Final Exam (2016 Fall)

PHYS 205A: University Physics

Date: 2016 Dec 16

(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.**) Starting at time $t = 0$, an object moves along a straight line. Its coordinate in meters is given by

$$x(t) = 24\,t^2 - 3.0\,t^4, \tag{1}$$

where t is in seconds. Determine the acceleration when it momentarily stops?

2. (**10 points.**) A student slides a mass off the top of a horizontal table. The height of the table is 1.30 m. The mass slides off the table with a horizontal velocity of 3.50 m/s. How far from the base of table does the mass strike the floor?

3. (**10 points.**) A bag of cement weighing $mg = 450\,\mathrm{N}$ hangs in equilibrium from two wires as suggested by the forces shown in Figure 1. Two of the forces make angles $\theta_1 = 20.0°$ and $\theta_2 = 70.0°$ with the horizontal. Assuming the system is in equilibrium, find the magnitude of the tensions T_1 and T_2.

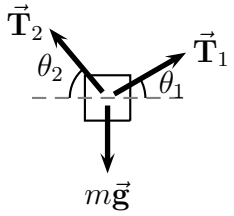

Figure 1: Problem 3.

4. (**10 points.**) A stuntman drives a car over the top of a hill, the cross section of which can be approximated by a circle of radius $R = 325\,\text{m}$. See Figure 2. What is the greatest speed at which he can drive without the car leaving the road at the top of the hill?

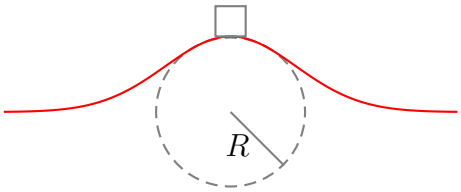

Figure 2: Problem 4

5. (**10 points.**) A block of mass $m = 4.50\,\text{kg}$ is released from rest from point A and slides on the frictionless track shown in Fig. 3. Assume A to be at a height of $7.0\,\text{m}$ from ground level and B to be at a height of $4.0\,\text{m}$.

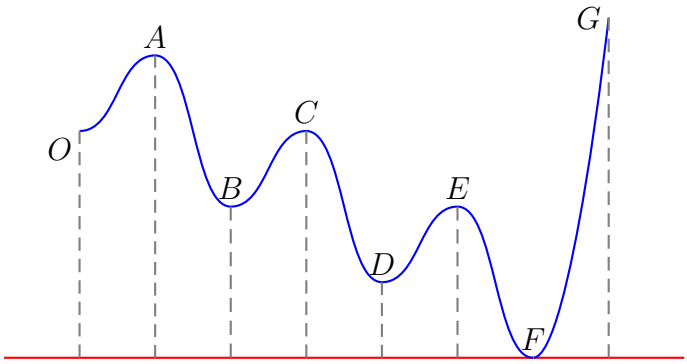

Figure 3: Problem 5.

(a) Determine the total work done by the normal force on the block while it moves from point A to point B.

(b) Determine the total work done by the gravitational force on the block as it moves from point A to point B.

6. (**10 points.**) A car of mass $m_1 = 2000.0\,\text{kg}$ is moving at speed $v_{1i} = 10.0\,\text{m/s}$ towards East. A truck of mass $m_2 = 6000.0\,\text{kg}$ is moving at speed $v_{2i} = 20.0\,\text{m/s}$ towards North. They collide at an intersection and get entangled (complete inelastic collision). What is the magnitude and direction of the final velocity of the entangled automobiles?

7. (**10 points.**) An object with a mass of $m = 5.0\,\text{kg}$ is attached to the free end of a light string wrapped around a reel of radius $R = 0.250\,\text{m}$ and mass of $M = 3.00\,\text{kg}$. The reel is a hollow disk ($I = MR^2/2$), free to rotate in a vertical plane about the horizontal axis passing through its center as shown in the figure below. Determine the magnitude of the acceleration of the object.

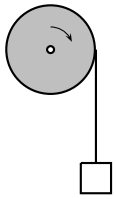

Figure 4: Problem 7

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 kg·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.**) Escape velocity on a particular planet is the minimum speed needed for an object to escape from the gravitational attraction of the planet. Calculate the escape velocity of Jupiter, given that the mass of Jupiter is 1.898×10^{27} kg and has a radius of 69.9×10^{6} km.

10. (**10 points.**) Four objects of equal mass m are located at the corners of a square of edge length L. Determine the magnitude and direction of the gravitational force on any one of the objects by the remaining three.