**Question #54576, Physics / Mechanics | Kinematics | Dynamics**

One ball is thrown upwards with an initial velocity of 20 m/s from the edge of a tall building. Three seconds later, a ball is dropped from the edge of the roof. Both balls hit the ground at the same time. How tall is the building?

**Answer.**

**Let H be the high of the building.**

**1-st ball**

**Time to highest point:** $v_0 - gt = 0 \rightarrow t = \frac{v_0}{g}$,

**high of this point from the roof:** $h = \frac{gt^2}{2} = \frac{v_0^2}{2g}$,

**time from this point to the ground:**

$$h + H = \frac{gt^2}{2} \rightarrow \quad t = \sqrt{\frac{2(H+h)}{g}} = \sqrt{\frac{2H}{g} + \frac{v_0^2}{g^2}}$$

**2-nd ball**

**time from roof to the ground:**

$$H = \frac{gt^2}{2} \rightarrow \quad t = \sqrt{\frac{2H}{g}}$$

**Thus** $\sqrt{\frac{2H}{g} + \frac{v_0^2}{g^2}} + \frac{v_0}{g} = \sqrt{\frac{2H}{g}} + 3$

**For** $v_0 = 20\frac{m}{s}$, $g = 9.81\frac{m}{s^2}$ **we have**

$$\sqrt{0.204H + 4.156} = \sqrt{0.204H} + 0.961 \rightarrow$$

$$\rightarrow \quad 0.204H + 4.156 = 0.204H + 1.992\sqrt{0.204H} + 0.924 \rightarrow$$

$$\rightarrow \quad 1.662 = \sqrt{0.204H} \quad \rightarrow \quad H = 13.54\ m.$$

**The building is 13.54 m  high.**