Name: _____

PHYS 1210-02 Exam 1

Standards 8–15

Calculators of any type are permitted. You may bring your own 8 ½" × 11"notes sheet, which may contain information on both sides, and an emotional support fossil. Each question is worth one point unless otherwise indicated.

Enter your answer to a free response question inside the box provided for the question. Include units with all quantitative answers. Do not make stray marks in the box, and do not write your answer outside the box. **Answers written outside the box will not be credited**. Show your work in the space provided with the question. It is a good idea to write your answers in pencil.

If the question asks for a single selection from provided options, **fill** the circle (○) by the most correct answer. If the question asks you to select all appropriate options, **fill** the squares (☐) by all correct options. Do not check, mark an "X," circle, or otherwise indicate your choices. If you want to revoke a choice, fully erase the mark.

1. A firefighter upstairs at the station hears an alarm. He puts on his turnout gear and jumps to the pole, which is a polished brass pole extending vertically from the garage floor below to the ceiling of the room upstairs. He wraps arms and legs around the pole, and descends to the floor of the garage at a steady speed in a few seconds.

   As the firefighter descends down the pole, what is the **direction** of the **net force** acting on him?

   ○ a. Vertically downward (straight down).
   ○ b. Vertically upward (straight up).
   ○ c. Toward the pole (inward).
   ○ d. Away from the pole (outward).
   ○ e. No direction: the net force is zero.

2. A soccer ball is kicked from ground level with an initial speed of 22.0 m/s at an angle of 35.0 degrees above the horizontal. Ignore air resistance.

   A. What is the vertical component of the ball's initial velocity?

   $v_{0y} =$ ☐

   B. What is the horizontal component of the ball's initial velocity?

   $v_{0x} =$ ☐

C. Once the ball is in the air, how does the vertical component of its velocity change with time? ("Increase" means "become more upward.")

- ○ a. The vertical component of its velocity increases until the ball hits the ground.
- ○ b. The vertical component of its velocity decreases until the ball hits the ground.
- ○ c. The vertical component of its velocity initially increases, then decreases before the ball hits the ground.
- ○ d. The vertical component of its velocity initially decreases, then increases before the ball hits the ground.
- ○ e. The vertical component of its velocity is constant but not zero until the ball hits the ground.
- ○ f. The vertical component of its velocity is zero until the ball hits the ground.

D. Once the ball is in the air, how does the horizontal component of its velocity change with time? ("Increase" means "become more forward.")

- ○ a. The horizontal component of its velocity increases until the ball hits the ground.
- ○ b. The horizontal component of its velocity decreases until the ball hits the ground.
- ○ c. The horizontal component of its velocity initially increases, then decreases before the ball hits the ground.
- ○ d. The horizontal component of its velocity initially decreases, then increases before the ball hits the ground.
- ○ e. The horizontal component of its velocity is constant but not zero until the ball hits the ground.
- ○ f. The horizontal component of its velocity is zero until the ball hits the ground.

E. Once the ball is in the air, how does its speed change with time? ("Increase" means "become faster.")

- ○ a. Its speed increases until the ball hits the ground.
- ○ b. Its speed decreases until the ball hits the ground.
- ○ c. Its speed initially increases, then decreases before the ball hits the ground.
- ○ d. Its speed initially decreases, then increases before the ball hits the ground.
- ○ e. Its speed is constant but not zero until the ball hits the ground.
- ○ f. Its speed is zero until the ball hits the ground.

F. How much time does it take the ball to reach the top (highest point) of its trajectory?

G. What is the speed of the soccer ball at the top (highest point) of its trajectory?

H. What is the height above the ground of the top (highest point) of its trajectory?

I. How far horizontally is the top (highest point) of its trajectory from the starting point?

3. A leaf carried by a whirlwind travels in a circle of diameter 7.20 meters at a constant speed, completing one circuit in 4.10 seconds.

A. What is the leaf's (tangential) **speed**?

B. What is the leaf's **period**?

C. What is the leaf's **angular speed**?

D. What is the magnitude of the leaf's **acceleration**?

E. What is the **direction** of the leaf's acceleration?

○ a. inward (toward the circle's center) ○ b. outward (away from the circle's center)
○ c. forward ○ d. backward ○ e. upward ○ f. downward ○ g. none of these

F. If the leaf traveled in a **tighter** (shorter diameter) circle with the **same period**, would the magnitude of its acceleration be greater or smaller?

○ a. The leaf would have a **greater** acceleration at the shorter diameter.
○ b. The leaf would have a **smaller** acceleration at the shorter diameter.
○ c. The leaf's acceleration would be the **same** at both diameters.

G. If the leaf traveled in a **tighter** (shorter diameter) circle with the **same tangential speed**, would the magnitude of its acceleration be greater or smaller?

○ a. The leaf would have a **greater** acceleration at the shorter diameter.
○ b. The leaf would have a **smaller** acceleration at the shorter diameter.
○ c. The leaf's acceleration would be the **same** at both diameters.

4. A bowler throws a 5.00-kilogram bowling ball toward the pins at the end of a bowling lane. The ball travels through the air for a short distance before landing on the wooden surface of the lane. The lane absorbs the impact of the ball so that the ball does not bounce. Kinetic friction slows the ball until it rolls without slipping down the lane. Consider several forces that act **on the ball** during this process: the throw from the bowler, gravity, the normal force from the lane, and kinetic friction. Tell me the directions of each of these forces.

A. throw from the bowler

B. the ball's weight

C. the normal force

D. kinetic friction

E. While the ball is in the air, before it contacts the lane, what is the magnitude of its **weight**?

F. While the ball is in the air, before it contacts the lane, what is the magnitude of the **normal** force acting on it?

G. After the ball lands, while it rolls down the lane, what is the magnitude of the **normal** force acting on it?

H. As the ball lands on the bowling lane, what force stops its downward motion?

○ a. the ball's weight ○ b. the normal force

○ c. kinetic friction ○ d. something else

5. A small frog amulet hangs by a 20-cm thread from the rear-view mirror of an automobile on a level road. As the automobile accelerates steadily away from a stop sign, the amulet swings backward, so that it hangs at an angle of 15 degrees from vertical.

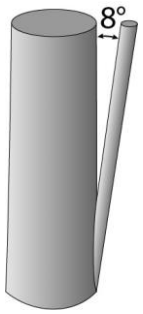
A. (3 points) Draw a free body diagram for the amulet. Assume that the car accelerates to the right (→).

B. What is the **vertical** component of the **tension** in the thread? Express in terms of the mass *m* of the amulet, any quantities given in the problem, and any constants that you need.

C. What is the **horizontal** component of the **tension** in the thread? Express in terms of the mass *m* of the amulet, any quantities given in the problem, and any constants that you need.

D. What is the **acceleration** of the car? Express in meters per second per second.

6. When I was a child, I liked to climb trees. One tree that was difficult to climb had branches that joined the trunk at a nearly vertical angle instead of being horizontal. One time I placed my foot in the gap between the trunk of the tree and a branch. When I put my weight on that foot, it got stuck. I want you to find the forces on my foot when I was stuck.



Assume that my mass at the time was 32.0 kg, that the trunk of the tree was vertical, and that the branch met the trunk at an angle of 8 degrees.

A. (3 points) Draw a free body diagram for my foot stuck in the gap.

B. When my weight was on my foot, what was the **vertical** component of the normal force exerted on my foot by the **branch**?

C. When my weight was on my foot, what was the **vertical** component of the normal force exerted on my foot by the **trunk** of the tree?

D. When my weight was on my foot, what was the **horizontal** component of the normal force exerted on my foot and the **branch**?

E. When my weight was on my foot, what was the **horizontal** component of the normal force exerted on my foot by the **trunk** of the tree?

Now, estimate that the coefficient of static friction between my shoe and the tree was 0.50.

F. What was the greatest possible magnitude of the force of **static friction** between the tree **trunk** and my shoe?