

Name: \_\_\_\_\_

## PHYS 1210-02 Exam 1

You may use a 3"×5" note card written on both sides and a calculator. You have a maximum of 110 minutes.

Clearly mark your answers to the free-response questions so that they are easy to find. Drawing a box around each answer would work nicely. Multiple choice questions have circles (○) before the choices. Fill the circle of the one best choice.

1. Here are some questions involving operations with vectors.

A. Add together the vectors  $(30.0 \text{ m}, 10.0 \text{ m}) + (10.0 \text{ m}, -20.0 \text{ m})$ .

B. Divide the sum from part A by 5.0 s and report the result as an ordered pair.

C. Express  $(30.0 \text{ m}, 10.0 \text{ m})$  in terms of magnitude and direction (counterclockwise of the  $+x$  axis).

Magnitude = \_\_\_\_\_ Direction = \_\_\_\_\_

D. Express  $(10.0 \text{ m}, -20.0 \text{ m})$  in terms of unit basis vectors  $\hat{i}$ ,  $\hat{j}$ , and  $\hat{k}$ .

E. Vector  $\vec{A} = 53.0$  newtons at  $30^\circ$ , and vector  $\vec{B} = 105.0$  newtons at  $180^\circ$ . Add  $\vec{A} + \vec{B}$  and report your result as magnitude and direction.

Magnitude: \_\_\_\_\_

Direction: \_\_\_\_\_

2. A physics student on the way to an exam walks down a staircase in the Classroom Building at a steady speed of 1.1 meters per second. The staircase descends at an angle of 36 degrees below horizontal. What is the direction of the net force on the student?

- a. No direction: the net force is zero.
- b. Straight down.
- c. 36 degrees below horizontal, in the direction of the staircase.
- d. Horizontal, in the direction the student is traveling.
- e. 54 degrees above horizontal, perpendicular to the staircase.
- f. Straight up.

3. A basketball player shooting a free throw makes a “swish” into the basket. The basketball leaves the player’s hands at a height of 2.15 meters above the floor, reaches its greatest height of 4.26 meters above the floor, and then enters the basket at a height of 3.04 meters above the floor. Horizontally, the center of the basket is 4.35 meters from where the player released the ball.

A. What is the vertical component of the basketball’s initial velocity? Show your work.

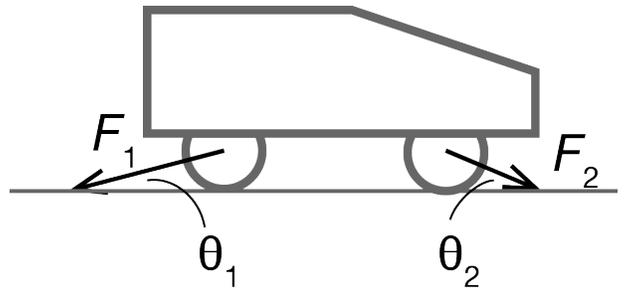
B. How much time elapsed between when the player released the ball and when it entered the basket? Show your work.

C. What is the horizontal component of the basketball’s initial velocity? Show your work.

D. At what angle is the basketball traveling when it reaches the basket? Show your work.

4. The star remnant known as the Crab Pulsar is a sphere with a radius of 10,000 meters spinning with a period of 33.5 ms per revolution.
- A. What is its angular speed in radians per second?
- B. What is the tangential speed at a point on its equator?
- C. What is the magnitude of the acceleration of a point on its equator?
- D. What is the direction of the acceleration of a point on its equator?
- a. Directly outward from the axis.
  - b. Directly inward toward the axis.
  - c. Right-handed (the direction that the thumb of your right hand points when you curl your right hand fingers in the direction of the spin).
  - d. Left-handed (the direction tht the thumb of your left hand points when you curl your left hand fingers in the direction of the spin).
  - e. In the direction of the point's velocity.
  - f. In the direction opposite the point's velocity.
  - g. No direction: the point is not accelerating.

5. A 1500-kg car is loaded onto a flatbed trailer and secured with two straps, one attached to its front axle and the other attached to its rear axle. The front strap is directed at an angle of  $\theta_2 = 40$  degrees from horizontal and has a tension of  $F_2 = 1800$  newtons. The rear strap is directed at an angle of  $\theta_1 = 30$  degrees from horizontal. Neglect friction between the trailer and the car's tires.



A. Draw a free body diagram for the truck.

B. What is the magnitude of the tension  $F_1$  in the rear strap? Show your work.

C. What is the magnitude of the normal force on the car? Show your work.

6. Peter stands on a scale in an elevator. As the elevator accelerates upward at a rate of  $2.1 \text{ m/s}^2$ , the scale reads 595 newtons.

A. Draw a free body diagram for Peter.

B. What is Peter's mass?

7. A passenger rides in a rotating amusement park ride. The forces acting on the passenger are the force of gravity directed straight down with a magnitude of 540 newtons, a normal force directed 15 degrees above horizontal with a magnitude of 1690 newtons, and a force of static friction directed 15 degrees off vertical (perpendicular to the normal force) with a magnitude of 106 newtons.

A. Draw a free body diagram for the rider.

B. What is the magnitude of the net force on the rider? Show your work.

8. A 30-kilogram block slides downhill on an incline angled 20 degrees below horizontal. The coefficient of kinetic friction between the block and the incline is 0.45.

A. Draw a diagram of the situation and a free-body diagram for the block.

B. What is the component of the block's weight parallel to the incline?

C. What is the component of the block's weight perpendicular to the incline?

D. What is the magnitude of the normal force on the block?

E. What is the magnitude of the force of friction on the block?

F. What is the magnitude of the net force on the block?

G. What is the magnitude of the block's acceleration?

H. Is the block speeding up or slowing down?

- a. The block is speeding up.
- b. The block is slowing down.