

# Midterm Exam No. 03 (2014 Fall)

## PHYS 205A: University Physics

Date: 2014 Nov 5

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(Name)

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### Instructions

1. Total time = 50 minutes.
2. There are 8 questions in this exam.
3. Equation sheet is provided separately.
4. To obtain partial credit for your work you need to show your work in detail and organize it clearly.

1. (10 points.) A block of mass  $m = 3.00$  kg is released from rest from point  $\textcircled{\text{A}}$  and slides on the track shown in Figure 1. (Let  $h_a = 7.00$  m. Do not neglect friction.) Determine the energy lost in form of frictional losses, and other forms of losses, if the block's speed at points  $\textcircled{\text{C}}$  is  $8.00$  m/s.

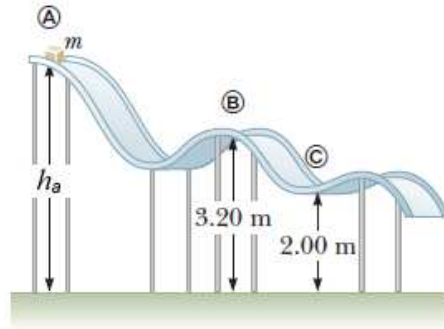


Figure 1: Problem 1.

2. (10 points.) A block of mass  $m = 10.0\text{ kg}$  is dropped from height  $h$  onto a spring of spring constant  $k = 1960\text{ N/m}$ . See Figure 2. If the maximum distance the spring is compressed is  $x = 0.20\text{ m}$ , find the height  $h$ .  
Caution: Do not neglect the extra height the block falls due to the compression in the spring.

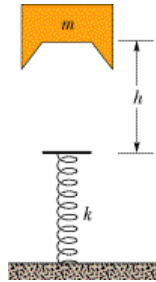


Figure 2: Problem 2.

3. (10 points.) The potential energy of a particle moving along the  $x$  axis is given by

$$U(x) = \left(1.0 \frac{\text{J}}{\text{m}^2}\right) x^2 - \left(1.0 \frac{\text{J}}{\text{m}^3}\right) x^3. \quad (1)$$

The force acting on the particle is

$$F(x) = -\frac{dU(x)}{dx}. \quad (2)$$

Determine the values of  $x$  at which the force is zero. (At these positions the particle is said to be in equilibrium.)

4. **(10 points.)** An archer weighing 60.0 kg, while standing on a frictionless surface, shoots an arrow of mass 30 grams at an angle  $\theta = 60^\circ$  with respect to the horizontal. Determine the velocity of the archer if the arrow has been shot at 80 m/s.

5. (10 points.) Two objects,  $X$  and  $Y$ , are held at rest on a horizontal frictionless surface. A spring is compressed between  $X$  and  $Y$ . The mass of  $X$  is  $3/5$  times the mass of  $Y$ . When the objects are released, what is the ratio of the kinetic energy of  $X$  to that of  $Y$ ?

6. (10 points.) A railroad car of mass  $m$  is moving with a speed of  $3.90 \text{ m/s}$ . 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  $1.95 \text{ m/s}$ . What is the speed of the four cars after the collision?

7. **(10 points.)** A 5.0g bullet is fired into a 2.5kg pendulum bob initially at rest and becomes embedded in it. If the pendulum rises a vertical distance of 4.0 cm, calculate the initial speed of the bullet.



8. (10 points.) Consider a thin rod of length  $L$  placed on the positive  $x$ -axis with one end at the origin. It has a mass density (mass per length) described by

$$\lambda = a x, \tag{3}$$

where  $x$  is the distance from end placed at the origin. Here  $a$  is independent of  $x$  and is measured in grams/meter<sup>2</sup>. At what distance from the end placed at the origin is the center of mass of the rod? Express your answer in terms of  $L$ .