CONSERVATION OF ENERGY

Goal:

- to understand that energy is conserved
- to understand the role of friction in energy conservation

Conservation of Energy

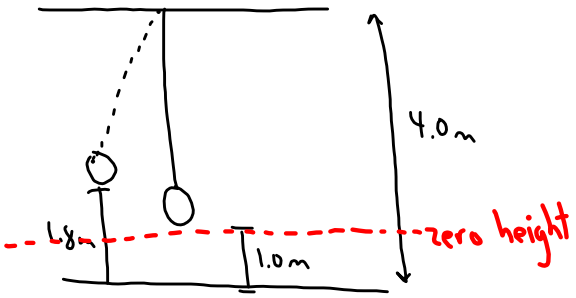
In a closed system, the total mechanical energy is constant.

$$ME_i = ME_f \quad \text{or} \quad ME_1 = ME_2$$

$$E_{k_1} + E_{p_1} = E_{k_2} + E_{p_2}$$

$$E_{k_1} + E_{g_1} + E_{e_1} = E_{k_2} + E_{g_2} + E_{e_2}$$

A 2-kg pendulum is attached to the ceiling 4.0 m above the ground. The rope of the pendulum is 3.0 m long. If the pendulum is released from a height of 1.8 m, what is the maximum speed it reaches?



At 1.8 m height:

$E_k = 0$ $E_e = 0$

$E_g = mgh = 2\,kg(9.8\,N/kg)(0.8\,m)$

$= 15.68\,J$

$ME_1 = 15.68\,J$

At 1.0 m height:

$E_e = 0$ $E_g = 0$!

$E_k = ?$

$ME_2 = ME_1$

$E_{k_2} + E_{e_2} + E_{g_2} = E_{k_1} + E_{e_1} + E_{g_1}$

$E_{k_2} = 15.68\,J$

$\frac{1}{2}mv^2 = 15.68\,J$

$\frac{1}{2}(2kg)v^2 = 15.68J$

$v^2 = 15.68\,J/kg$

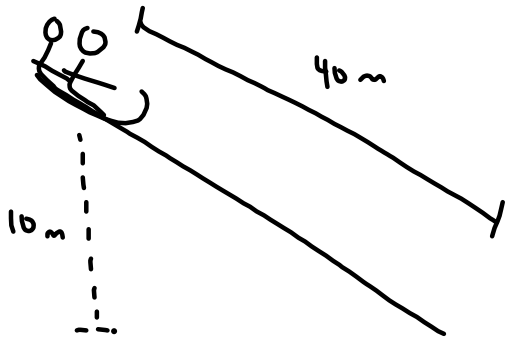
$v = 3.96\,m/s$

When there is friction in the system, energy is still conserved.
The work done by friction will be the apparent loss in energy.

$$ME_1 + W_f = ME_2$$

↑ work done by friction is negative

Two people slide down a hill on a sled from a height of 10.0 m. The average force of friction exerted on the sled is 200 N. The mass of the people and the sled is 100 kg and the hill is 40.0 m long. Calculate the speed of the people at the bottom of the hill.



At highest pt:

$E_e = 0$ $E_g = mgh$

$E_k = 0$ $= 100\,kg(9.8\,N/kg)(10\,m)$

$= 9800\,J$

$ME_1 = 9800\,J$

work done by friction:

$W_f = -200N(40m)$

$= -8000\,J$

$ME_1 + W_f = ME_2$

$9800\,J + (-8000\,J) = ME_2$

$ME_2 = 1800\,J$

At bottom:

$E_e = 0$ $ME_2 = E_e + E_g + E_{k_2}$

$E_g = 0$ $1800\,J = E_{k_2}$

$1800\,J = \frac{1}{2}(100kg)v^2$

$36 = v^2$

$v = 6\ m/s$