Physics 1A: Physics for Scientists and Engineers: Mechanics **Winter 2015**

Discussion 10: Final Review

Exercise 1: Uniform accelerated motion. Conventional artillery launches projectiles of mass m at an angle θ with muzzle velocity v. Given that angle, at what range L can it hit a target? A railgun can deliver more than 6 times the conventional velocity, $v_r = 6v$. How does the railgun range L_r compare to L?

Exercise 2: Energy and momentum. Consider the following collision in 1D. Puck 1, of mass m_1, moving with initial velocity v_1, hits puck 2 (of mass m_2), which is intially at rest. The collision is elastic. (a) Find m_2 in terms of m_1 such that the final velocity of puck 2 is $v_1/2$. (b) What is the final velocity v_f of puck 1?

Exercise 3: Rotational motion. A poorly constructed roller coaster has vertical loop of radius 12 meters after a 20 meter drop. Does the roller coaster need vertical guards installed on the track to prevent the train from falling at the top of the loop?

Exercise 4: Impulse. In a laser, light is trapped between two parallel mirrors (i.e. light bounces back and forth between the mirrors). Light consists of particles (photons) each carrying a momentum $p = h\nu/c$ (ν is the frequency of the light, c the speed of light, h a funamental constant of nature which is called Planck's constant). Photons travel at speed c (strange, but true). Suppose the distance between the mirrors is l and there is only one photon in the laser. (a) Calculate the (average) force exerted by thte light on one mirror. (b) If we increase the distance between the mirrors to 2L, what is the work done by this "radiation force"?

Exercise 5: Challenge Question. A uniform rope of mass m and length L is partly hanging over the edge of a fricitonless table. Initially,, 1/4 of the rope is hanging over the edge (the rest is stretched out on the table). The rope is released from rest and slides down. (a) Calculate the velocity of the rope when the trailing end is just over the edge of the table. (b) Same question, but now there is also a coefficient of dynamic friction μ_d between the rope and (the horizontal part of) the table. Assume friction is small enough that the rope still slides, and the table height is larger than L.