Physics 2A 1st Midterm (200 Points MAX)
Spring 2005

Show your work with diagrams, explanations, and clear writings. No credit will be given for answers without diagrams, explanations, and clear writings.

1. (a) The distance light travels in a year is called a *light-year*(ly). Given that 1.00 ly = 5.88 x 10^{12} mi, how far is that in meters?

   (b) Suppose that you have a bag of identical marbles each of which has a mass of 20.0 g. How many marbles will it take to match the mass of an exactly 1/2-kg banana?

2. (a) Each of two runners at either end of 1000-m straight track jogs toward the other at a constant 5.00 m/s. How long will it take before they meet?

   (b) If an alien power straight out of a comic book were to cause the Sun to vanish *now*, we would still be bathed in sunshine for the next 8.3 min. We would see our star blazing in the sky as usual for all that time. Taking the speed of light to be roughly 3.0 x 10^8 m/s, compute the average Earth-Sun distance in meters.

3. (a) A big, black dog saunters down the aisle of an Amtrak Pullman at a velocity of 5.00 km/h-EAST with respect to the car. The train, all the while, is traveling at 10.00 km/h-EAST. A resident flea heading rumpward along the hound's back moves at 0.01 km/h-WEST with respect to the dog. Find the velocity of the flea with respect to the Earth.

   (b) A firefighter dashes up a 26-m ladder (making an angle of 67.4^o with the ground). What is the vertical displacement of her feet at the top?

4. (a) A flea jumps into the air and lands about 8.0 in. away, having risen to an altitude of about 130 times its own height (that's comparable to you jumping 650 ft up). Assuming a 45^o launch, compute the flea's take-off speed. Make use of the mathematical fact that 2 sinθcosθ = sin2θ and ignore air friction.

   (b) Having been kicked, a soccer ball rolls in a straight line past a kid holding a stopwatch. At the moment the ball passes the kid it has an instantaneous speed of 4.0 m/s and the watch reads 10.0 s. If the watch reads 23.3 s when the ball comes to rest, what's its average acceleration?

5. (a) A baseball recoiling from a bat soars into the air at an angle of 40.0^o above the ground traveling at 45.7 m/s (i.e., 150 ft/s). Assuming it's caught at the same height at which it's hit, calculate the ball's theoretical range ignoring aerodynamic effects.

   (b) A driver traveling at 60 km/h sees a chicken dash out onto the road and slams on the brakes. Accelerating at -7 m/s^2, the car stops just in time 23.3 m down the road. What was the driver's reaction time (i.e., the time that elapsed before he engaged the brake)?

6. (a) Place a book flat on a table and press down on it with your hand. Now suppose the hand-book and table-book values of μ_k are 0.50 and 0.40, respectively; the book's mass is 1.0 kg and your downward push on it is 10 N. How much horizontal force is needed to keep the book moving at a constant speed if your hand is stationary with respect to the table?

   (b) The gravitational acceleration on the surface of Mercury is 0.38 times its value on Earth. What is the weight of a 1.0-kg mass on that planet?

7. (a) A ball (0.142 kg) left a player's hand at a speed of 20.0 m/s. If the straight throw lasted 0.020 s, determine the magnitude of the force exerted on the ball, assuming it to be constant.

   (b) A 1000-kg car traveling on a road that runs straight up a hill reaches the rounded crest at 10.0 m/s. If the hill at that point has a radius of curvature (in a vertical plane) of 50 m, what is the net downward force acting on the car at the instant it is horizontal at the very peak?

8. (a) A circular track with a 20-m radius is to be banked at an angle θ appropriate for a "4.0-min mile," which is equivalent to 1.609 x 10^3 m in 240 s. Compute θ.

   (b) What fraction of what you weigh on Earth would you weigh in a rocket ship firing its rockets so that it was stationary with respect to the center of the planet$4R_\oplus$ from its surface?