Physics 103b

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Order of Magnitude Physics

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Problem Set 6

Due at *beginning* of class *18 February 1997*

Homework Problems:

1. A steel ball and a solid ball of soft rubber (one which you can deform perceptibly by squeezing hard) are dropped onto a hard steel plate. What is the maximum height from which the steel ball can be dropped before its coefficient of restitution begins to drop due to inelastic deformations? For the rubber ball? Do the sizes of the balls matter?

2. The blue superball which was dropped off the top of Millikan library has a diameter of 4.2 cm and a mass of 38 g. Resting on a hard surface, the radius of the circle of contact is measured to be 0.13 cm.
   a) What is the elastic modulus of the rubber?
   b) When you drop the rubber ball, it bounces with decreasing height and increasing frequency until it stops bouncing and begins simply to vibrate. What is the minimum time between bounces of the rubber ball?

3. Yet more fun with balls
   a) If you drop the blue superball of problem 2 from height $h = 1\,\mathrm{m}$ with no spin while you are at rest, it will rebound with no spin. But if you drop it while walking, it will be spinning when it rebounds. Why? Is Galilean invariance wrong? Estimate the rotation frequency of the ball after bouncing.
   b) You repeat the experiment, but now dropping the ball out of a car with horizontal velocity v_x adjustable to higher values than walking speed. Estimate the critical v_x above which the ball skids, in the speedometer units of your native land.

4. Mars has atmospheric pressure 5×10^{-3} earth atm, and radius 0.5 earth radii.
   a) Equipped with an oxygen mask, could an earth native bird fly on Mars?
   b) Could it land?
   c) Could a mouse on Mars hear a falcon coming towards it in a free-fall dive?

5. How fast could a plant grow (height per unit time)? Consider limitations due to availability of light, water and CO_2.

6. Invent a problem of your own.