Final Exam (2014 Fall)

PHYS 205A: University Physics

Date: 2014 Dec 12

(Name) (Signature)

Instructions

1. Total time = 105 minutes.
2. There are 10 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 speeder passes a parked police car at 40 m/s (=90 miles/hour). The police car starts from rest with a uniform acceleration of $4.0\,\mathrm{m/s^2}$, immediately after the speeder passes by. How far does the speeder get before being overtaken by the police car?

2. (**10 points.**) A projectile's launch speed is five times its speed at maximum height. Find launch angle θ_0.

3. (**10 points.**) Your mass is 75 kg, which corresponds to a weight of 735 N. How much will you weigh on a bathroom scale inside an elevator that is

   (a) slowing down at $2\,\mathrm{m/s^2}$ while moving downward?

   (b) speeding up at $2\,\mathrm{m/s^2}$ while moving upward?

4. (**10 points.**) In the Atwood machine shown in Fig. 1, the masses m_1 and m_2 are connected by a string that goes around a pulley. The masses of the pulley and string are negligible by comparison. Assume that the pulley turns without friction and the string does not stretch. Using Newton's laws, determine the acceleration of the masses.

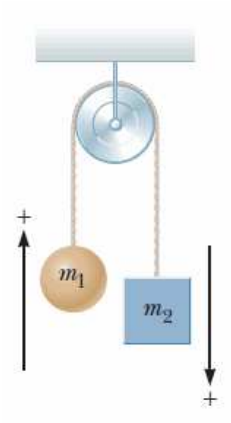

Figure 1: Problem 4.

5. (**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 $R = 250\,\mathrm{m}$. What is the greatest speed at which he can drive without the car leaving the road at the top of the hill?

6. (**10 points.**) A 5.0 g bullet is fired into a 2.5 kg 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.

7. (**10 points.**) Let us reconsider the Atwood machine in Problem 4 without neglecting friction in the pulley. In the Atwood machine shown in Fig. 2, the masses m_1 and m_2 are connected by a string that goes around a pulley. The pulley has mass m_3 and radius R, with moment of inertia of a solid cylinder $I = \frac{1}{2}m_3R^2$. Assume the mass of the string is negligible by comparison. Determine the acceleration of the masses.

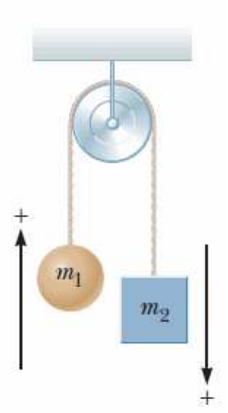

Figure 2: Problem 7.

8. (**10 points.**) The rotational inertia of a collapsing spinning star changes to $\frac{1}{4}$ its initial value. What is the ratio of the new rotational kinetic energy to the initial rotational kinetic energy?

9. (**10 points.**) A space probe is fired as a projectile from the Earth's surface with an initial speed of 1.78×10^4 m/s. What will its speed be when it is very far from the Earth? Ignore atmospheric friction and the rotation of the Earth. Mass of Earth is 5.97×10^{24} kg and radius of Earth is 6.371×10^6 kg.

10. (**10 points.**) How much energy is required to change a 50.0 g ice cube from ice at $-10.0°C$ to water at $+10.0°C$? Specific heat of ice is 2090 J/kg/°C, specific heat of water is 4186 J/kg/°C, and specific heat of steam is 2010 J/kg/°C. Latent heat of fusion for water is 330 kJ/kg, and latent heat of vapourization for water is 2260 kJ/kg.