

Final Exam (2017 Fall)

PHYS 205A-002: University Physics

Date: 2017 Dec 15

(Name)

(Signature)

Instructions

1. Seating direction: Please be seated on seats with seat-numbers divisible by 3.
2. Total time = 120 minutes.
3. There are 10 questions in this exam.
4. Equation sheet is provided separately.
5. To be considered for partial credit you need to show your work in detail and organize it clearly.
6. A simple calculator (with trigonometric functions) is allowed.
7. Use of mobile phones is strictly prohibited. It should stay out of reach during the exam.

1. **(10 points.)** A baseball is hit so that it travels straight upward after being struck by the bat. A fan observes that it takes 3.00 s for the ball to reach its maximum height. Find the ball's initial velocity.

2. (10 points.) A curve in a road forms part of a horizontal circle of radius 250 m. A car of mass 2500 kg goes around it at constant speed 14.0 m/s.
- (a) Identify the individual forces acting on the car.
 - (b) Determine the magnitude and direction of the total force acting on the car.

3. (10 points.) Two objects (32.0 kg and 28.0 kg) are connected by a massless string that passes over a massless, frictionless pulley. The pulley hangs from the ceiling.
- (a) Find the acceleration of the objects.
 - (b) If the 32.0 kg mass is initially at rest at a height of 3.0 m from ground, how long does it take for it to reach the ground.

4. (10 points.) A rod of length $L = 5.00$ m has mass density (mass per length) given by

$$\frac{dm}{dx} = a, \tag{1}$$

where x is the distance from one end, and $a = 3.00$ kg/m.

- (a) Determine the mass of the rod.
- (b) How far from the $x = 0$ end is its center of mass?

5. (10 points.) Figure 1 shows a pendulum of length $L = 1.0$ m and mass $m = 5.0$ kg. It starts from rest after it is moved a height $h = 0.40$ m. Neglect air resistance.

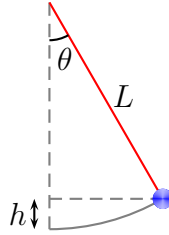


Figure 1: Problem 5.

- Determine the work done by the force of tension due to the string on the mass.
- Determine the work done by the force of gravity on the mass.
- Determine the change in kinetic energy while the mass falls the height h .

6. (**10 points.**) A railroad car of mass 2.40×10^4 kg is moving with a speed of 4.00 m/s. It collides and couples with three other coupled railroad cars, each of the same mass as the single car and moving in the same direction with an initial speed of 2.00 m/s. How much mechanical energy is lost in the collision?

7. (10 points.) A small solid marble of mass m and radius $r = R/5$ (with rotational inertia $I = \frac{2}{5}mr^2$) will roll without slipping along the loop-the-loop track if it is released from rest somewhere on the straight section of the track. (See Figure 2.) If the marble is released from height $h = 7R$ above the bottom of the track, what is the angular speed ω of the marble at point Q ? Express your answer in terms of g , R , and r .

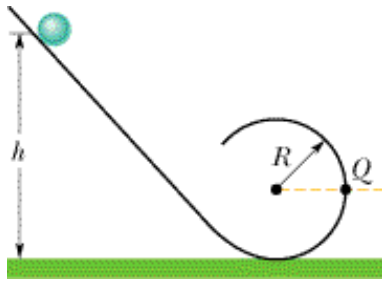


Figure 2: Problem 7.

8. **(10 points.)** A horizontal platform in the shape of a circular disk rotates on a frictionless bearing about a vertical axle through the center of the disk. The platform has a mass of 150 kg, a radius of 2.0 m, and a rotational inertia of $300 \text{ kg}\cdot\text{m}^2$ about the axis of rotation. A 50 kg student walks slowly from the rim of the platform toward the center. If the angular speed of the system is 2.4 rad/s when the student starts at the rim, what is the angular speed when she reaches the center?

9. (10 points.) Three objects of equal mass M are located at three distinct corners of a square of edge length L . Find the magnitude and direction of the gravitational field at the center of the square. Express your answer in terms of G , M , and L .

10. (10 points.) In an engine, a piston oscillates with simple harmonic motion so that its position varies according to the expression,

$$x = 3.00 \cos \left(\frac{2\pi}{4} t + \frac{\pi}{7} \right), \quad (2)$$

where x is in centimeters and t is in seconds.

- (a) What is the amplitude of the oscillations?
- (b) What is the frequency of the oscillations?