Potential Energy U=mgy

$V_f=0$

$F=-mg$

h

+y

V_0

$W=-mgh=\Delta K$

Initial velocity V_0
What is h ?

$mgh=mgy_2-mgy_1=U_2-U_1$
$=\Delta U$

$W=-\Delta U=\Delta K$

$V_f = 0$

$F = -mg$

$W = -mgh = \Delta K$

V_0

h
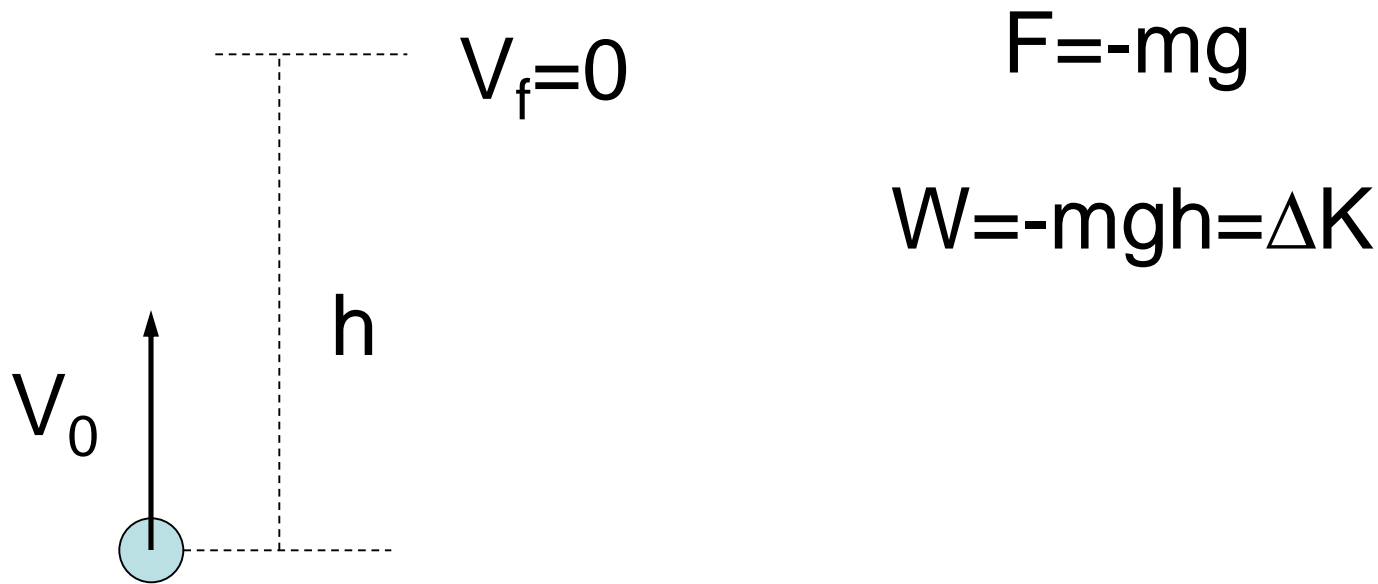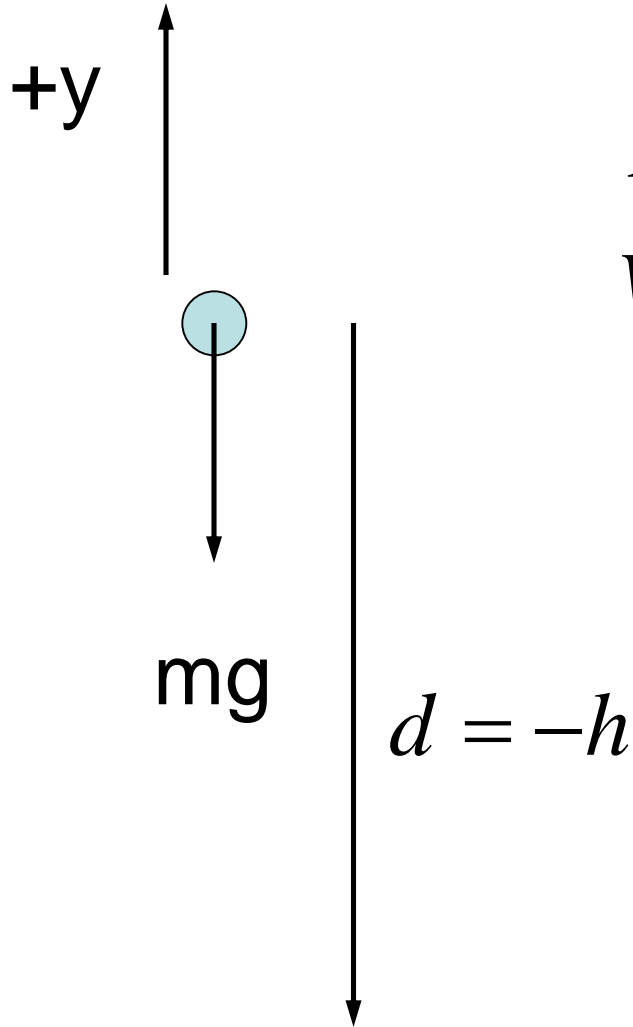
$$\Delta K = \frac{1}{2}mV_f^2 - \frac{1}{2}mV_0^2 = -\frac{1}{2}mV_0^2$$

$$-mgh = \Delta K = \frac{1}{2}mV_f^2 - \frac{1}{2}mV_0^2 = -\frac{1}{2}mV_0^2$$

$$V_0^2 = 2gh \quad (h = \frac{V_0^2}{2g})$$

$-\Delta U = \Delta K$

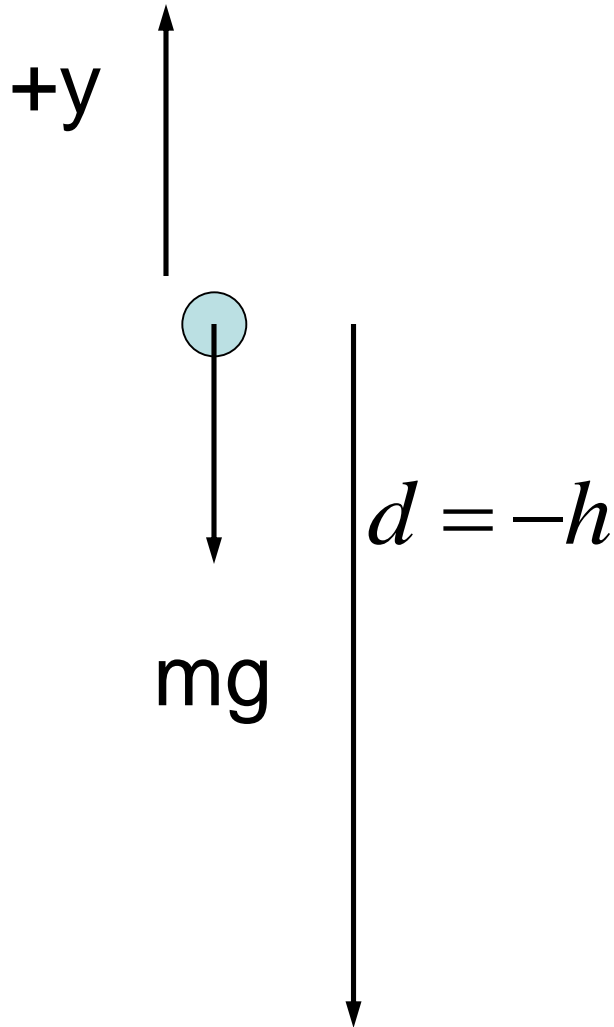# Ex: Drop a mass (gravity does work)

+y

$$F = -mg \ , \ d = -h$$

$$W = (-mg)(-h) = mgh = \Delta K$$

mg

$$d = -h$$

Ex: Drop a mass (gravity does work)

+y

mg

$d = -h$
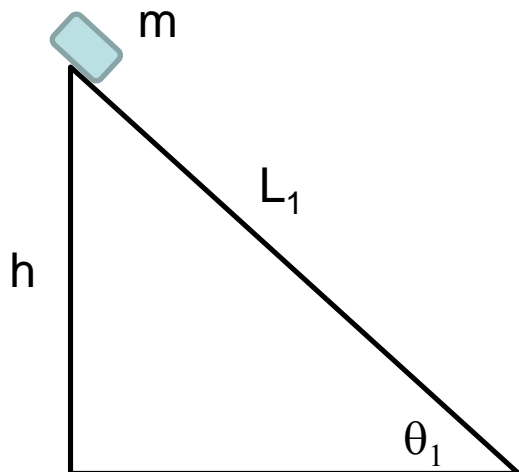
$$F = -mg \, , \, d = -h$$

$$W = \vec{F} \cdot \vec{d} = +mgh = K_f - K_i$$

$$= \frac{1}{2}mV_f^2 - \frac{1}{2}mV_0^2$$

W=-ΔU=ΔK

No Friction. Initially at rest.

m

L_1

h

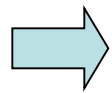θ_1

V_{1f}=?
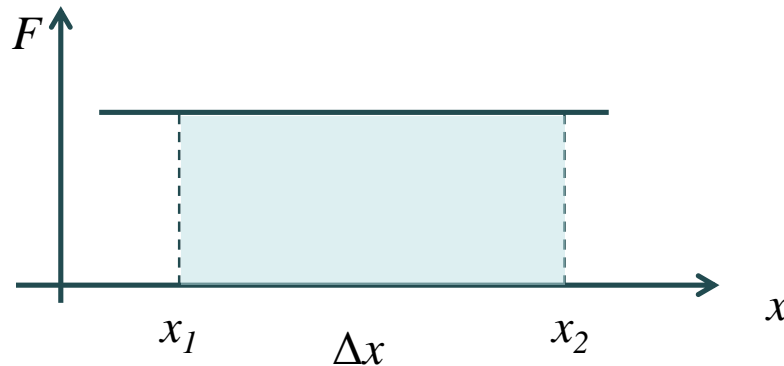
m

L_2

h

θ_2
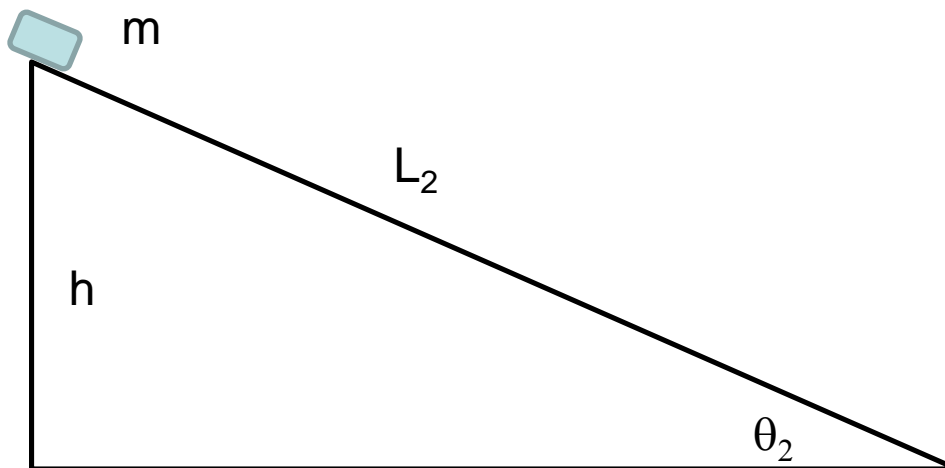
V_{2f}=?

$$U_1 + K_1 = U_2 + K_2$$

$$U = mgy$$

Work done by a constant force

$$W = \vec{F} \cdot \Delta\vec{x}$$

Work done by a changing force

$$W = \int_{1}^{2} F(x)\,dx$$
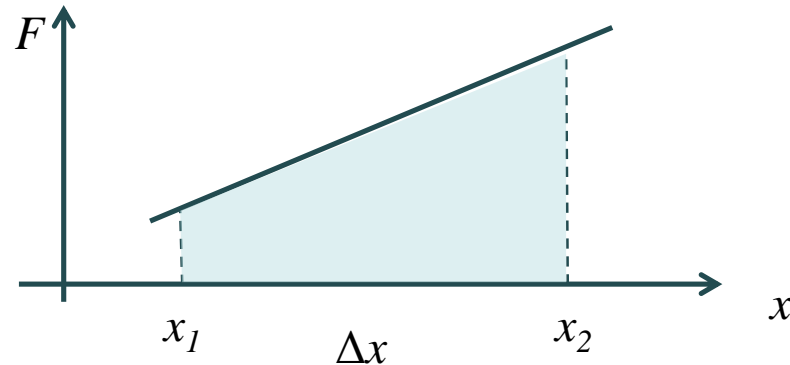
The engine of a 1000 kg sports car rotates the tires, creating a net forward pushing force F on the tires of the car that varies as a function of distance. The force is shown below. If the car starts at rest, what is the speed of the car after traveling 500 meters?

$1 \times 10^4 \ N$

Force

0

distance

500 m

1. 0 m/s
2. 71 m/s
3. 100 m/s
4. 141 m/s
5. 200 m/s

Work done by the spring force

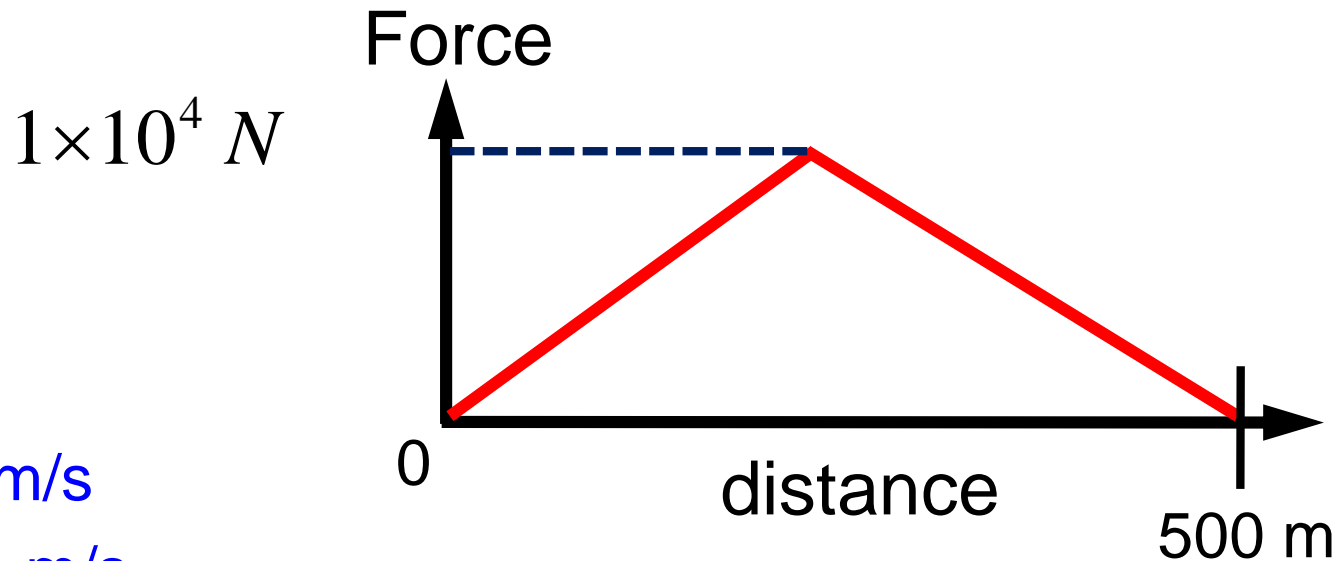Spring (Hooke's law)   F=-k(x-x$_0$)   *Force of spring on mass m.*

(x-x$_0$): displacement

x$_0$=0   x$_1$ x$_2$

+x
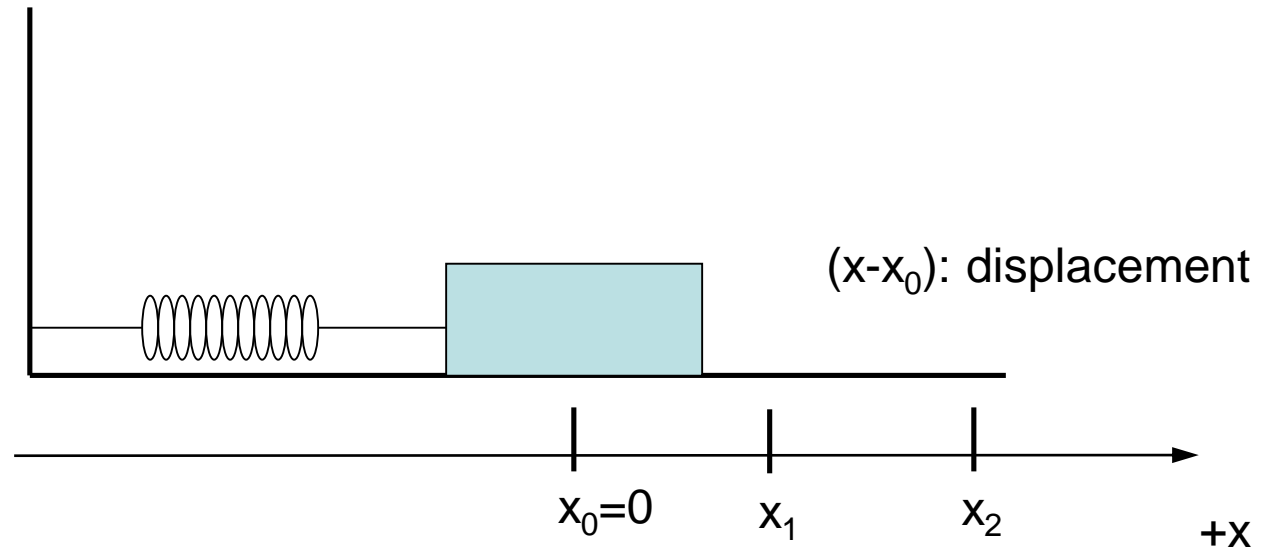
x_0 is where the spring is fully relaxed or balanced, which is usually set to be 0. Ignore all frictions.

$$W_{12} = \int_{x_1}^{x_2} F(x)dx = \int_{x_1}^{x_2} -kx\,dx = -\frac{1}{2}kx^2 \Big|_{x1}^{x2}$$

$$= \frac{1}{2}kx_1^2 - \frac{1}{2}kx_2^2 \quad (Set\ x_0 = 0)$$

The spring is relaxed at x_0. The block is pushed against the spring to x_1 and held stationary (the spring is compressed.) Then the block is released. What is the block's velocity at x_2?
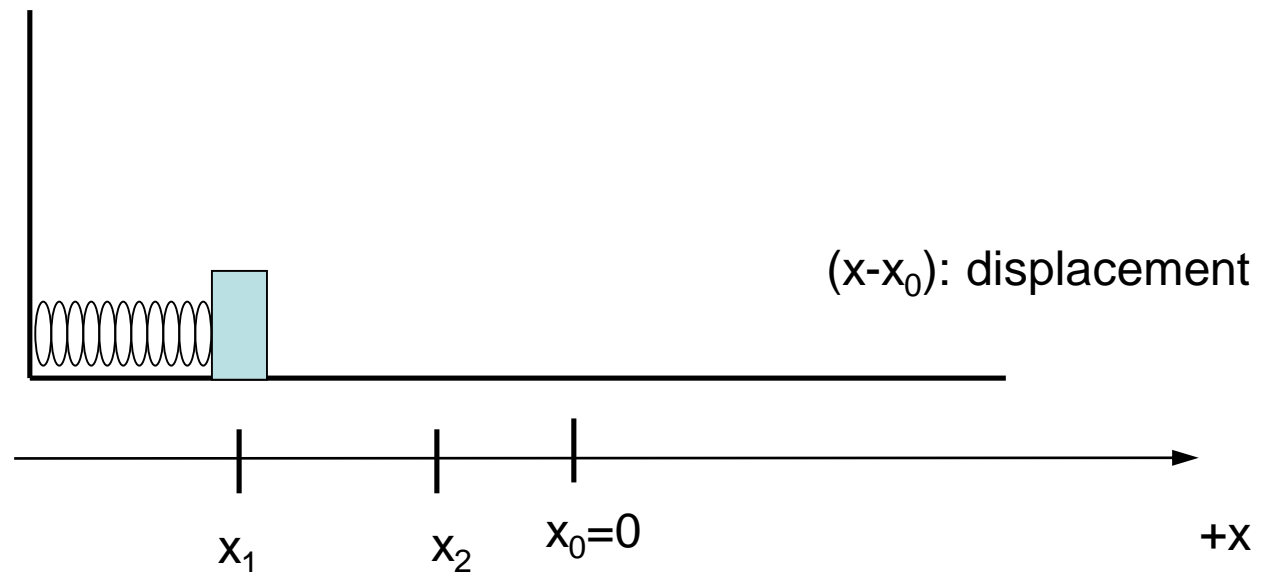
$F=-k(x-x_0)$ $\mu=0$, m=10 kg, x_1=-0.5m, x_2=-0.2m, k=200N/m

(x-x_0): displacement

x_1 x_2 x_0=0   +x

$$W_{12} = \frac{1}{2}kx_1^2 - \frac{1}{2}kx_2^2 = \frac{1}{2}k(x_1^2 - x_2^2) = \frac{1}{2}200(0.5^2 - 0.2^2) = 21(J)$$

$$W_{net} = \Delta K = K_2 - K_1 = \frac{1}{2}mV_2^2 - \frac{1}{2}mV_1^2$$

The spring is relaxed at x_0. The block is pushed against the spring to x_1 and held stationary (the spring is compressed.) Then the block is released. What is the block's velocity at x_2?
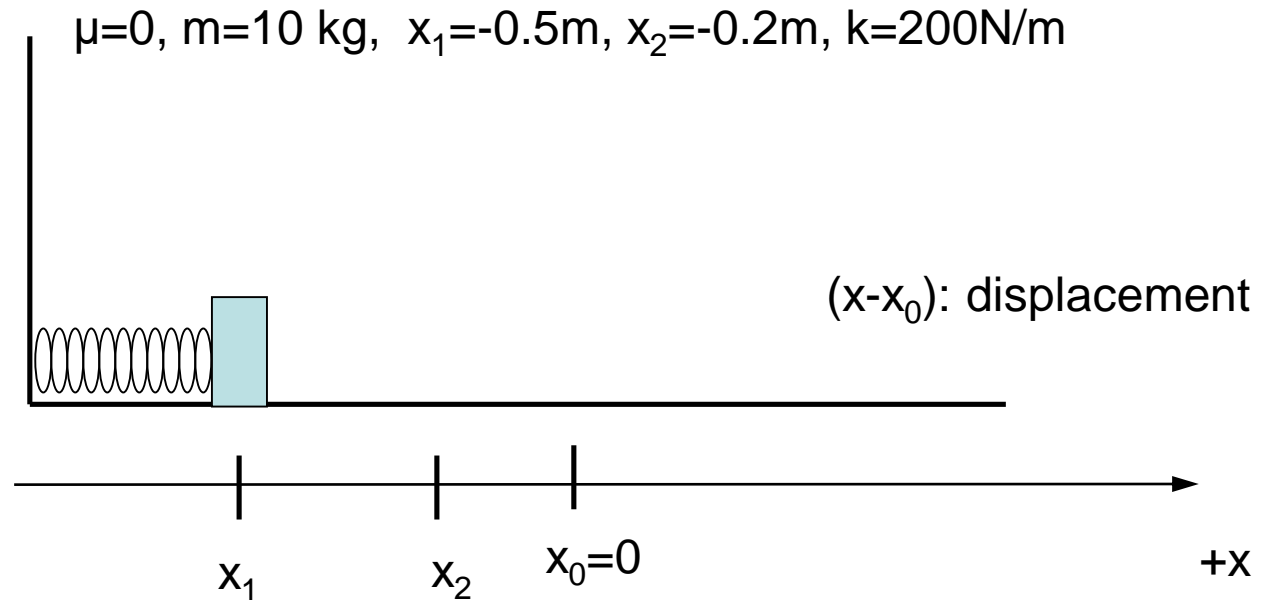
μ=0, m=10 kg, x_1=-0.5m, x_2=-0.2m, k=200N/m

(x-x_0): displacement

x_1 x_2 x_0=0   +x

$$W_{12} = \frac{1}{2} k x_1^2 - \frac{1}{2} k x_2^2 = \frac{1}{2} k(x_1^2 - x_2^2) = \frac{1}{2} 200(0.5^2 - 0.2^2) = 21J$$

$$W_{net} = \Delta K = K_2 - K_1 = \frac{1}{2} m V_2^2 - \frac{1}{2} m V_1^2 = \frac{1}{2} m V_2^2 = 21J$$

$$V_2 = \sqrt{\frac{2 \times 21J}{10kg}} = 2.02 \, m/s$$

Work done by the spring force

F (+), Δx (+) => W (+)   F (-), Δx (-) => W (+)

V_{max}

V=0 ⟶   ⟵ V=0

$-X_{max}$ x=0 X_{max}

a=+a_{max} a=0   a=-a_{max}

F (+), Δx (-) => W (-)   F (-), Δx (+) => W (-)

V_{max}

V=0 ⟵   ⟶ V=0

$-X_{max}$ x=0 X_{max}