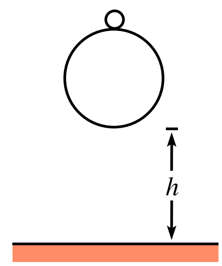
Week 1 (9/16/02)

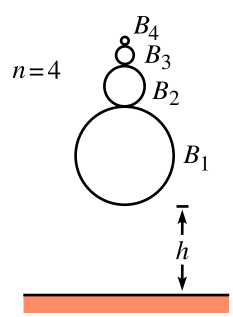
Basketball and tennis ball

(a) A tennis ball with (small) mass m_2 sits on top of a basketball with (large) mass m_1. The bottom of the basketball is a height h above the ground, and the bottom of the tennis ball is a height $h + d$ above the ground. The balls are dropped. To what height does the tennis ball bounce?



Note: Work in the approximation where m_1 is much larger than m_2, and assume that the balls bounce elastically.

(b) Now consider n balls, $B_1, \ldots, B_n$, having masses $m_1, m_2, \ldots, m_n$ (with $m_1 \gg m_2 \gg \cdots \gg m_n$), sitting in a vertical stack. The bottom of B_1 is a height h above the ground, and the bottom of B_n is a height $h + \ell$ above the ground. The balls are dropped. In terms of n, to what height does the top ball bounce?



Note: Work in the approximation where m_1 is much larger than m_2, which is much larger than m_3, etc., and assume that the balls bounce elastically.

If $h = 1$ meter, what is the minimum number of balls needed for the top one to bounce to a height of at least 1 kilometer? To reach escape velocity? Assume that the balls still bounce elastically (which is a bit absurd here). Ignore wind resistance, etc., and assume that ℓ is negligible.