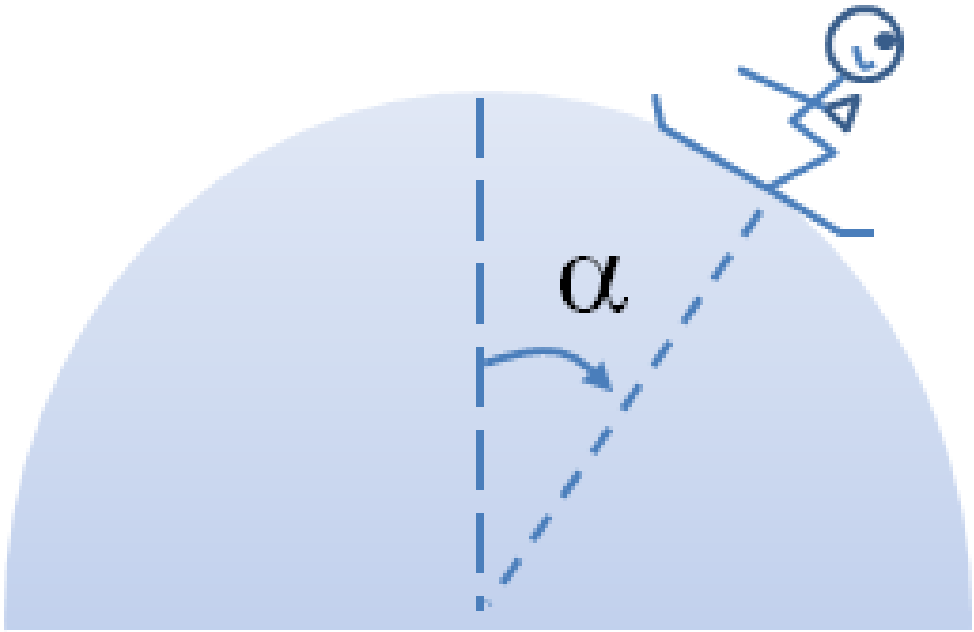
Note:

Supplementary HW #3



Challenge question: Existence of friction

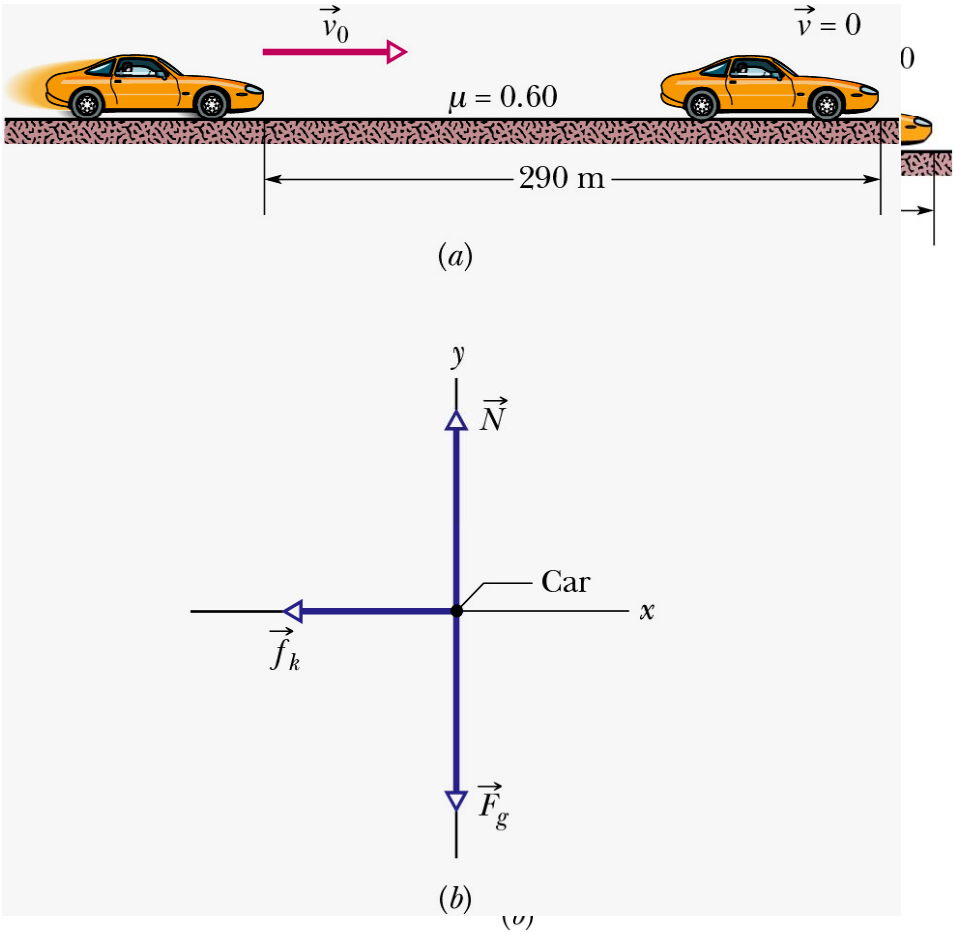
Special Case:

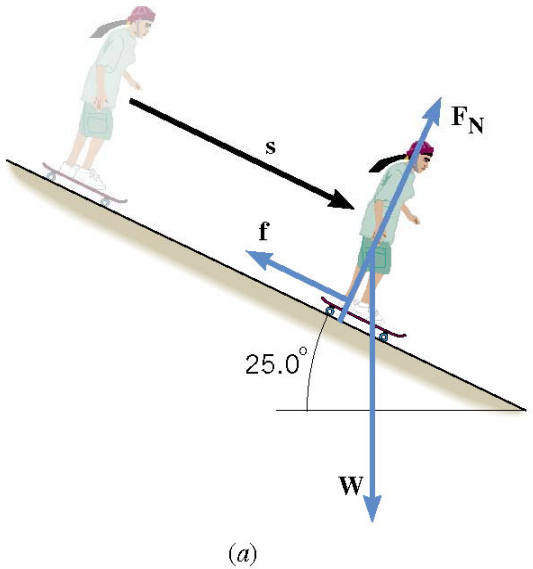
Work due to Friction:

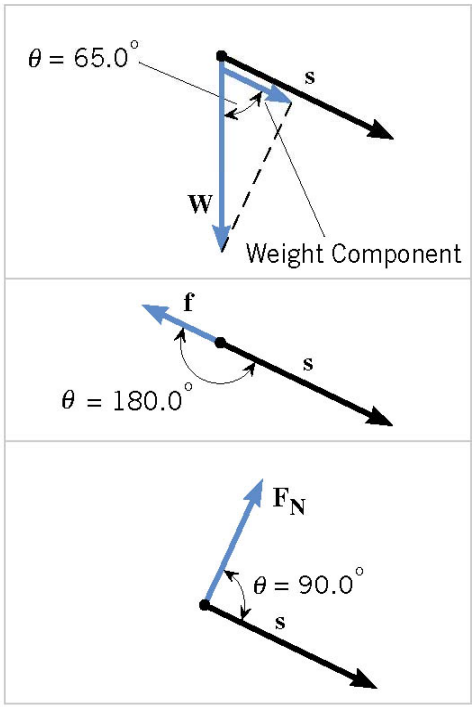
WORK due to friction is ALWAYS NEGATIVE

- Energy is transferred OUT
- Kinetic energy decreases or $\Delta KE < 0$ (slow down)

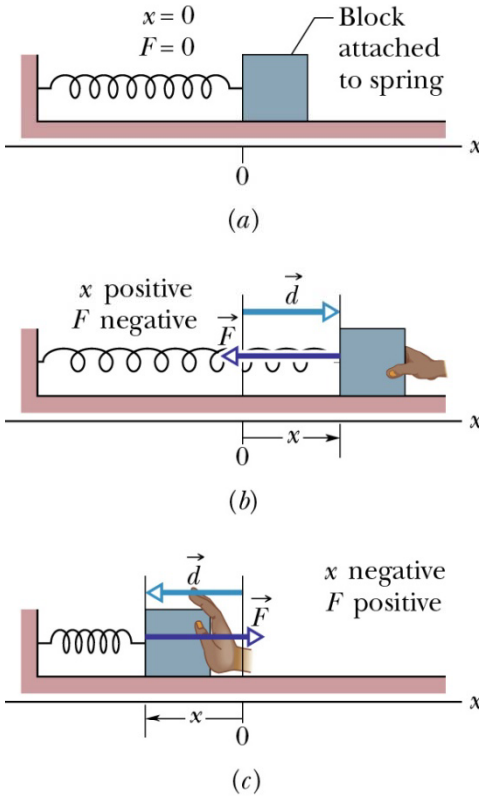
Where did the energy go? THERMAL/Sound







Special Case: Work done by a Spring Force



Hooke's Law
variable force ➡ $\vec{F} = -k\vec{d}$

$\vec{F}$ = force from the spring

k = spring constant (*stiffness*) - units [N/m]

$\vec{d}$ = displacement from equilibrium ($x = 0$)

Note: the force is always directed to "restore" the equilibrium position

Work- Spring force

$$W_{spring} = \int \vec{F}_{spring}(x) \cdot d\vec{x}$$

$$= \int_{x_1}^{x_2} (-kx)\,dx = -k\int_{x_1}^{x_2} x\,dx$$

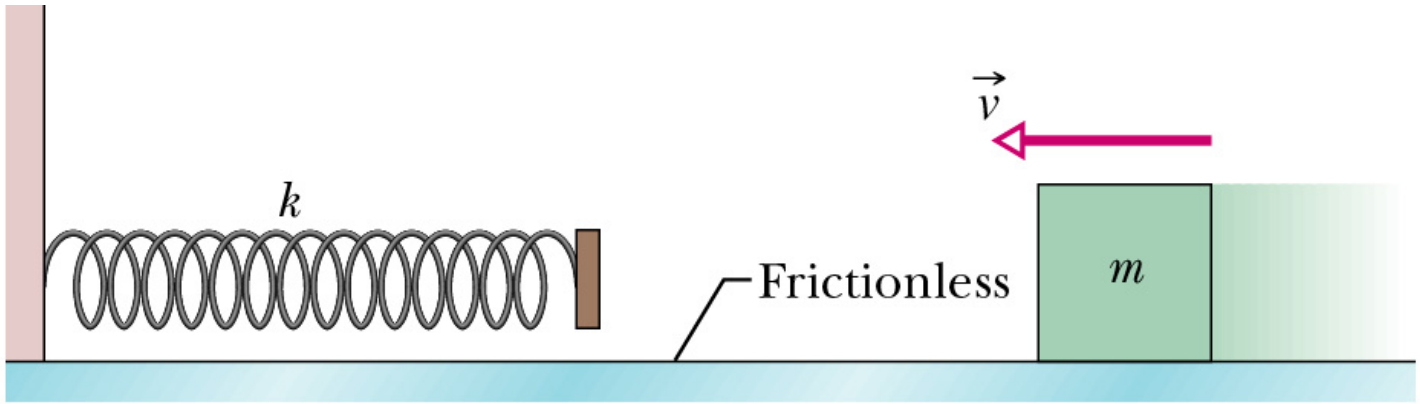
$$= \left(-\tfrac{1}{2}k\right)\left[x^2\right]_{x_1}^{x_2} = -\tfrac{1}{2}k\left(x_2^2 - x_1^2\right)$$

$$W_{spring} = -\tfrac{1}{2}k\left(x_2^2 - x_1^2\right)$$

Note: Work done by spring is positive (negative) if bock moves towards (away) equilibrium position. It is zero if the block ends up at the same distance from x=0

Sample Problem 7-8

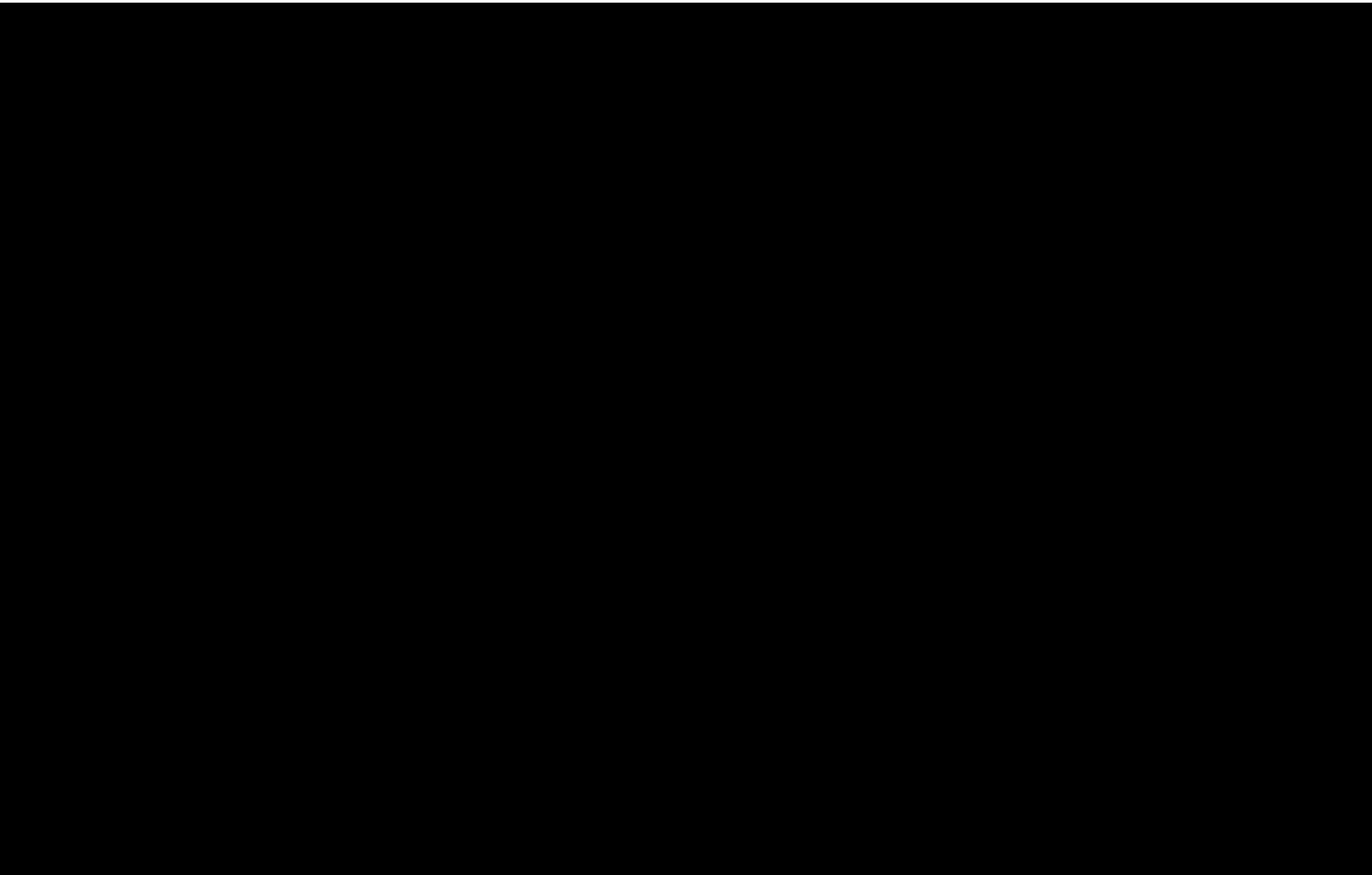
A block of mass **m** slides across a horizontal frictionless counter with speed $\mathbf{v_0}$. It runs into and compresses the spring of spring constant k. When the block is momentarily stopped by the spring, by what distance d is the spring compressed?



Work by Spring force: $W_{spring} = \frac{1}{2}kx_i^2 - \frac{1}{2}kx_f^2$

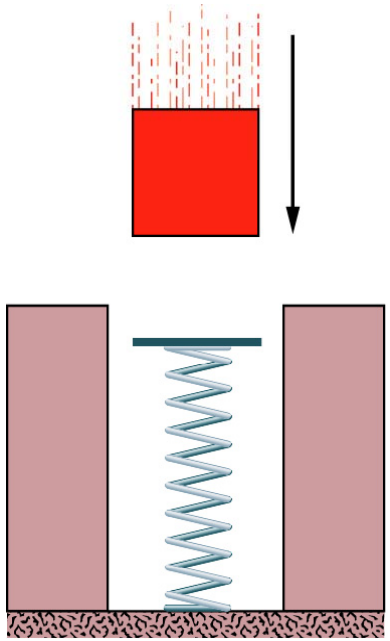
Work-Kinetic Energy theorem: $W_{net} = \Delta KE$

Demo



Problem 7-54

A block of mass **m** is dropped onto a spring. The block becomes attached to the spring and compresses it by distance **d** before momentarily stopping.



While the spring is compressed, what work is done on the block by:
a) the gravitational force on it
b) the spring force?
c) What is the speed of the block just before it hits the spring?

Work by Gravitational force: $W_g = \vec{F}_g \cdot \vec{d}$

Work by Spring force: $W_{spring} = \frac{1}{2}kx_i^2 - \frac{1}{2}kx_f^2$

Work-Kinetic Energy theorem: $W_{net} = \Delta KE$

d) From what height **h** was the box dropped?