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 \( \ell \) is negligible.