FIRST MIDTERM

At \( t = 0 \) a ball is dropped from rest at the top of a building 110 m high. Exactly two seconds later, a second ball is thrown downwards with an initial speed \( v_0 \).

(a) If both balls arrive at the bottom at the same time, calculate \( v_0 \).
(b) Calculate the speed of the second ball when it arrives at the ground.

\[ y = y_0 + v_{0y} t + \frac{g y t^2}{2} \]

\[ g_y = -g \]

**1st ball:**

\[ v_{0y} = 0 ; y_0 = h \]

\[ 0 = h - \frac{g t_1^2}{2} \]

\[ t_1 = \sqrt{\frac{2h}{g}} = 4.74 \text{ s} \]

**2nd ball:**

\[ v_{0y} = -v_0 \]

\[ v_{0y} t_2 = h - \frac{g(t_1 - 2)^2}{2} \]

\[ v_0 = \frac{h - \frac{g(t_1 - 2)^2}{2}}{t_1 - 2} \]

\[ v_{2y} = v_{0y} + g t_2 \]

\[ v_{2y} = -v_0 - g(t_1 - 2) \]

\[ v_2 = \sqrt{v_{2y}^2} = v_0 + g(t_1 - 2) \]

\[ v_2 = 53.6 \text{ m/s} \]