

Question #81262, Physics / Other

You drop a rock from rest out of a window on the top floor of a building, 30.0 m above the ground. When the rock has fallen 3.00 m, your friend throws a second rock straight down from the same window. You notice that both rocks reach the ground at the exact same time. What was the initial velocity of the rock that your friend threw? (Assume upward is the positive direction and downward is negative. Indicate the direction with the sign of your answer.)

Solution

For the first throw:

$$H = \frac{gt^2}{2}, h = \frac{gt_1^2}{2}$$

$$t = \sqrt{\frac{2H}{g}}, t_1 = \sqrt{\frac{2h}{g}}$$

For the second throw:

$$H = -v(t - t_1) + \frac{g(t - t_1)^2}{2}$$

$$H = -v\left(\sqrt{\frac{2H}{g}} - \sqrt{\frac{2h}{g}}\right) + \frac{g}{2}\left(\sqrt{\frac{2H}{g}} - \sqrt{\frac{2h}{g}}\right)^2$$

$$v = \frac{-H + \frac{g}{2}\left(\sqrt{\frac{2H}{g}} - \sqrt{\frac{2h}{g}}\right)^2}{\left(\sqrt{\frac{2H}{g}} - \sqrt{\frac{2h}{g}}\right)}$$

$$v = \frac{-30 + \frac{9.8}{2}\left(\sqrt{\frac{2(30)}{9.8}} - \sqrt{\frac{2(3)}{9.8}}\right)^2}{\left(\sqrt{\frac{2(30)}{9.8}} - \sqrt{\frac{2(3)}{9.8}}\right)} = -9.44 \frac{m}{s}.$$

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