Conservation of Energy
Definitions

• **Energy** = Ability to do work
• **Kinetic Energy (K)** = motion energy = \( \frac{1}{2}mv^2 \)
• **Potential Energy (U)** = energy of configuration. PE has the potential to change back into KE (motion).
• **Conservative force** = one whose work can be stored as PE. The PE can then be converted back into KE. Ex: \( F_g, F_s \)
• **Non-conservative force** = one whose work is not stored as PE. Ex: \( F_f \)
• Potential energy can only be associated with a conservative force.
Potential Energy Formulas

1. **Gravity**

   \[ U_g = mgH \]

   \[ U_g = [kg][10 \frac{m}{s^2}][m] = [N][m] \]

   - \( U_g \) can be + or – depending on if it is at + or – elevation.

2. **Springs**

   \[ U_s = \frac{1}{2} kx^2 \]

   \[ k = spring\_constant = [N/m] = (+) \]

   \[ U_s = \frac{1}{2} [N/m][m^2] = [Joules] \]

3. **Friction**: \( F_f \) has no potential energy.
Conservation of Energy

\[ U_0 + K_0 = U + K \]

\[ U_g = mgH \]

\[ U_s = \frac{1}{2} kx^2 \]

\[ K = \frac{1}{2} mv^2 \]

- When there are no non-conservative forces acting, the total amount of mechanical energy in a system is conserved.

**Ex:** A ball is tossed straight up at 10 m/s. How high above the release point does it go? How fast is it going at h=3 m?
Conservation of Energy for Downhill Skiing

Height = 52.0 m  |  Speed = 0.0 m/s

Unpacked Snow
Conservation of Energy in a Swinging Pendulum
Ex: A mass is released from rest and slides down a frictionless plane inclined at 70° to the horizontal. What is the speed of the mass after sliding along the incline a distance of 3.5 m?
Springs

- **Hooke’s Law:** \( F_s = -kx \)
- \( F_s \) = Spring force on the mass [N]
- \( x \) = location on the # line, displacement from equilibrium [m]
  + = stretched       - = compressed
- \( k \) = spring constant [N/m]
- - = restoring force. Restoring forces always try to push or pull the mass back to the equilibrium position at the origin.

![](image)
Energy Considerations

• **Potential Energy:**
• $U_s$ is always (+)
• $U$ stretch is the same as $U$ compression since $x$ is squared.
• **Intuitions:**
Ex:

What is the maximum speed of the block?

What max height does it reach?

What is $v$ when $h = _____$?