Spring 2024 **Physics 1135** Print LAST Name: _____

Rec Sec Number ____ **TEST 1 (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 of the test.**

Test Total =_____ / 200

_____1. (10 points) An object moves along the *x*-axis. Its *x*-component of velocity as a function of time *t* is given by $v_x(t) = bt - d$ where *b* and *d* are positive constants. Which of the following statements about the object is true?

A) Its acceleration is not constant.
B) It stops momentarily at time $t = d/b$.
C) Its acceleration is in the negative *x*-direction.
D) At time $t=0$ it moves in the positive *x*-direction.

____ 2. (10 points) A child kicks a ball from the ground with an initial velocity directed at 45° above the horizontal. The ball hits the level ground some horizontal distance away. Which of the following is **true** about the ball?

A) It hits the ground with a speed that is larger than the initial speed.
B) Its velocity is zero at the highest point of the trajectory.
C) Its acceleration decreases up to the highest point, and then increases during the downward motion.
D) The horizontal velocity component when it hits the ground equals the initial horizontal velocity component.

____ 3. (10 points) A box is suspended from a vertical rope. Which of the following scenarios results in the smallest tension in the rope? The box is…

A) moving upward and speeding up.
B) moving upward at a constant speed.
C) moving downward and slowing down.
D) moving downward and speeding up.

____ 4. (10 points) Block A is on a horizontal surface. It is being pulled by a string to the right with a constant force. Block B sits on top of block A and doesn't slip. What is the direction of the frictional force acting on block B?

A) Static friction, directed to the right.
B) Static friction, directed to the left.
C) Kinetic friction, directed to the right.
D) Kinetic friction, directed to the left.

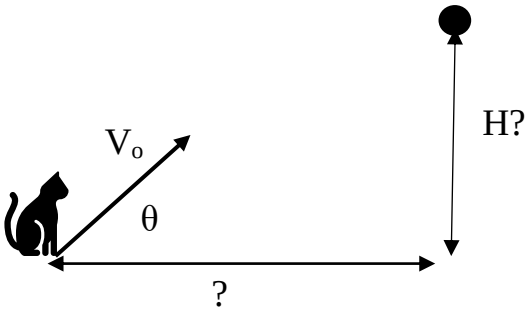
____ 5. (10 points) A particle of mass *M* moves in a vertical circle at the end of a taut string of length *L*. At the lowest point, its speed is *V*, and the string tension is *T*. At its lowest point, the magnitude of the **net** force on the mass is _____ and is directed _____.

A) $\frac{MV^2}{L} + T - Mg$, downward
B) $\frac{MV^2}{L} + T$, upward
C) $\frac{MV^2}{L}$, upward
D) $\frac{MV^2}{L}$, downward

_____ / 50 for this page

Name:_____

6. A cat jumps off the floor with initial velocity V_0 directed at an angle θ with respect to the horizontal to catch a ball that is dangling at some unknown height above the floor. She reaches the ball **with only a horizontal component of her velocity**.



a) (10 points) Complete the diagram on the right with all information necessary to solve the parts below.

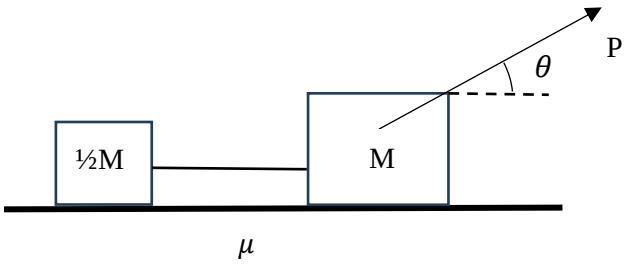
b) (20 points) (OSE) Derive an expression for the vertical height *H* of the ball, in terms of system parameters.

c) (20 points) (OSE) In terms of system parameters, derive an expression for the horizontal distance covered by the cat.

_____ / 50 for this page

Name:_____

7. A block of mass *M* is connected by a massless cord to a block of mass ½*M*. The two blocks are moving to the right on a rough horizontal surface because a pulling force of magnitude P is applied to the block of mass *M* at an angle of θ with respect to the horizontal. The coefficient of kinetic friction between each block and the horizontal surface is μ.



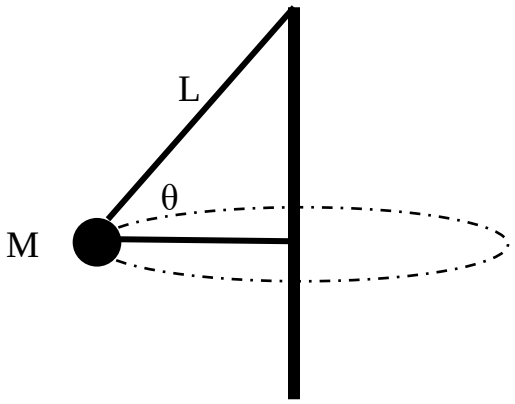
a) (10 points) On the figure, superimpose fully labeled free-body diagrams for each block, including all information that you need to solve the task below.

b) (40 points) (OSE) Derive an expression for the magnitude of the tension in the string connecting the blocks, in terms of system parameters. Begin with Newton's 2nd Law for **each** of the blocks.

_____ / 50 for this page

Name:_____

8. A ball of mass *M* is connected to a central vertical shaft by means of **two** massless cables. One cable of length *L* is attached to the top of the shaft, making an angle θ with the horizontal. The other cable is horizontal, as shown in the figure. The ball rotates in a horizontal circle with speed *V*.



a) (5 points) Complete the diagram on the right with all information necessary to solve part b).

b) (45 points) (OSE) In terms of system parameters, derive an expression for the tension in the horizontal cable.

_____ / 50 for this page