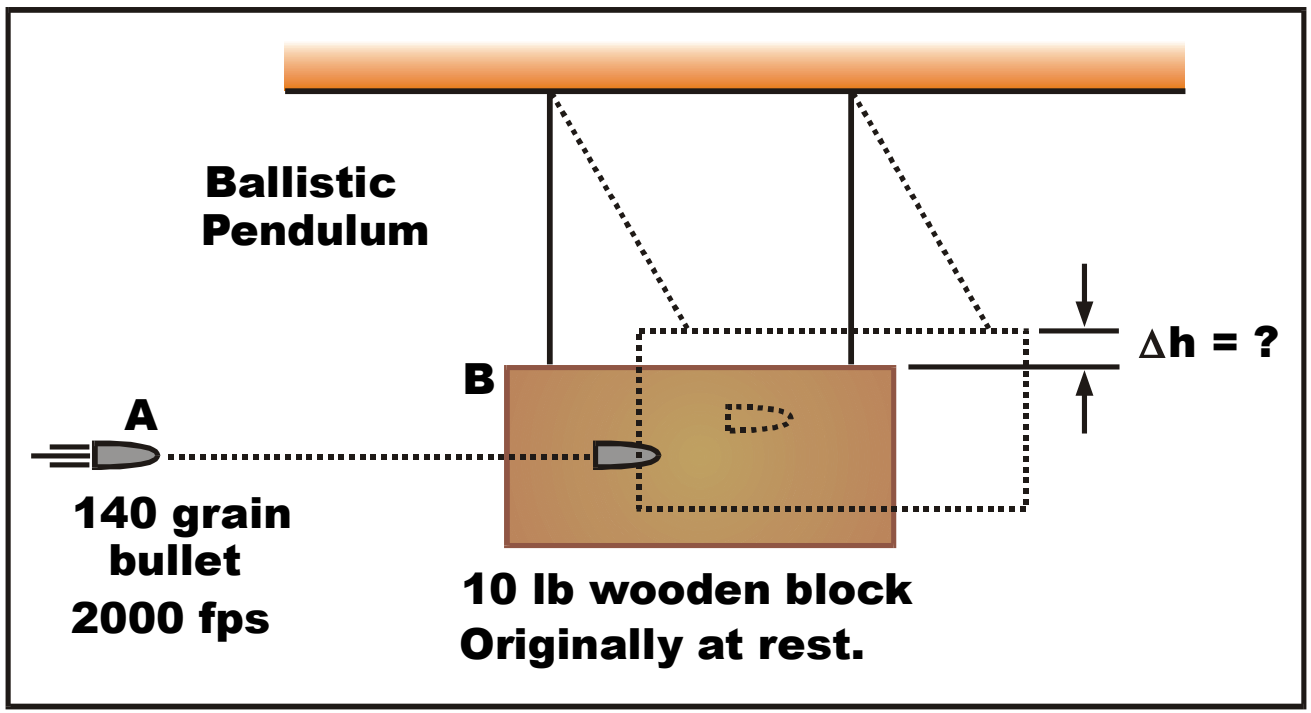
Conservation of Momentum: Example Problem 2

A 140 grain bullet moving at 2000 fps strikes and embeds in a 10 lb wooden block. Please determine:

(a) The velocity of the wooden block with the embedded bullet.

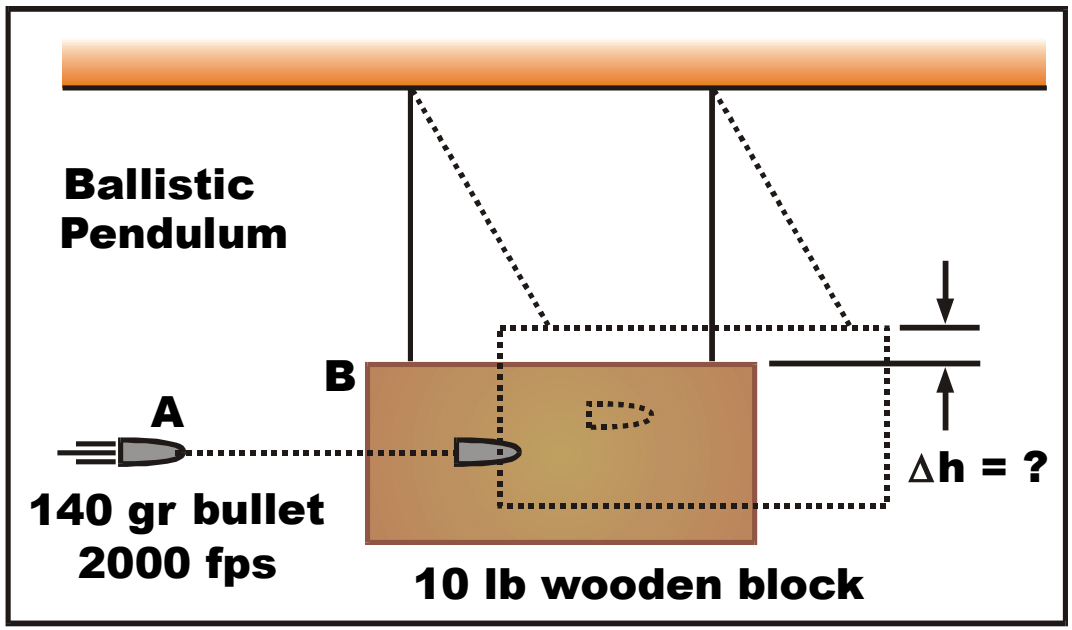
(b) The maximum height Δh to which the block rises..

Note: 7000 grains = 1 lb.



Discussion…

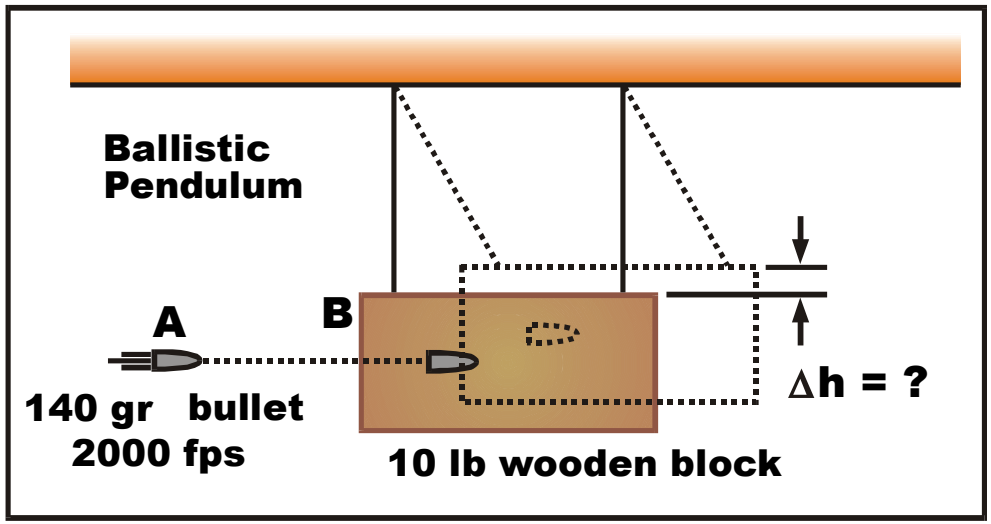
This is called a "ballistic pendulum." Before modern chronographs were developed to measure the speed of bullets exiting the barrel of a gun, this was the method of choice. Fire the bullet at a block of known weight or mass, measure the elevation change, and use conservation of momentum to calculate the speed of the bullet.



This is a two step problem.

(1) Use Cons of Momentum to calculate the speed once the bullet fully embeds in the block.

(2) Use the Work-Energy Equation to calculate the max height Δh reached by the block (at which the block comes to rest).



Remember:
7000 grain = 1 lb

Write the x scalar conservation of momentum equation:

Particles "stick together" after impact

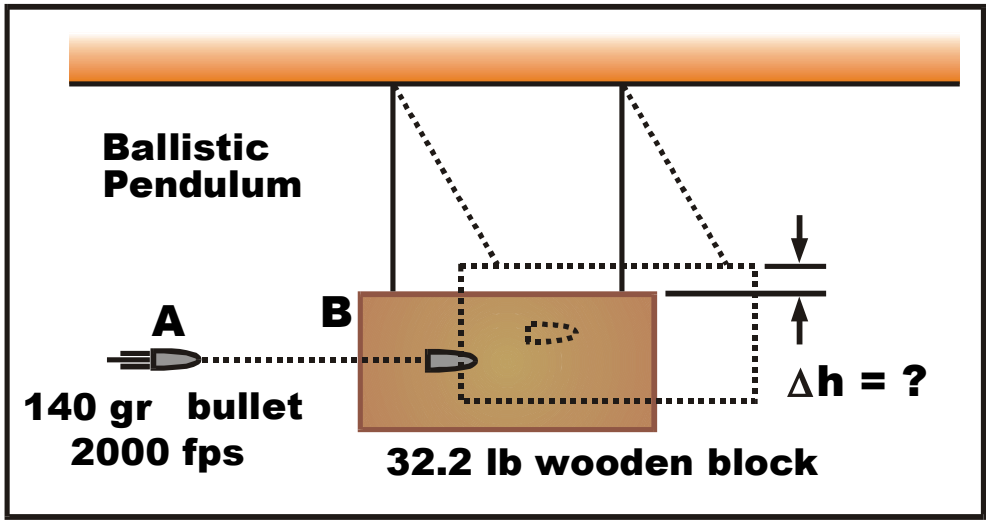
$$+\rightarrow \quad m_A v_{Ax1} + m_B v_{Bx1} = (m_A + m_B) v_{2x}$$

$$+\rightarrow \quad \left[\frac{140/7000}{32.2}\right](2000) + 0 = \left[\frac{1/50 + 10}{32.2}\right] v_{2x}$$

Elim the 32.2's

$$40 + 0 = 10.02\, v_{2x}$$

$$v_{2x} = 3.99 \text{ fps} \rightarrow$$



Remember:
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$v_{2x} = 3.99$ fps →

Write a work-energy equation for the block:

Write the Work-Energy Equation:

$$\frac{1}{2}mv^2 = mgh$$

$$\frac{1}{2}\cancel{m}(3.99)^2 = \cancel{m}(32.2)h$$

$$h = 0.2475 \text{ ft}$$
$$= 2.97 \text{ inch}$$