Conservation of Energy

Definitions

- **Energy** = Ability to do work
- **Kinetic Energy (K)** = motion energy = $(1/2)mv^2$
- **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

$$U_g = mgH$$

$$U_g = [kg][10\,\tfrac{m}{s^2}][m] = [N][m]$$

- 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

$$U_0 + K_0 = U + K$$

$$U_g = mgH$$

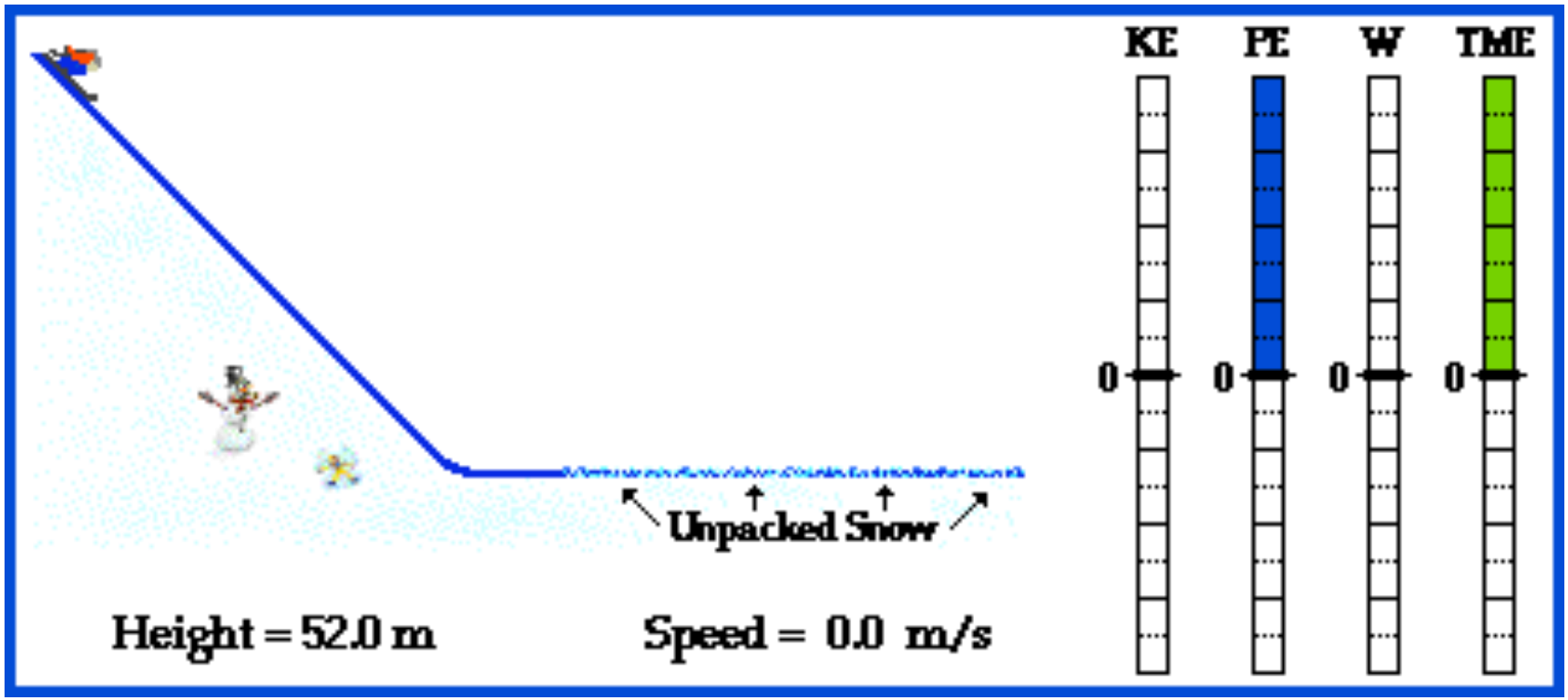
$$U_s = \frac{1}{2}kx^2$$

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

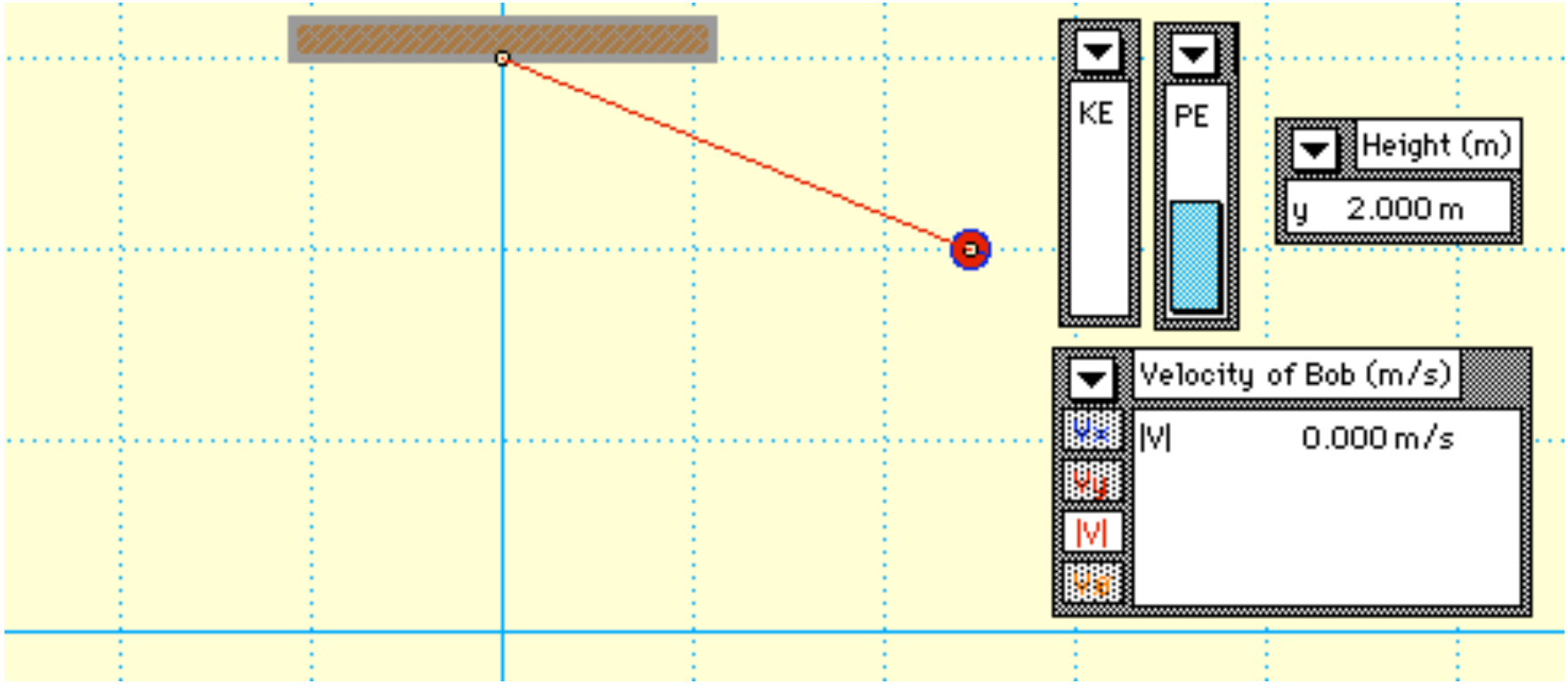
- When there are no non-conservative forces acting, the total amount of mechanical energy in a system is conserved.

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?

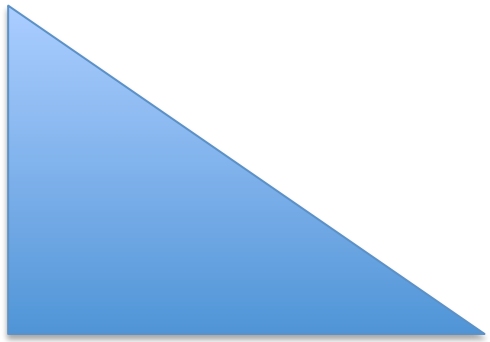
Conservation of Energy for Downhill Skiing



Conservation of Energy in a Swinging Pendulum



Ex: A mass is released from rest and slides down a frictionless plane inclined at 70^{o} to the horizontal. What is the speed of the mass after sliding along the incline a distance of 3.5 m?

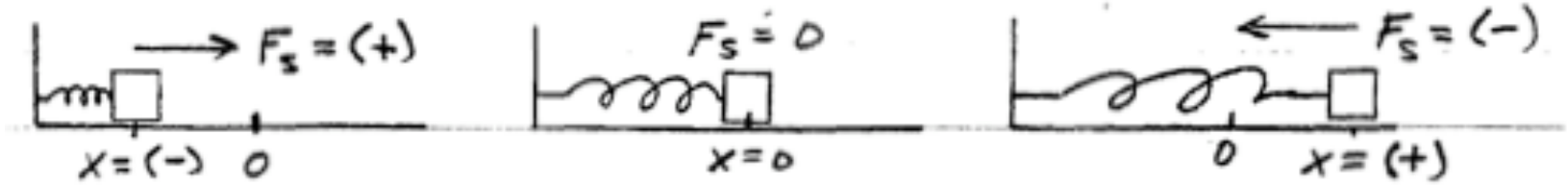


Springs

$$F_s = -kx$$

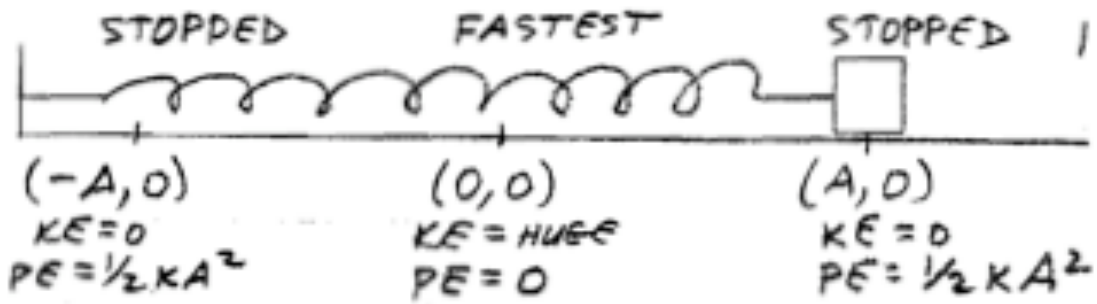
- **Hooke's Law:** $F_s = -kx$
- F_S = Spring force on the mass [N]
- x = location on the # line, displacement from equilibrium [m]

  + = 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.

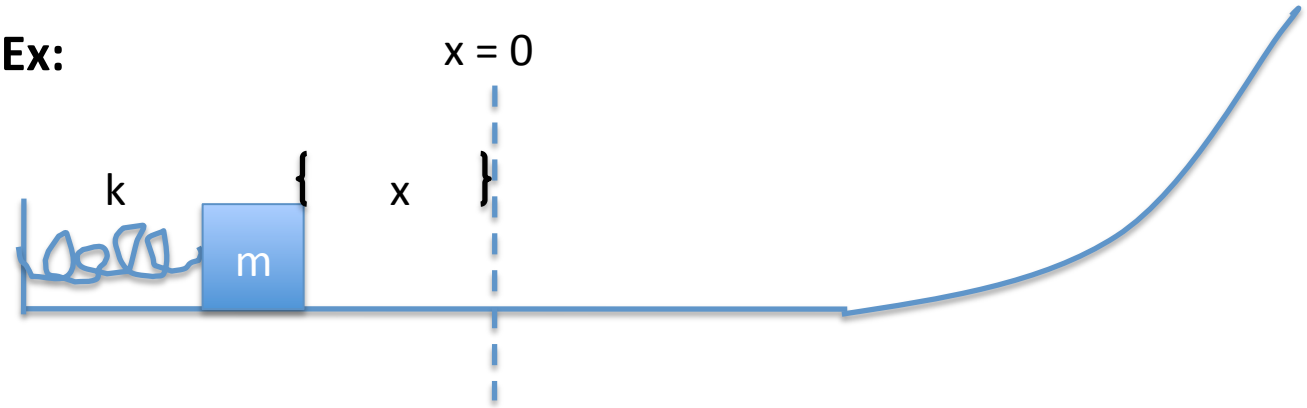


Energy Considerations

- **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 = _____ ?