Physics 10310 — General Physics I

Departmental Exam 2 – Fall 2010
There are 5 problems. Please do all problems. Please show all work.

1. Two cars are traveling at 100 km/h one behind the other. The driver in the second car reacts by braking 0.8 seconds after she observes the sudden braking of the car ahead of her. The front car has a mass of 1200 kg and the coefficient of friction between the tires and the road with the brakes applied is 0.8. The second (following) car has a mass of 1600 kg and its coefficient of friction with the brakes applied is 0.7. How far behind must the second car have been to avoid hitting the front car?

2. A spring gun is made by compressing a spring (assumed to be perfect and massless) and latching it. A spring of constant $k = 60$ N/m is used and the latch is located at a distance of 7 cm from equilibrium. The pellets have a mass of 4 grams. What is the muzzle velocity (speed at which the pellet is launched) of the gun?

3. A pendulum of length L and mass m starts from an initial position which makes an angle θ_i with the vertical. Calculate the work done by the force of gravity as the mass moves from θ_i to θ_f and use your result to calculate the speed of the pendulum at the bottom of the swing ($\theta = 0$). Why is it possible to ignore the tension in the string in computing the velocity?

4. A mass m moves on a horizontal table. The surface is frictionless. Gravity and the normal force from the table are balanced. Consider motion in the two dimensions of the table. The mass is attached to a central point so that the radial force on the mass is $-kr$, where r is the radius, the distance from the mass to the central point.
   (a) Write an expression for the total energy.
   (b) If the object is moving in uniform circular motion at a radius R what can you say about the velocity?

5. A stone of weight w, $w = mg$, is thrown vertically upward into the air with an initial speed v_0. If a constant force f due to air resistance acts on the stone throughout its flight,
   (a) show that the maximum height reached by the stone is: $h = \frac{v_0^2}{2g(1+\frac{f}{w})}$
   (b) Show that the speed of the stone on impact with the ground is: $u = v_0\sqrt{\frac{w-f}{w+f}}$. Note that the direction of the force f changes direction when the stone falls.