Final Exam (2017 Fall)

PHYS 205A-001: University Physics

Date: 2017 Dec 15

(Name) (Signature)

Instructions

1. Seating direction: Please be seated on seats with seat-numbers divisible by 4.
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 ball is thrown vertically downward from the top of a 36.6 m tall building. The ball passes the top of a window that is 12.2 m above the ground 2.00 s after being thrown. What is the speed of the ball as it passes the top of the window?

2. (**10 points.**) A block slides down a frictionless plane having an inclination of 20.0°. The block starts from rest at the top, and the length of the incline is 3.00 m.

   (a) Find the acceleration of the block.

   (b) Find the time taken by the block to reach the bottom of the incline.

3. (**10 points.**) A stuntman whose mass is 75 kg drives a car at a uniform speed of 25 m/s through the bottom of a valley, the cross section of which can be approximated by a circle of radius $R = 150\,\text{m}$. What is the normal force acting on the stuntman while crossing the deepest part of the valley?

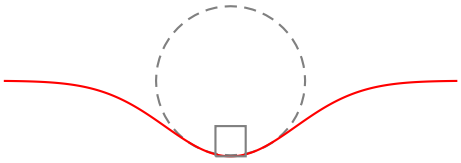

Figure 1: Problem 3

4. (**10 points.**) An object has a kinetic energy of 60.5 J and a momentum of magnitude 11 kg·m/s. Find the speed and the mass of the object.

5. (**10 points.**) A mass $m = 25\,\text{kg}$ slides down a frictionless incline, starting from rest at point A at height h. After sliding down the incline it moves horizontally on a frictionless surface before coming to rest by compressing a spring of spring constant $k = 4.0\times10^4\,\text{N/m}$ by a length $x = 15\,\text{cm}$. See Figure 2. Ignore friction.

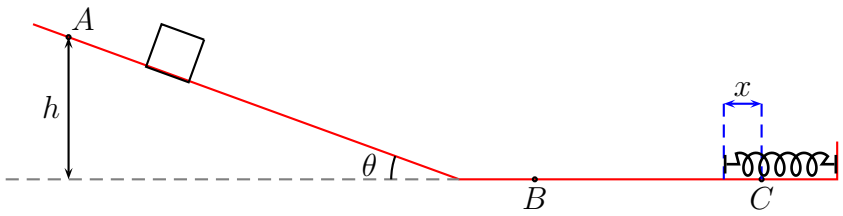

Figure 2: Lecture-Example 5.

(a) Determine the the work done (including sign) by the normal force on the mass while the mass moves from point A to point C.

(b) Determine the the work done by force of spring (including sign) on the mass while the mass moves from point A to point C.

(c) Determine the change in kinetic energy of the mass while the mass moves from point A to point C.

(d) Determine the the work done by gravity (including sign) on the mass while the mass moves from point A to point C.

6. (**10 points.**) A 10.1 g bullet is fired into a stationary block of wood having mass $m = 5.09\,\text{kg}$. The bullet imbeds into the block. The speed of the bullet-plus-wood combination immediately after the collision is $0.597\,\text{m/s}$. 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 $I = 2mr^2/5$) 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 3.) If the marble is released from height $h = 6R$ above the bottom of the track, what is the horizontal component of the force acting on it at point Q? Express your answer in terms of mg.

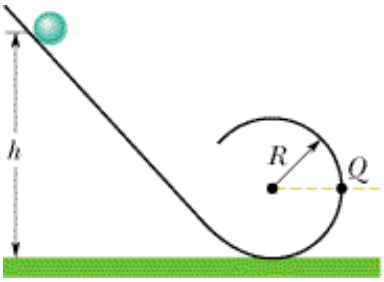

Figure 3: Problem 7.

8. (**10 points.**) The rotational inertia of a collapsing spinning star changes to $\frac{1}{3}$ its initial value. What is the ratio of the new rotational kinetic energy to the initial rotational kinetic energy?

9. (**10 points.**) Four objects of equal mass M are loacted at the corners of a square of edge length L. Find the magnitude and direction of the gravitational force on any one of the mass. 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,

$$x = 3.00 \cos\left(\frac{\pi}{4}t + \frac{\pi}{7}\right), \tag{1}$$

where x is in centimeters and t is in seconds.

(a) What is the amplitude of the oscillations?

(b) What is the time period of the oscillations?