Final Exam (2018 Spring)

PHYS 203A: College Physics

Date: 2018 May 7

(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 hot-air balloon is rising upward with a constant speed of 3.50 m/s. When the balloon is 15.0 m above the ground, the balloonist accidentally drops a compass over the side of the balloon. How much time elapses before the compass hits the ground?

2. (**10 points.**) A rifle is aimed horizontally at a target 30.0 m away. The bullet hits the target 1.9 cm below the aiming point. What is the bullet's speed as it emerges from the rifle?

3. (**10 points.**) A student is skateboarding down a ramp that is 6.0 m long and inclined at 15° with respect to the horizontal. The initial speed of the skateboarder at the top of the ramp is 3.0 m/s. Neglect friction. Find the speed of the student at the bottom of the ramp.

4. (**10 points.**) A box rests on a rough board 10.0 meters long. When one end of the board is slowly raised to a height of 6.0 meters above the other end, the box begins to slide. What is the coefficient of static friction?

5. (**10 points.**) A mass of $m = 25.0\,\text{kg}$ slides down a *frictionless* incline that makes an angle of $\theta = 30.0^\circ$ with the horizontal. Assume that the mass starts from rest. The two forces acting on the mass during the slide are the normal force and the force of gravity. The mass slides $d = 10.0\,\text{m}$ along the incline. Determine the work done by the gravitational force while the mass slides $d = 10.0\,\text{m}$ along the incline.

6. (**10 points.**) A car of mass $m_1 = 2000.0\,\text{kg}$ is moving at speed $v_{1i} = 20.0\,\text{m/s}$ towards East. A truck of mass $m_2 = 5000.0\,\text{kg}$ is moving at speed $v_{2i} = 10.0\,\text{m/s}$ 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 car is traveling with a speed of 25 m/s along a straight horizontal road. The wheels have a radius of 0.30 m. If the car speeds up with a linear acceleration of 2.0 m/s^2 for 7.0 s, find the angular displacement of a point on the outer edge of each wheel during this period.

8. (**10 points.**) The center of mass of a person may be determined by an arrangement shown in Figure 1 below. A light (massless) plank rests on two scales separated by a distance equal to the height $h = 1.80\,\text{m}$ of the person. The scales that measure the normal forces read $N_1 = F_{g1} = 500.0\,\text{N}$ and $N_2 = F_{g2} = 300.0\,\text{N}$. Determine the distance of the girl's center of mass from her feet.

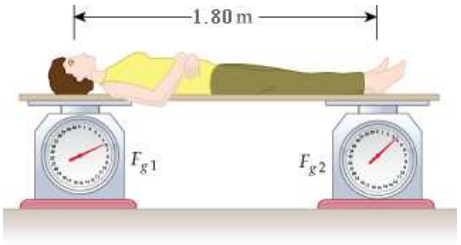

Figure 1: Center of mass.

9. (**10 points.**) A solid sphere ($I = \frac{2}{5}MR^2$) rolls perfectly (without sliding or slipping) on an inclined plane. If the cylinder started from rest at the top, vertical height of 10.0 m, what is the velocity of the cylinder when it reaches the bottom of the incline?

10. (**10 points.**) A merry-go-round, in the shape of a disc, is free to rotate (without friction) about its symmetry axis. (It has mass $M = 100.0\,\text{kg}$, radius $R = 2.00\,\text{m}$, and moment of inertia $I = \frac{1}{2}MR^2$.) A kid (mass $m = 25.0\,\text{kg}$) walks from the outer edge of the disc to the center. If the angular speed of the merry-go-round was $\omega_i = 0.30\,\text{rev/s}$ when the kid was at the outer edge, what is the angular speed of the merry-go-round when the kid is at the center?