**Ex:** Consider a device called a **ballistic pendulum**. This device was used to measure the speeds of bullets.

![Diagram of a ballistic pendulum](image)

Consider \( M = 5.4 \text{ kg} \) and \( m = 9.5 \text{ gm} \)

If the block/bullet system swings upward \( h = 6.3 \text{ cm} \), what was the speed of the bullet just prior to the collision?

- First recognize this collision as completely inelastic. After the collision the block + bullet are ‘stuck’ together.

\[ mv = (M + m)V \]

- As the collision is inelastic, kinetic energy is **NOT** conserved. But *after* the collision, mechanical energy *is* conserved.
Conservation of mechanical energy after the collision tells us:

\[ \frac{1}{2}(M + m)V^2 = (M + m)gh \]

Now we can solve for \( v \) (the initial speed of the bullet) using the expression from momentum conservation to give us \( V \).

\[ v = \sqrt{\frac{M + m}{m}}\sqrt{2hg} \]

\[ = \left( \frac{5.4 \text{ kg} + 0.0095 \text{ kg}}{0.0095 \text{ kg}} \right)\sqrt{2(9.81 \text{ m/s}^2)(0.063 \text{ m})} = 630 \text{ m/s} \]