

Conservation Laws

2nd Newton's Law

$$m\Delta\vec{v} = \vec{F}\Delta t$$

Only conservative forces:
Energy conservation

$$K + U = \text{const}$$

Kinetic Energy: $K = \frac{mv^2}{2}$

No external forces:
Momentum conservation

$$\vec{p}_1 + \vec{p}_2 + \dots + \vec{p}_n = \text{const}$$

Momentum: $p = m\vec{v}$

Examples of Potential Energy, U:

Earth gravity, $F = mg$: $U(x) = mgx$

Hooke's spring, $F = kx$: $U(x) = \frac{kx^2}{2}$

Homework

Problem 1

A bullet of mass m that moves horizontally with speed v , hits boxer's punch bag that hangs up from the ceiling. The punch bag has mass M , and bullet gets stuck in it. As a result, the punch bag starts moving as a pendulum. Find the maximum height Δh which it will reach, with respect to its initial position.

Hint: you have to split the problem on two halves, and decide which conservation law works in each part.

