Physics 10310 — General Physics I

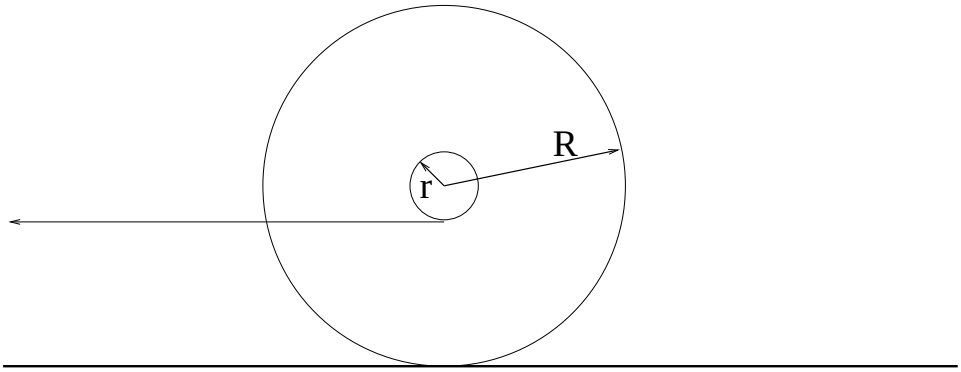
Departmental Exam 3 – Fall 2010
There are 5 problems. Please do all problems. Please show all work.

1. **Superman rushes to save Lois Lane, who has fallen from a window 65 meters above a crowded street. Superman swoops down in the nick of time arriving when Lois is 1.0 m above the street and stopping her at ground level. Lois has a mass of 52.5 kg. Ignore air resistance. A) What is the impulse Lois receives as Superman catches her? B) If the force Superman applies in stopping Lois is constant, how long does it take her to come to rest? C) What is the average force Superman applies to Lois? Compare this to the force of gravity. How realistic is such a last minute rescue?**

2. **Two persons, one of mass m_1 and the other of mass m_2 are sitting initially at rest on a bobsled of mass M on a frozen lake. Treat the lake surface as frictionless. From the rest frame of the fixed lake, A) What is the final velocity of the bobsled if the person of mass m_1 jumps off the rear of the bobsled with velocity v followed a few seconds later by the person of mass m_2 who jumps off with the same horizontal velocity? B) What is the final velocity of the bobsled if the person of mass m_2 jumps off first and is followed my the person of mass m_1? C) What is the speed of the bobsled if they both jump off at the same time? Use the same velocity v for each of the passengers.**

3. **A rigid solid undergoes rotational motion about an axis. Its angular velocity has magnitude $\omega = \alpha t$, where α is a constant. As the angular speed ω increases with time, the period T decreases. A) Show that the rate of change of the period is described by the equation $\frac{dT}{dt} = \frac{-2\pi}{\alpha t^2}$. The period is infinite at $t = 0$ since the rotation has not yet started. B) Show that the change in the period between $t = t_1$ and $t = t_2$ is given by $T(t_2) - T(t_1) = \frac{2\pi}{\alpha}(\frac{1}{t_2} - \frac{1}{t_1})$**

4. **A wheel of radius 24.6 cm whose axis is fixed starts from rest and reaches an angular velocity of 4.15 rad/s in 2.68 s due to a force of 13.4 N acting tangentially on the rim. A) What is the moment of inertia of the wheel? B) What is the change in angular momentum during the 2.68 s? C) How many revolutions does the wheel make? D) How much rotational kinetic energy does the wheel have after the 2.68 s?**



5. **A yo-yo has mass M and radius R. The central stem has negligible mass and radius r. The string, wrapped about the stem of radius r is pulled horizontally from the lower side, with a constant force F, while the yo-yo rests on a rough (friction) horizontal surface. What is the maximum value of F for which the yo-yo will roll without slipping assuming the coefficient of static friction between the yo-yo and the surface is μ? For a solid disk about its center of mass $I = \frac{1}{2}MR^2$.**