacement is a maximum.

C) the magnitude of the acceleration is a minimum.

D) the potential energy is a maximum.

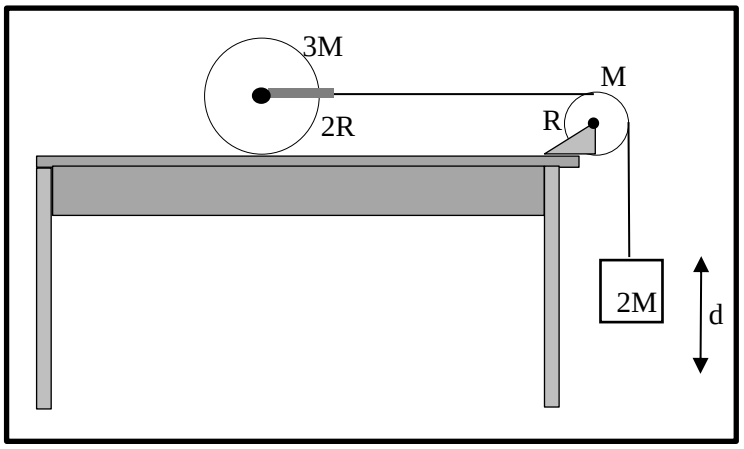
____5. (10 points) A uniform rod of mass *M* and length *L* is pivoted at a point ⅓*L* from its end and undergoes harmonic oscillations. Its period for small oscillations is

A) $2\pi\sqrt{L/g}$ B) $2\pi\sqrt{7L/36g}$ C) $2\pi\sqrt{2L/3g}$ D) $2\sqrt{7L/2g}$

____ / 50 for this page

Name:_____

6. (50 points) A uniform, solid cylinder with mass 3*M* and radius 2*R* rests on a horizontal tabletop. A massless string is attached to a massless yoke which is in turn attached to a frictionless axle that runs through the central axis of the cylinder, so that the cylinder can rotate about the axle. The string passes over a solid cylindrical pulley with mass *M* and radius *R* that is mounted on a frictionless axle. A block of mass 2*M* is suspended from the free end of the string. The string does not slip over the pulley surface, and the cylinder rolls without slipping on the tabletop.

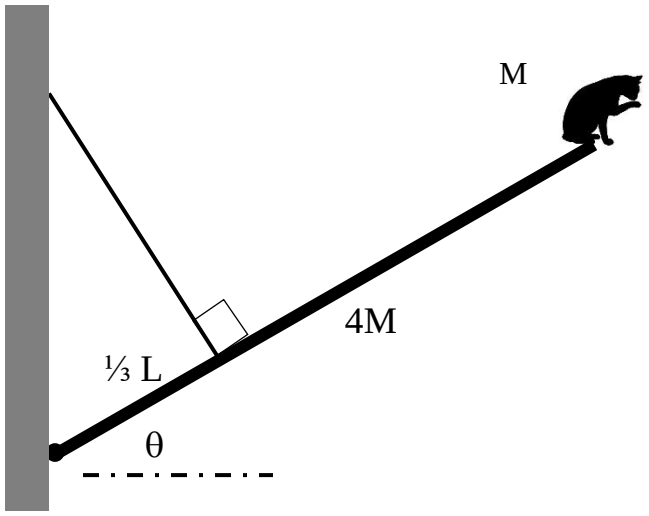


Use energy methods to derive an expression for the speed of the block after it has descended a distance *d*.

_____ / 50 for this page

Name:_____

7. (50 points) A beam of mass 4*M* and length *L* is attached to a building wall by a hinge and by a cable. The cable is attached to the beam ⅓ *L* from the hinge and makes a right angle with the beam, as shown in the diagram. The beam makes an angle θ with the horizontal floor. A cat of mass *M* sits on the upper end of the beam, as shown in the figure.



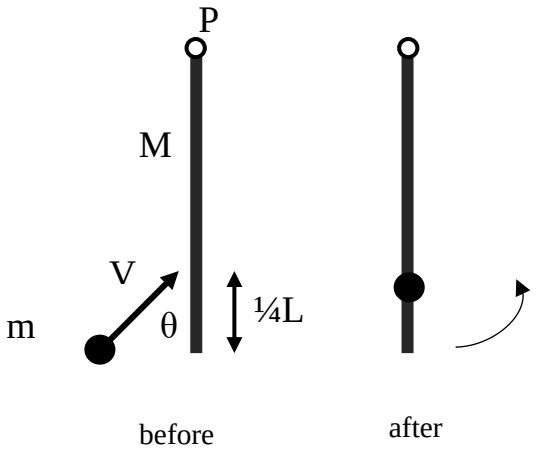
a) (OSE) (30 points) Derive an expression for the tension in the cable, in terms of relevant system parameters.

b) (OSE) (20 points) In terms of system parameters, derive expressions for the horizontal and vertical components of the support force at the hinge**. Treat the tension *T* as a system parameter for this part.**

_____ / 50 for this page

Name:_____

8. (50 points) A uniform rod of mass *M* and length *L* is suspended at point P at its upper end and is initially at rest. A small putty ball of mass *m* traveling at speed *V* strikes the rod at a distance ¼ *L* from its lower end at an angle θ with the rod, as shown in the figure. The putty ball sticks to the rod.



a) (OSE) (20 points) Derive an expression for the combined moment of inertia of the rod with the putty ball stuck to it.

b) (OSE) (30 points) Derive an expression for the angular speed of the rod after the collision, in terms of system parameters.

_____ / 50 for this page