Midterm Exam 03 (2015 Summer)

PHYS 203A: College Physics

Date: 2015 Jul 24

(Name) (Signature)

Instructions

1. Total time = 60 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.
5. A simple calculator (with trigonometric functions) is allowed.

1. (**10 points.**) Earth rotates once per day about an axis passing through the North and South poles, an axis that is perpendicular to the plane of the equator. Assuming Earth is a sphere with a radius of 6.38×10^6 m, find the centripetal acceleration of a person standing at the equator.

2. (**10 points.**) A motorcycle is traveling up one side of a hill and down the other side. The crest of the hill is a circular arc with a radius of 60.0 m. Determine the maximum speed that the cycle can have while moving over the crest without losing contact with the road.

3. (**10 points.**) Consider a mass $m = 30.0\,\text{kg}$ being pulled by a force $F_{\text{pull}} = 75.0\,\text{N}$, exerted along a line making angle $\theta = 30.0°$ below the horizontal, such that the mass moves, on a horizontal surface with coefficient of kinetic friction $\mu_k = 0.30$. Assume that the mass starts from rest and moves a horizontal distance $d = 10.0\,\text{m}$. The four forces acting on the mass are described in Figure 1.

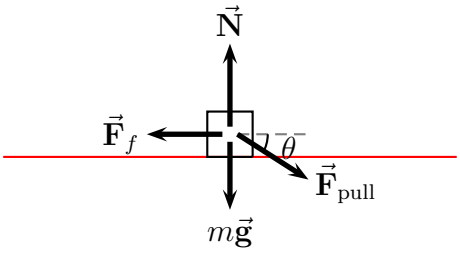

Figure 1: Problem 3

(a) Determine the work done by the force of gravity during the motion.

(b) Determine the work done by the normal force during the motion.

(c) Determine the work done by the force F_{pull} during the motion.

(d) Determine the work done by the force of friction during the motion.

4. (**10 points.**) A roller coaster of mass $m = 400.0\,\text{kg}$ moves on the curve described in Figure 2. Assume frictionless surface. It starts from rest at point A at height $h_A = 50.0\,\text{m}$. Determine the velocity of the mass at point E, given height $h_E = 20.0\,\text{m}$.

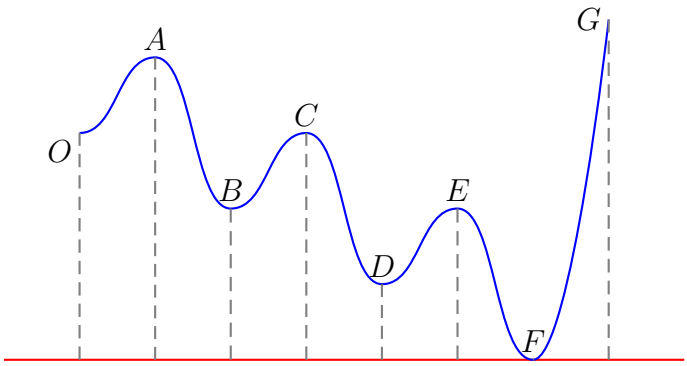

Figure 2: Problem 4.

5. (**10 points.**) A student of mass $m = 75.0\,\text{kg}$ jumps off a table from height $h = 1.20\,\text{m}$, with zero initial speed. While hitting the floor he bends his knees such that the time of contact is $75.0\,\text{ms}$ to come to rest. What is the magnitude of the force exerted by the floor on the student?

6. (**10 points.**) A car of mass $m_1 = 2500.0\,\text{kg}$ is moving at speed $v_{1i} = 20.0\,\text{m/s}$ towards East. A truck of mass $m_2 = 6000.0\,\text{kg}$ is moving at speed $v_{2i} = 25.0\,\text{m/s}$ 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.**) A ball is attached to one end of a wire, the other end being fastened to the ceiling. The wire is held horizontal, and the ball is released from rest (see Figure 3). It swings downward and strikes a block initially at rest on a horizontal frictionless surface. Air resistance is negligible, and the collision is elastic. The masses of the ball and block are, respectively, 1.50 kg and 2.50 kg, and the length of the wire is 1.00 m.

   (a) Find the velocity (magnitude and direction) of the ball just before the collision.

   (b) Find the velocity (magnitude and direction) of the block just after the collision.

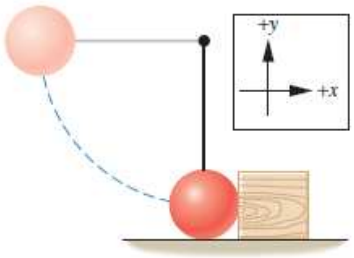

Figure 3: Problem 7.

8. (**10 points.**) John's mass is 80.0 kg, Barbara's is 50.0 kg. John is standing on the x axis at $x_J = +15.0\,\mathrm{m}$. Where on the x axis should Barbara stand if their center of mass is to be at $x_{\mathrm{cm}} = 10.0\,\mathrm{m}$?