Raul Barrea
@PhysicsSensei

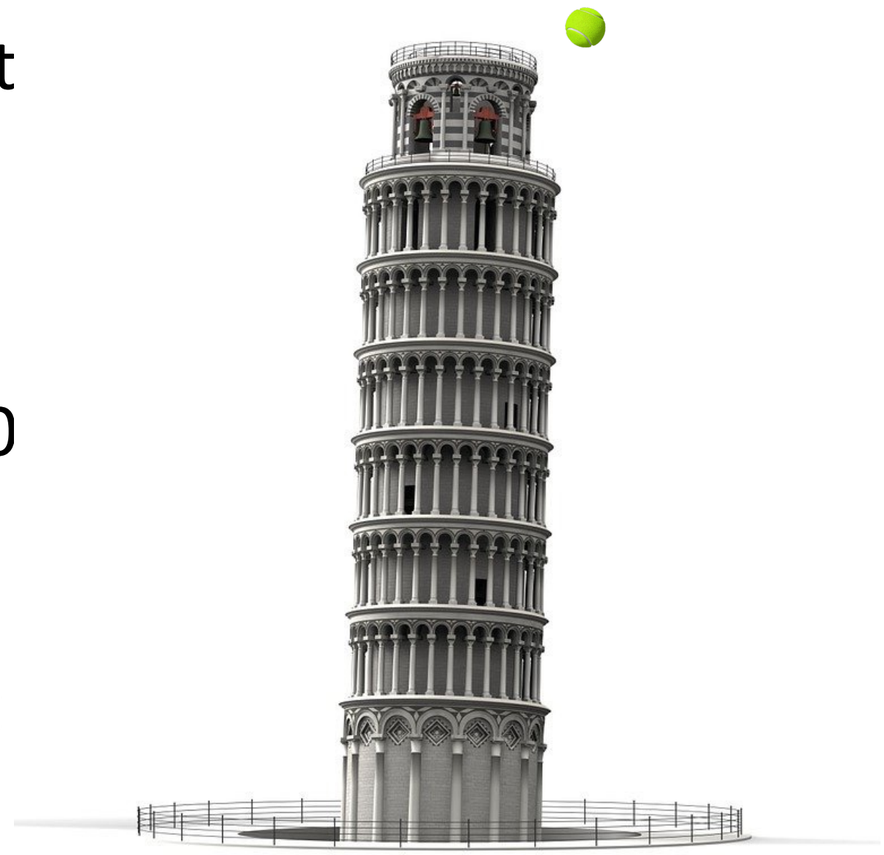
Object in Free Fall with initial Velocity

Drop a tennis ball from the top of a tower

You climb to the top of a tower, 70 m above the ground. You drop a tennis ball with initial velocit

$v_i = 10.0\ \frac{m}{s}$, from the top of the tower.

1. Calculate how far the ball has fallen after 1.0 and 2.00 s,
2. Calculate its velocity at each of these times.
3. Calculate how long it takes for the ball to hit ground.
4. Calculate the final velocity of the ball right before hitting ground.



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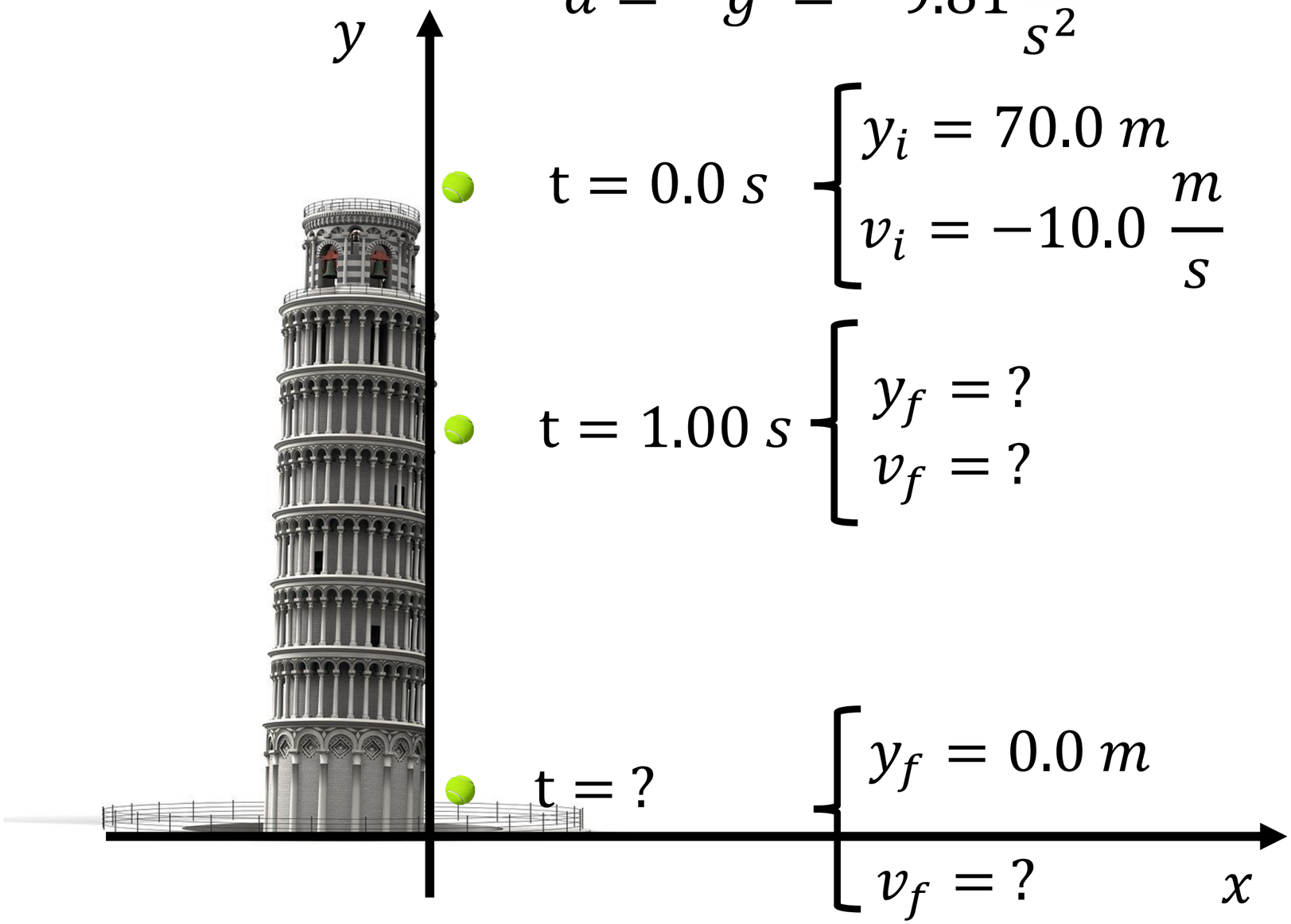
$$a = -g = -9.81\,\frac{m}{s^2}$$



$$\text{t} = 0.0\ s \begin{cases} y_i = 70.0\ m \\ v_i = -10.0\ \dfrac{m}{s} \end{cases}$$

$$\text{t} = 1.00\ s \begin{cases} y_f = ? \\ v_f = ? \end{cases}$$

$$\text{t} = ? \begin{cases} y_f = 0.0\ m \\ v_f = ? \end{cases}$$

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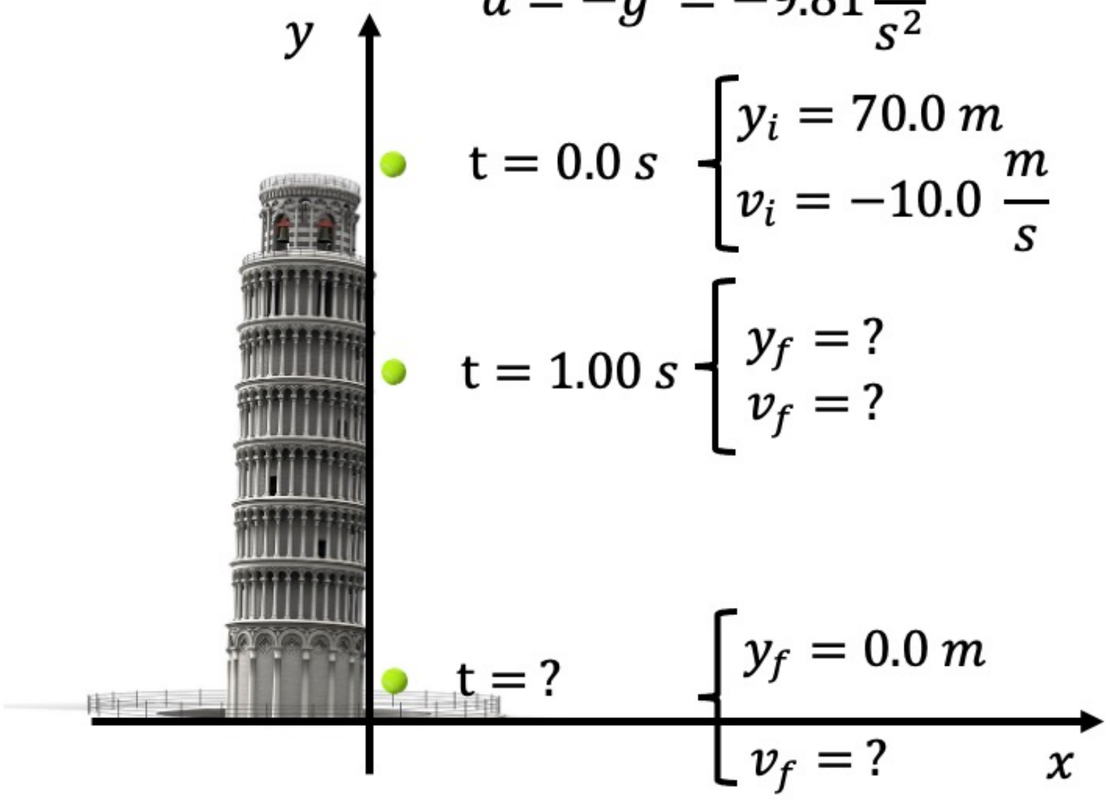

Equations

$$y_f = y_i + v_i \cdot t + \frac{1}{2} \cdot a \cdot t^2$$

$$v_f = v_i + a \cdot t$$

$$v_f{}^2 = v_i{}^2 + 2 \cdot a \cdot \Delta y$$

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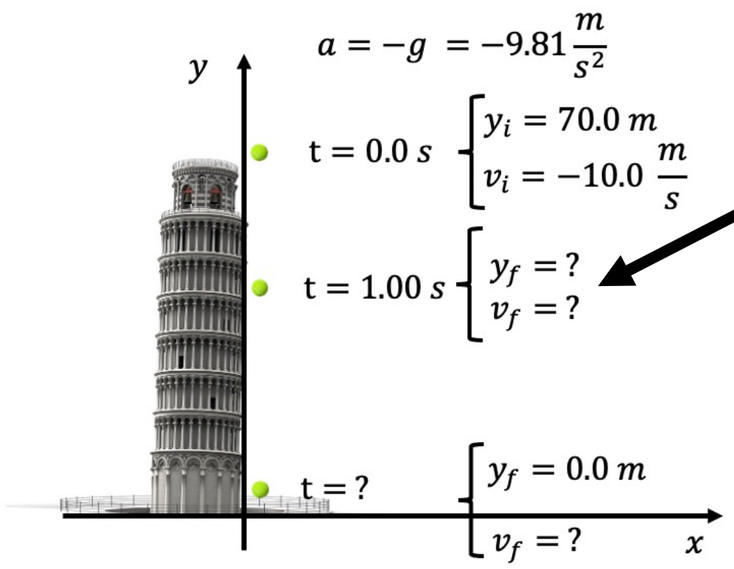
Calculate how far the ball has fallen after 1.00s

$$y_f = y_i + v_i \cdot t + \frac{1}{2} \cdot a \cdot t^2$$

$$y_f = 70.0\ m - 10.0\frac{m}{s} \cdot (1.00s) + \frac{1}{2} \cdot (-9.81\frac{m}{s^2}) \cdot (1.00s)^2$$

$$y_f = 70.0\ m - 10.0\ m\ -\ 4.905\ m$$



$$y_f = 55.1\ m$$

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Object in Free Fall with initial Velocity

Drop a tennis ball from the top of a tower

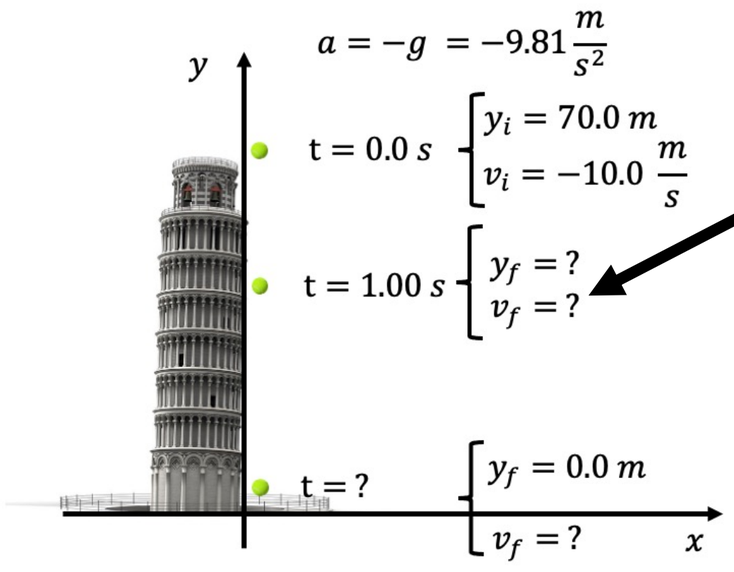
Calculate its velocity at 1.00 s

$$v_f = v_i + a \cdot t$$

$$v_f = -10.0\frac{m}{s} + (-9.81\frac{m}{s^2}) \cdot (1.00s)$$

$$v_f = -10.0\frac{m}{s} - 9.81\frac{m}{s}$$

$$v_f = -19.81\ \frac{m}{s}$$



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Object in Free Fall with initial Velocity

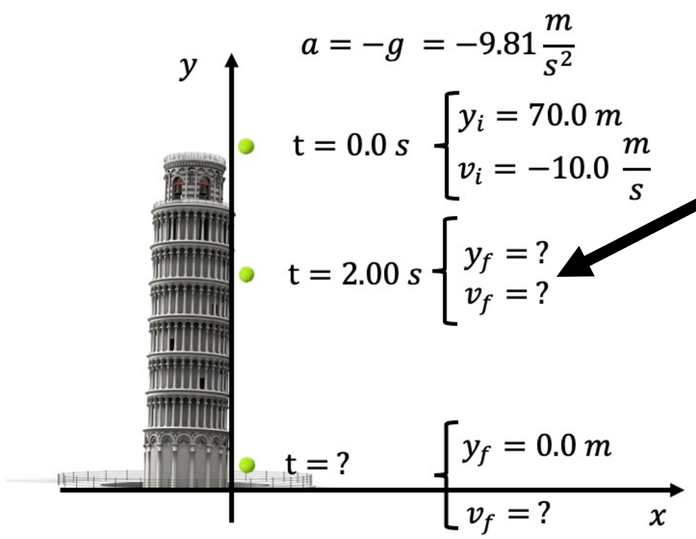
Drop a tennis ball from the top of a tower

Calculate how far the ball has fallen after 2.00s

$$y_f = y_i + v_i \cdot t + \frac{1}{2} \cdot a \cdot t^2$$

$$y_f = 70.0\ m - 10.0\frac{m}{s} \cdot (2.00s) + \frac{1}{2} \cdot (-9.81\frac{m}{s^2}) \cdot (2.00s)^2$$

$$y_f = 70.0\ m - 20.0\ m - 19.62\ m$$



$$y_f = 30.4\ m$$

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Object in Free Fall with initial Velocity

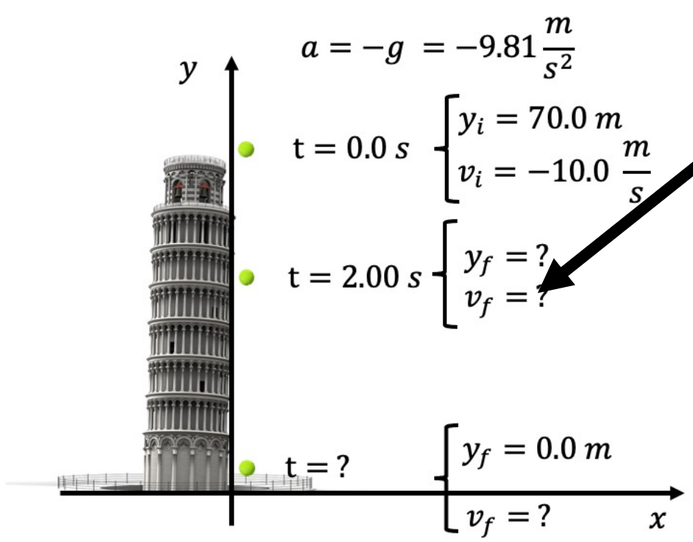
Drop a tennis ball from the top of a tower

Calculate its velocity at 2.00 s

$$v_f = v_i + a \cdot t$$

$$v_f = -10.0\ \frac{m}{s} + (-9.81 \frac{m}{s^2}) \cdot (2.00s)$$

$$v_f = -29.6\ \frac{m}{s}$$



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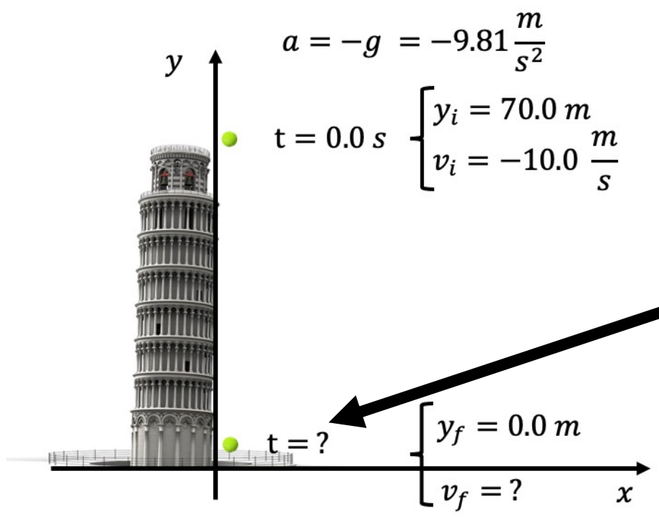
Drop a tennis ball from the top of a tower

Calculate how long it takes for the ball to hit ground

$$y_f = y_i + v_i \cdot t + \frac{1}{2} \cdot a \cdot t^2$$

$$0 = 70.0\,m - 10.0\frac{m}{s} \cdot t + \frac{1}{2} \cdot (-9.81\frac{m}{s^2}) \cdot t^2$$

$$t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$



$t_1 = 2.89\ s$

~~$t_2 = -4.93\ s$~~

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Object in Free Fall with initial Velocity

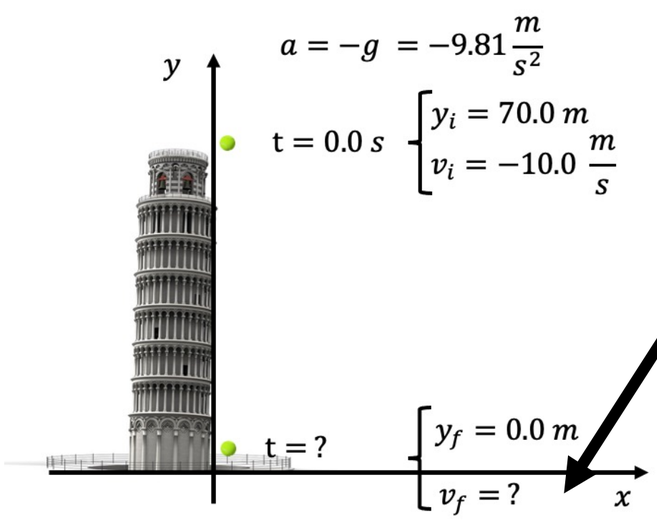
Drop a tennis ball from the top of a tower

Calculate the final velocity of the ball right before hitting ground

$$v_f = v_i + a \cdot t$$

$$v_f = -10.0\frac{m}{s} + (-9.81\frac{m}{s^2}) \cdot (2.89s)$$

$$v_f = -38.4\ \frac{m}{s}$$



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