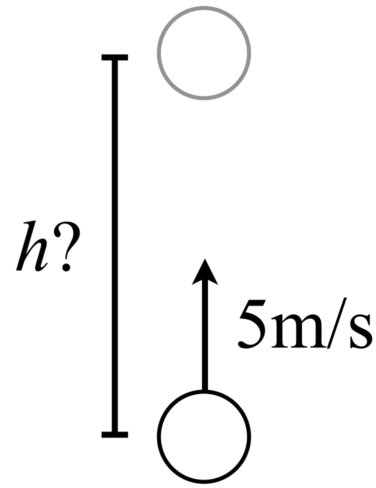
1. Throw a 2kg ball with speed 5m/s into the air. How high does it go?



Initial Energy

KE $\frac{1}{2}mv^2 = \frac{1}{2}(2)(5)^2 = 25$

PE 0

Final Energy

KE 0

PE $mgh = (2)(9.8)h = 19.6h$

Solve $\boldsymbol{E_f = E_i + W}$

$25 = 19.6h$

$h = 25/19.6 = \mathbf{1.28\,m}$

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

$$\Downarrow$$

$$h = v^2 / 2g$$

2a. The natural length of this spring is 5cm and it has a stiffness of 800N/m. When the spring is released, it pushes the block across the floor. How fast is the block moving as soon as it loses contact with the spring?

Initial Energy

KE 0

PE $\frac{1}{2}k(\Delta L)^2$
$= \frac{1}{2}(800)(0.03)^2$
$= 0.36\text{J}$

Final Energy

KE $\frac{1}{2}(0.5)v^2$
$= 0.25v^2$

PE 0

Work $\boldsymbol{W}$ 0J

Solve $\boldsymbol{E_f = E_i + W}$

$$0.36 = 0.25v^2$$

$$v = \sqrt{0.36/0.25} = 1.2\text{m/s}$$

2b. Same setup as before. If the coefficient of kinetic friction between block and table is μ_K=0.2, how far will the block go before stopping?

Initial Energy

KE 0

PE 0.36J

Final Energy

KE 0

PE 0

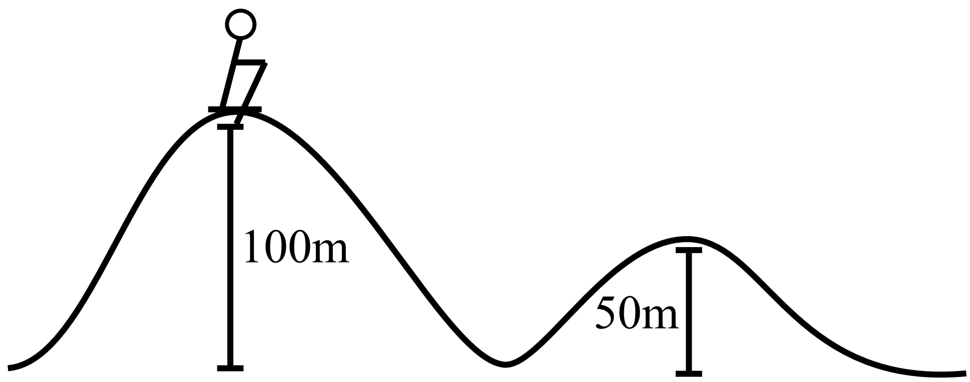
Work ***W***

$$F = \mu_K N = \mu_K mg$$
$$= (0.2)(0.5)(9.8) = 0.98$$
$$W = -F\Delta x = -0.98\Delta x$$

Solve $E_f = E_i + W$

$$0 = 0.36 - 0.98\Delta x$$
$$\Delta x = 0.36/0.98 = \mathbf{37cm}$$

3. A 50kg skiier starts from rest at the top of a hill. How fast is she moving at the top of the second hill? (Assume no friction.)



Initial Energy

KE 0

PE $= mgh$
$= (50)(9.8)(100)$
$= 49{,}000\text{J}$

Work ***W*** 0

Final Energy

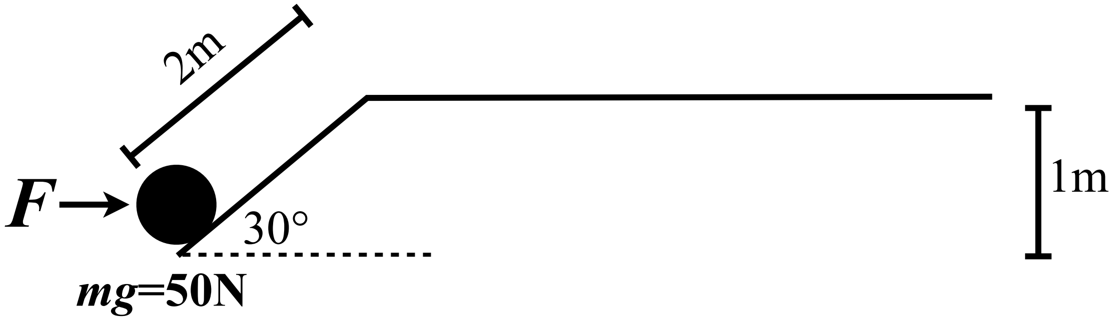
KE $\tfrac{1}{2}mv^2 = 25v^2$

PE $= mgh$
$= (50)(9.8)(50)$
$= 24{,}500\text{J}$

Solve $E_f = E_i + W$

$$25v^2 + 24500 = 49000 + 0$$
$$v^2 = 24500/25 = 980$$
$$v = \sqrt{980} = \mathbf{31.3m/s}$$

4. What is the minimum force required to push this bowling ball (weight mg=50N) 2 meters to the top of the ramp?



Initial Energy

KE 0

PE $(mg)h$

$-(50\text{N})(1\text{m})$

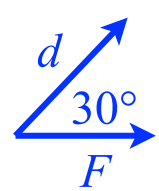
$=-50$

Final Energy

KE 0 (minimum)

PE 0

Work ***W*** $F(2\text{m})\cos 30° = 1.73F$

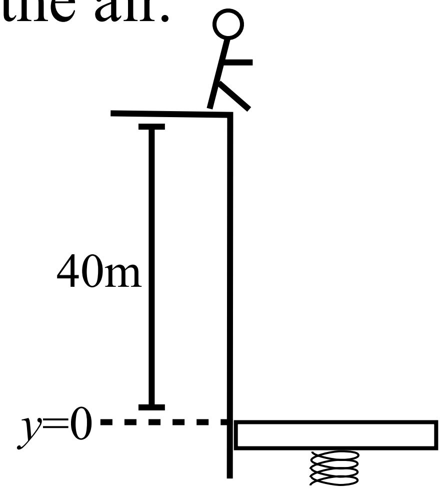


Solve $E_f = E_i + W$

$0 = -50 + 1.73F$

$F = 50/1.73 = \mathbf{29N}$

5. An 80kg man falls 40m and lands on a spring with stiffness k=4000 N/m. The spring compresses by Δy before bouncing him back into the air. Find Δy.



Initial Energy

KE 0

PE_G $= mgh$

$= (80)(9.8)(40)$

$= 31360$

PE_S 0

Final Energy

KE 0

PE_G $-mg\Delta y = -784\Delta y$

PE_S $\frac{1}{2}k(\Delta y)^2 = 2000(\Delta y)^2$

Solve $E_f = E_i$

$$2000(\Delta y)^2 - 784\Delta y = 31360$$

$$2000(\Delta y)^2 - 784\Delta y - 31360 = 0$$

$$\Delta y = \frac{784 \pm \sqrt{784^2 - 4(2000)(-31360)}}{4000}$$

$$\Delta y = \{\mathbf{0.40m}, \cancel{-0.005m}\}$$