March 22, Week 9

Today: Chapter 7, Elastic Potential Energy

Homework Assignment #6 - Due Today

Mastering Physics: 9 problems from chapters 5 and 6

Written Questions: 6.73

Homework Assignment #7 - Due March 29

Mastering Physics: 6 problems from chapter 7

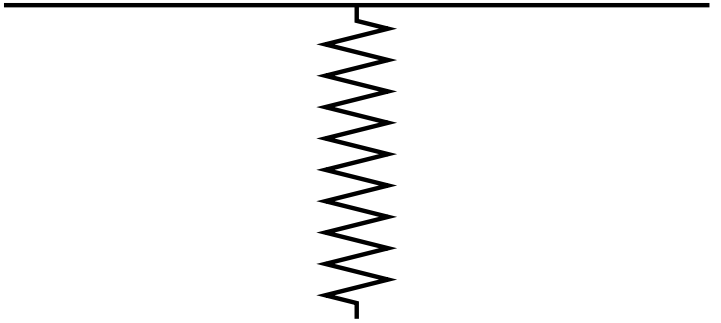
Written Questions: 7.60

Help sessions with Jonathan:

M: 1000-1100, RH 111 T: 1000-1100, RH 114
Th: 0900-1000, RH 114

Hooke’s Law

A simple example of a variable force is the force needed to stretch a spring.



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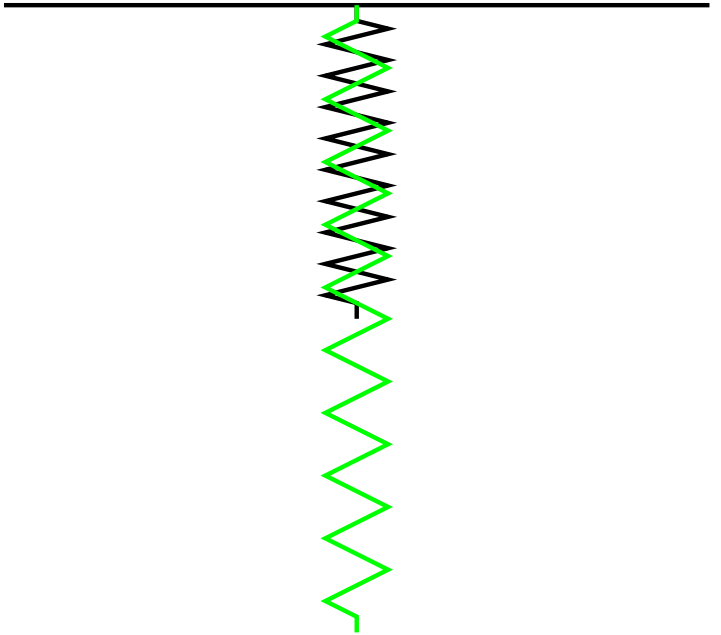

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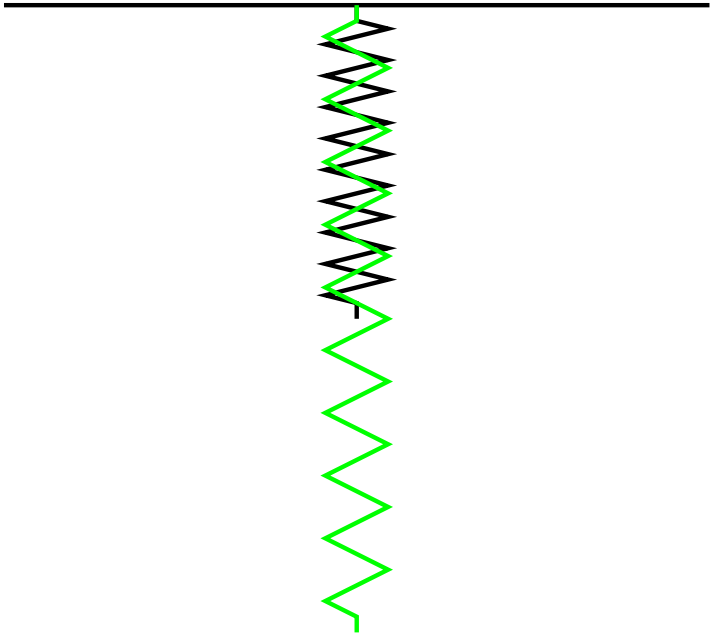

Hooke’s Law - The force needed to stretch or compress a spring increases linearly with stretching distance

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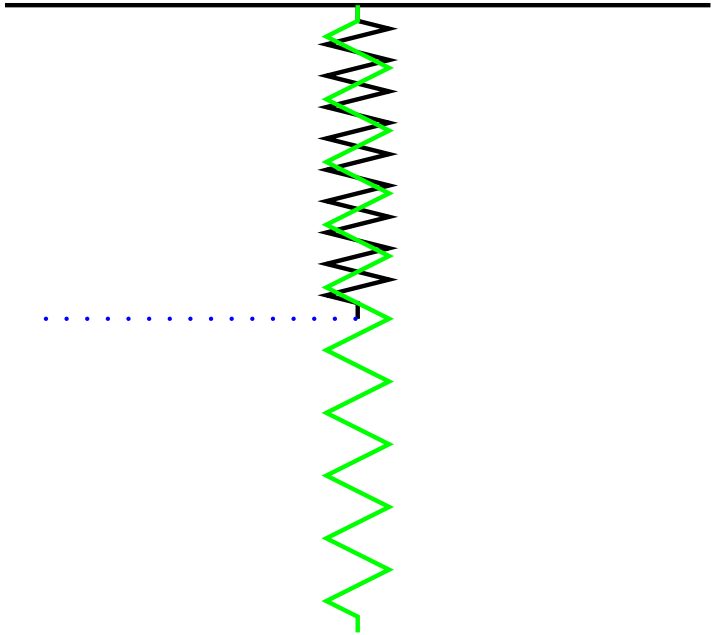

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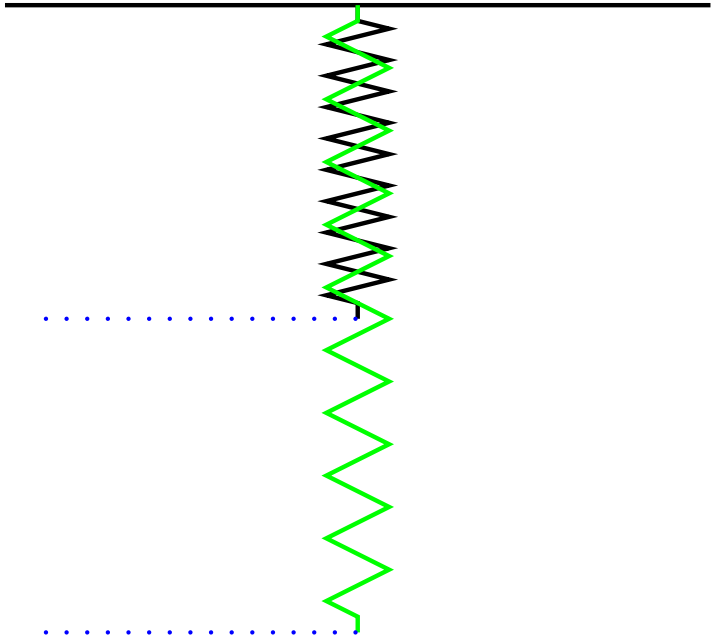

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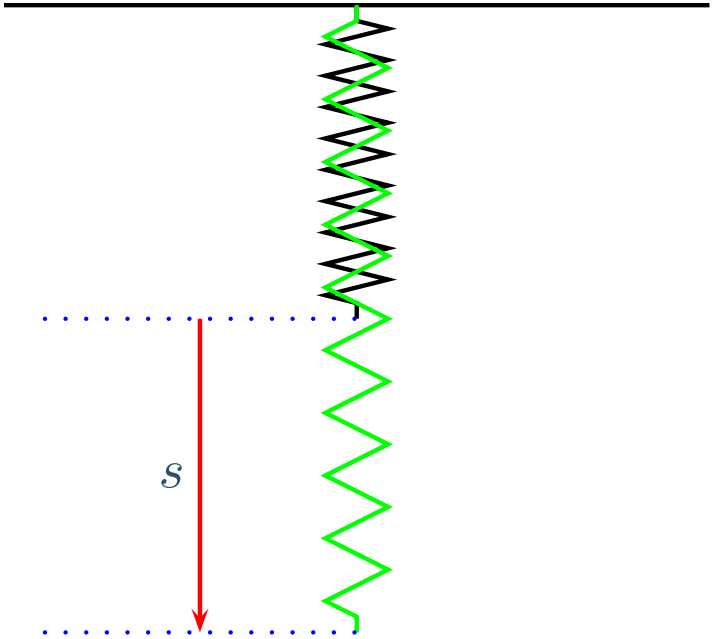

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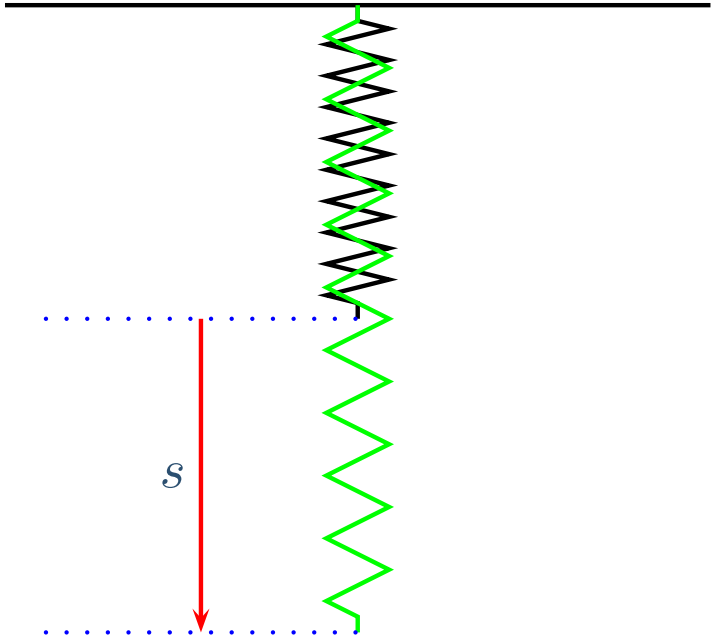

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$$F_{sp} = ks$$

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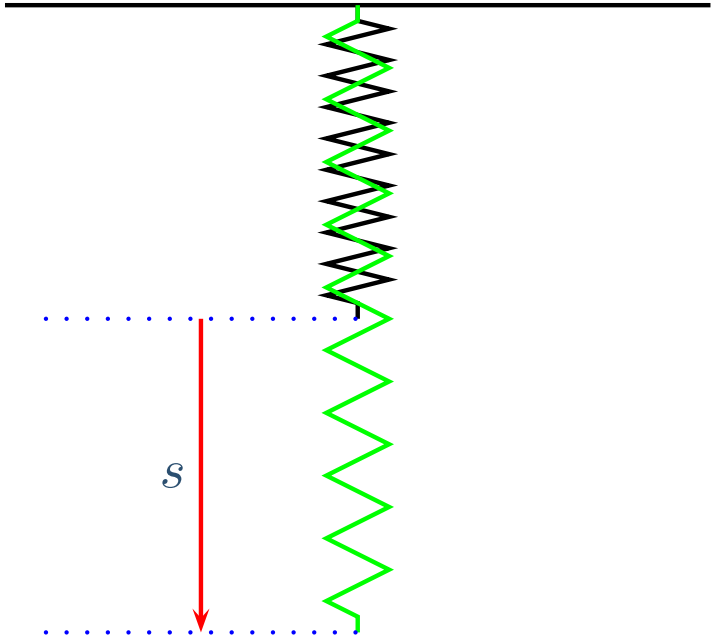

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$$F_{sp} = ks$$

k = spring constant, Unit: N/m

s = stretching distance

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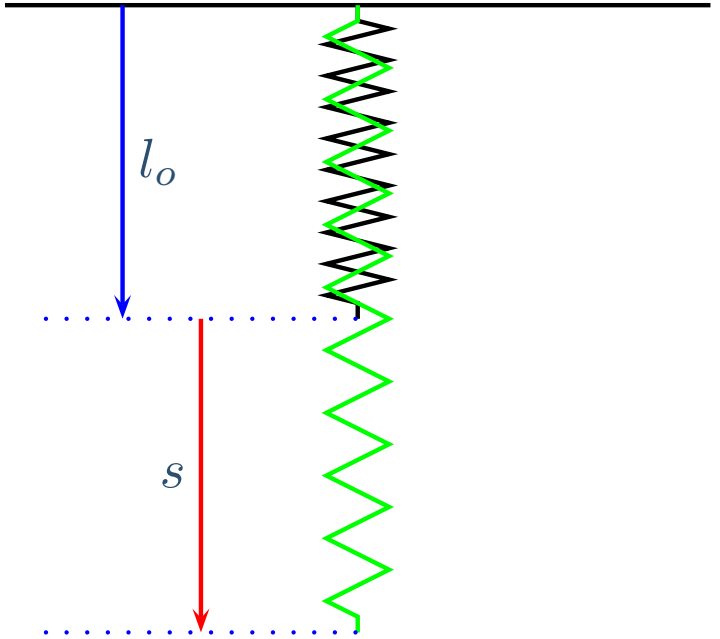

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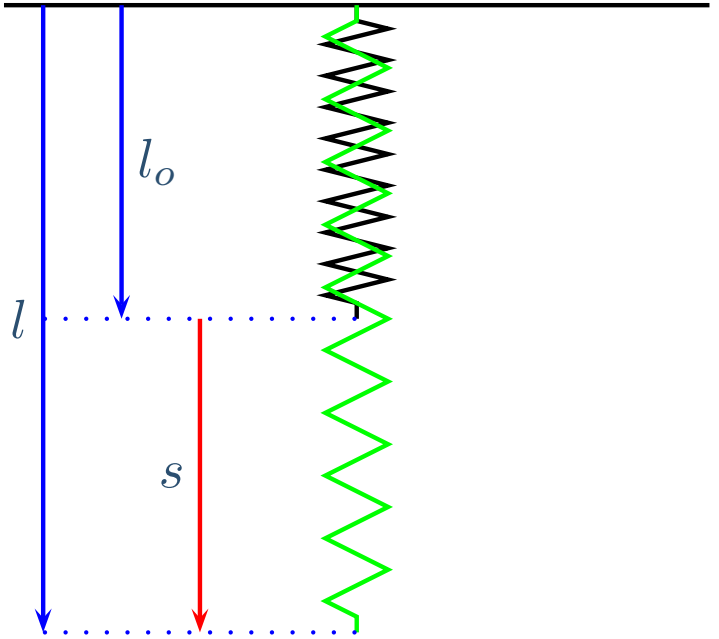

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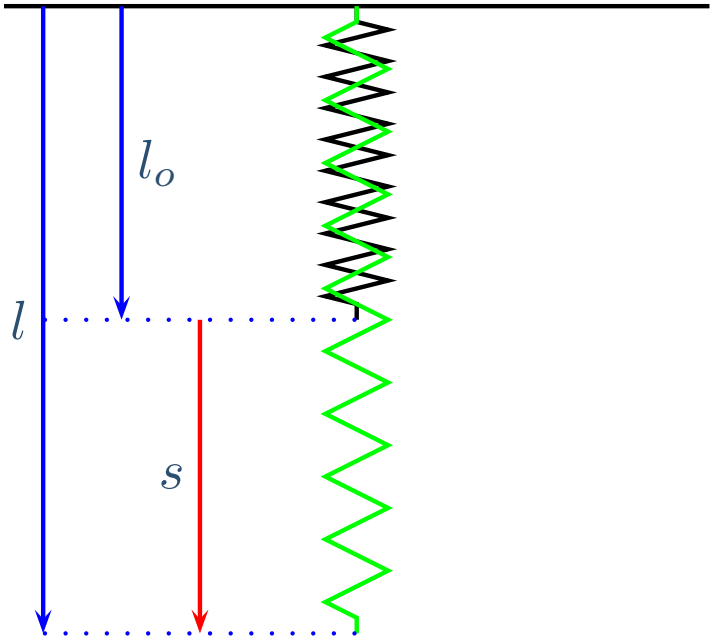

$$s = l - l_o$$

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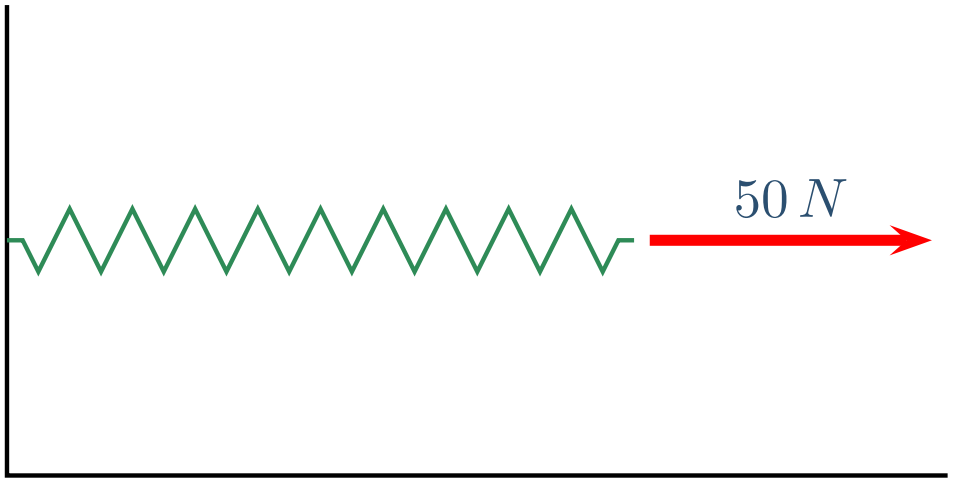
Spring Exercise

$$F_{sp} = ks$$

A horizontal $50\,N$ force is applied to a $100\,N/m$ spring whose unstretched length is $0.5\,m$. What is the spring's length after the force has been applied?



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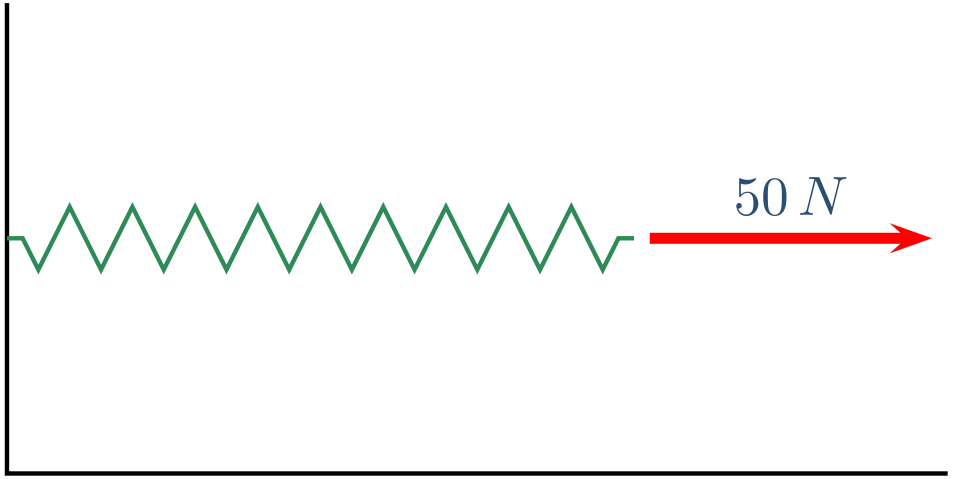
(a) $0\,m$



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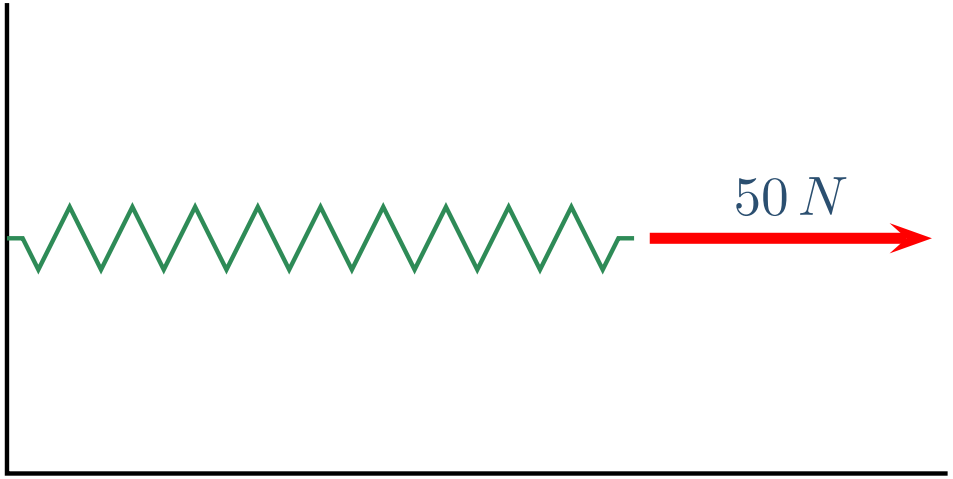

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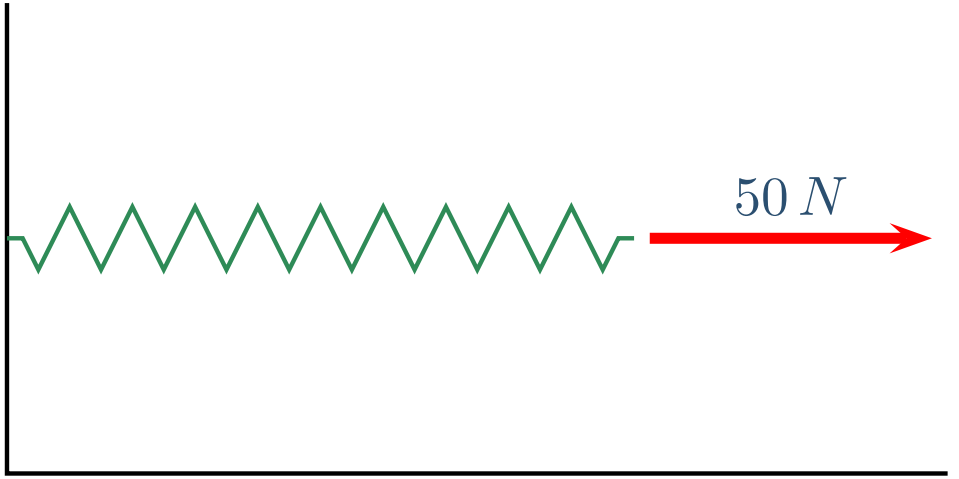
(c) $1\,m$



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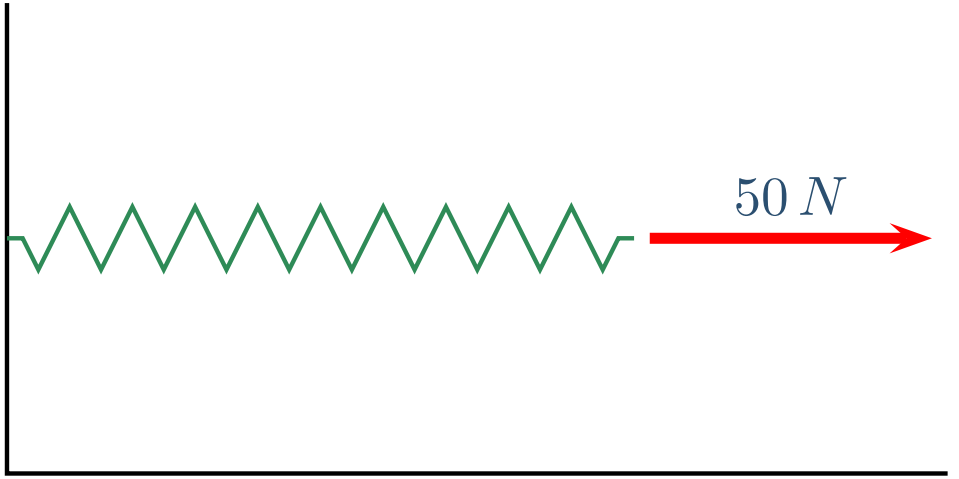

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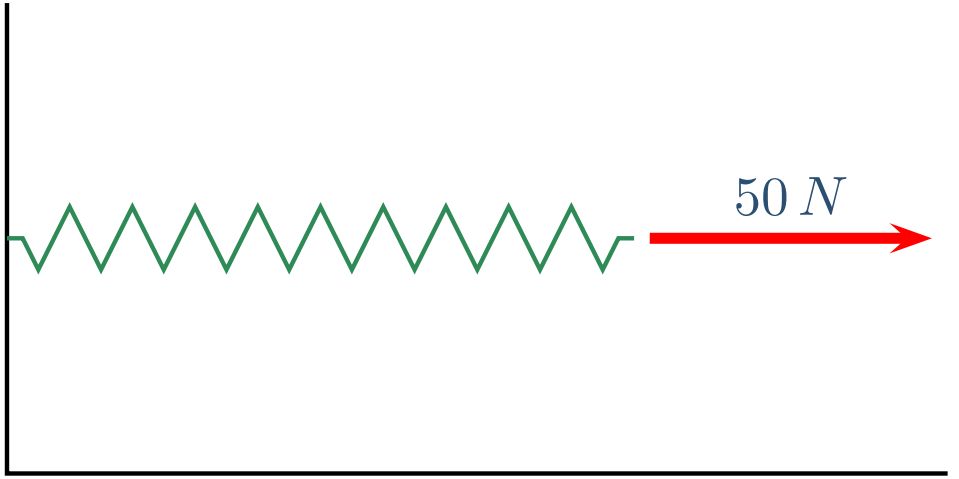

(a) $0\,m$

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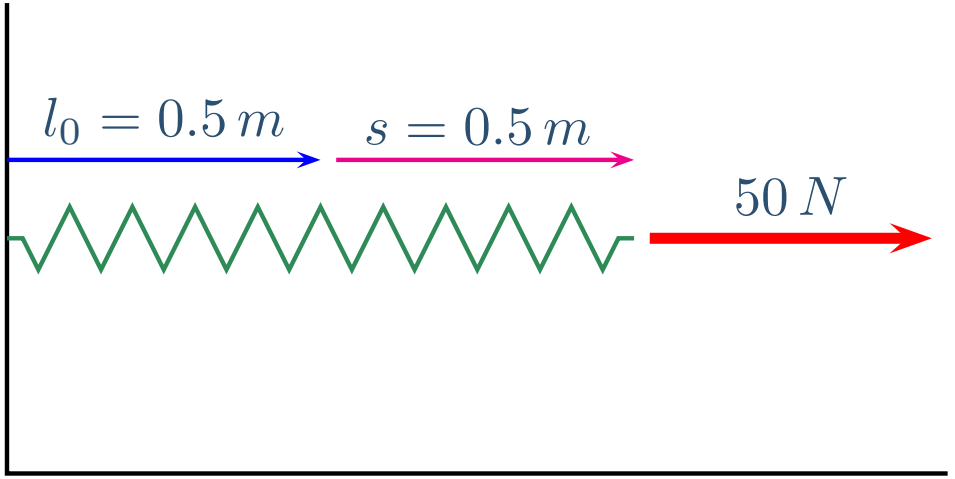

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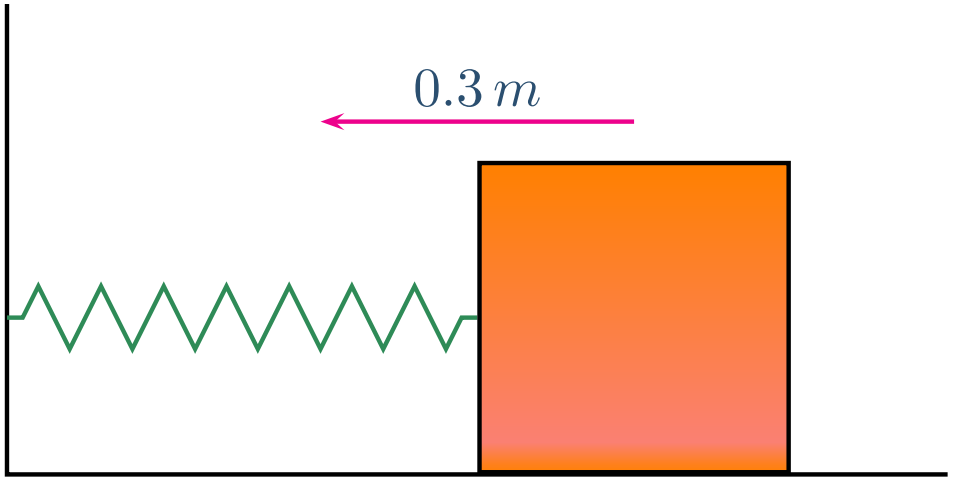
Spring Exercise II

$$F_{sp} = ks$$

A 5-kg mass is attached, as shown, to a $100\,N/m$ spring whose unstretched length is $0.5\,m$. If the mass is pushed $0.3\,m$ to the left, what is the magnitude and direction of the force exerted by the spring on the mass?



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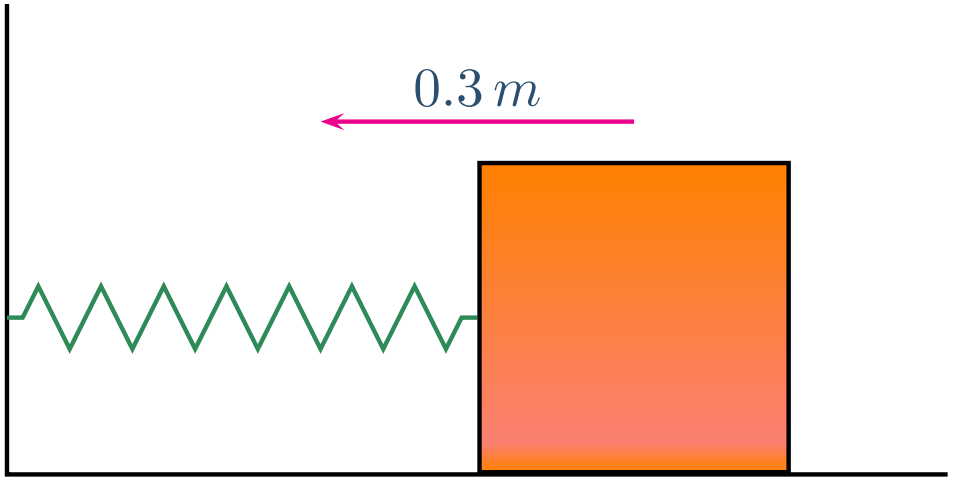

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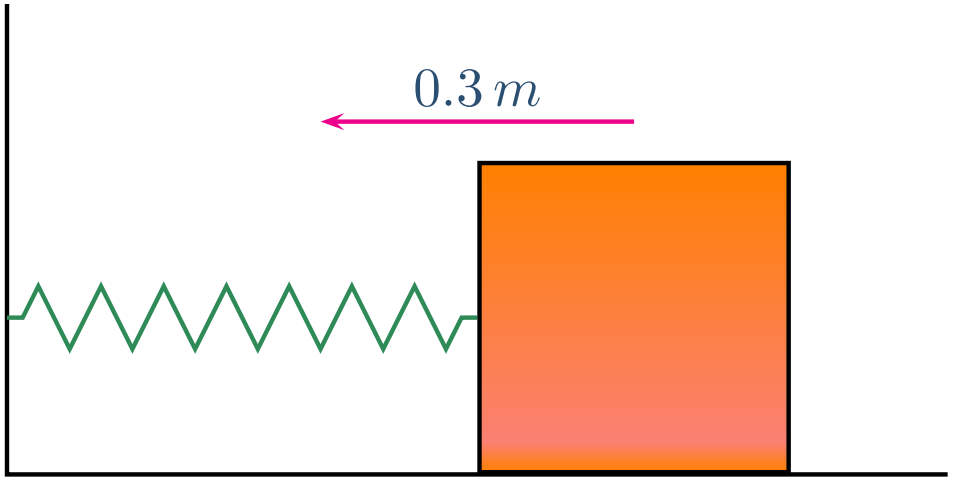
(b) $30\,N,$ Right



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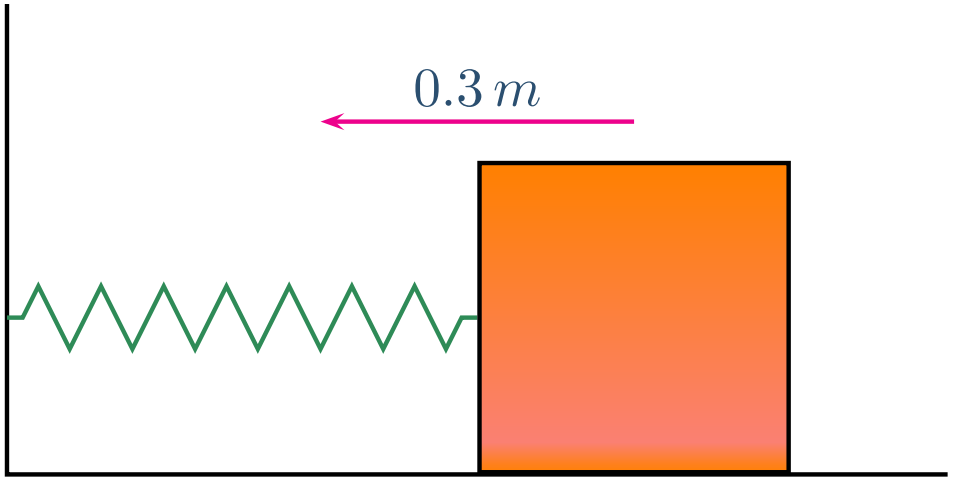
(b) $30\,N,$ Right

(c) $20\,N,$ Left



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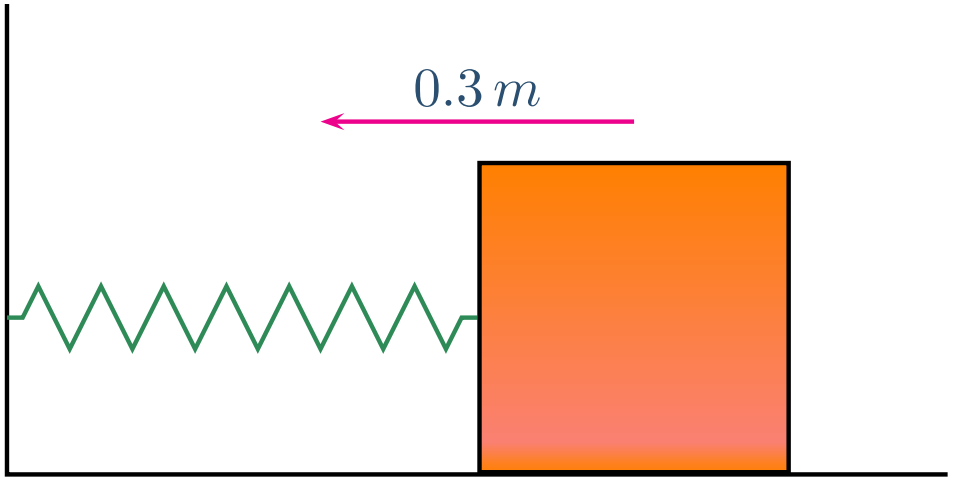

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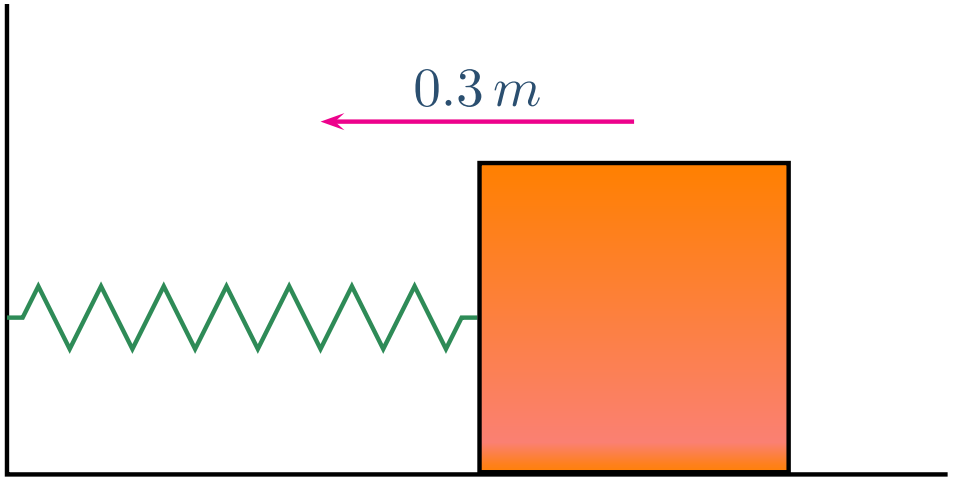

(a) $30\,N,$ Left

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(d) $20\,N,$ Right

(e) $50\,N,$ Right

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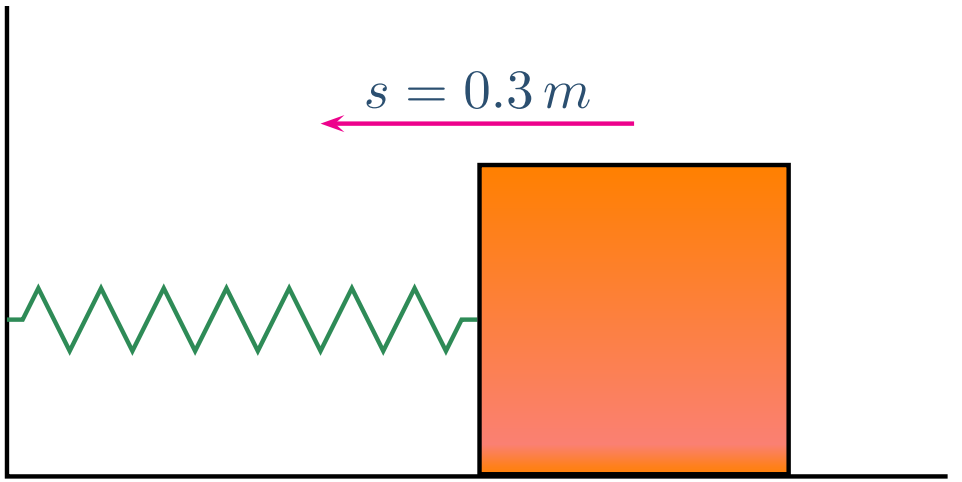
Springs can push or pull



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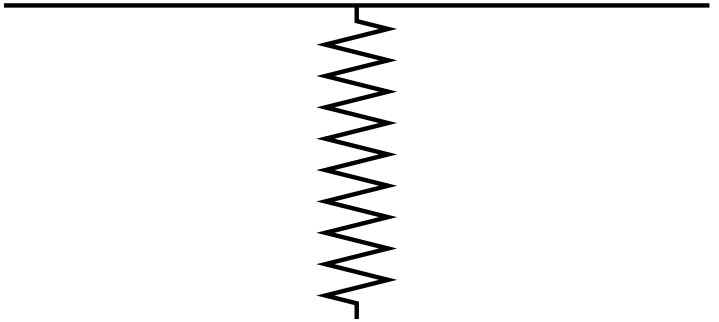
(c) $20\,N,$ Left

(d) $20\,N,$ Right

(e) $50\,N,$ Right

Work to Stretch a Spring



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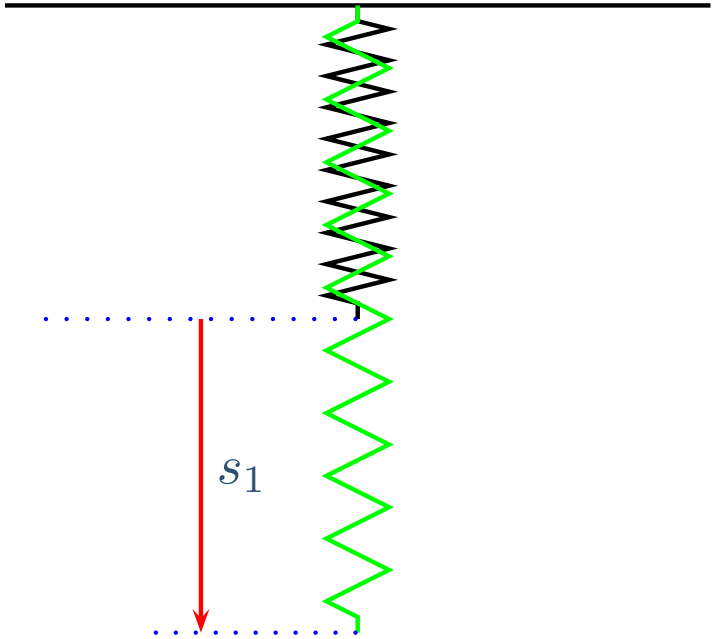

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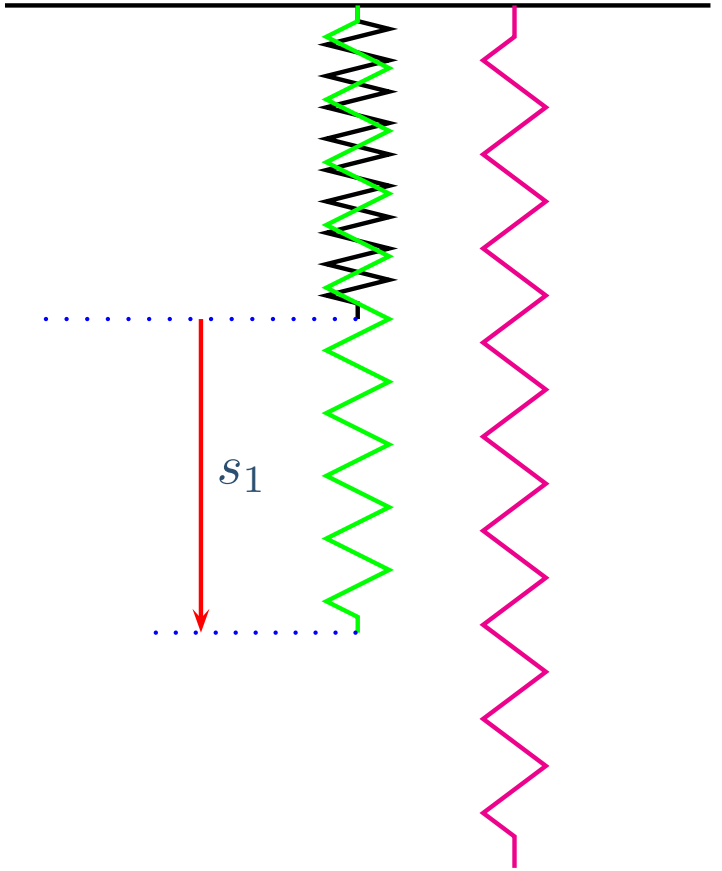

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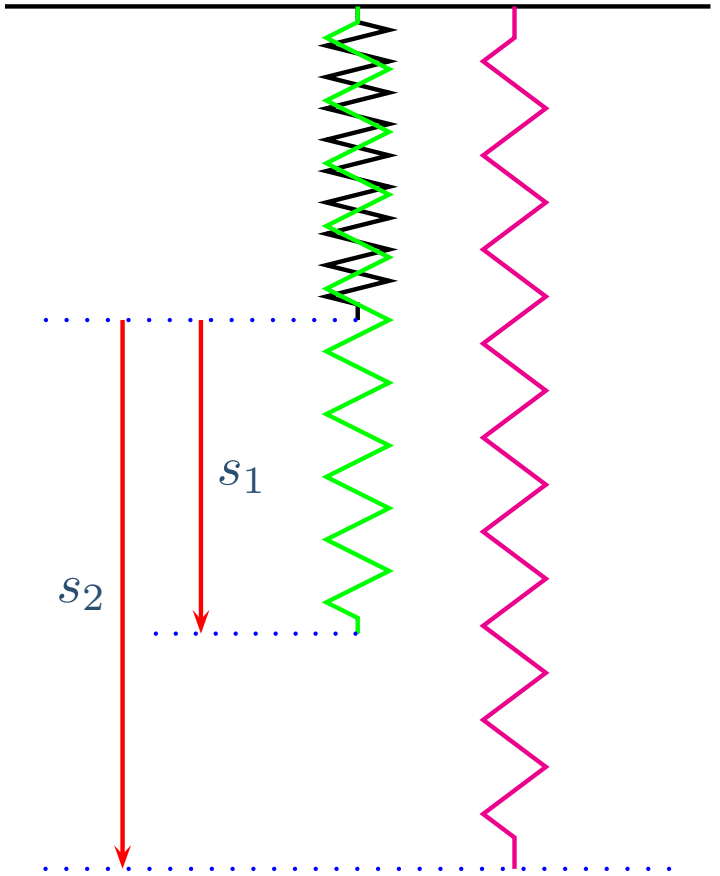

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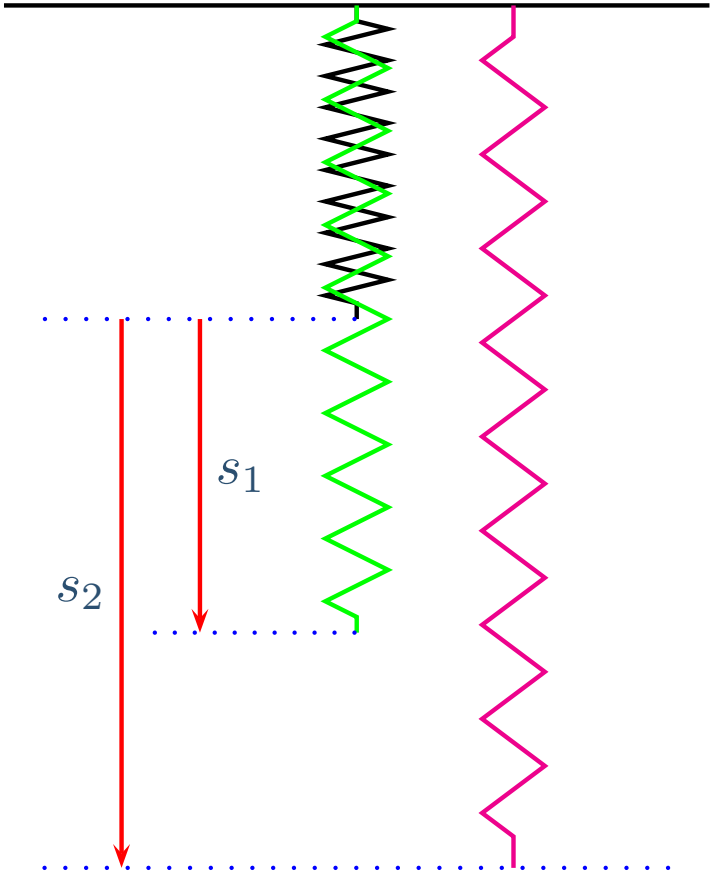

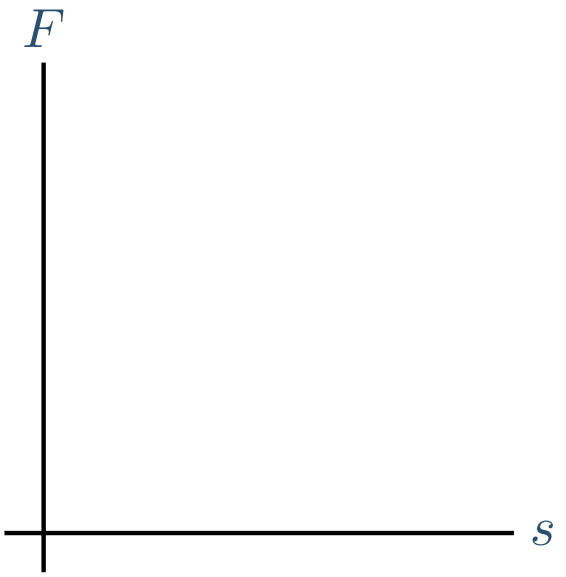

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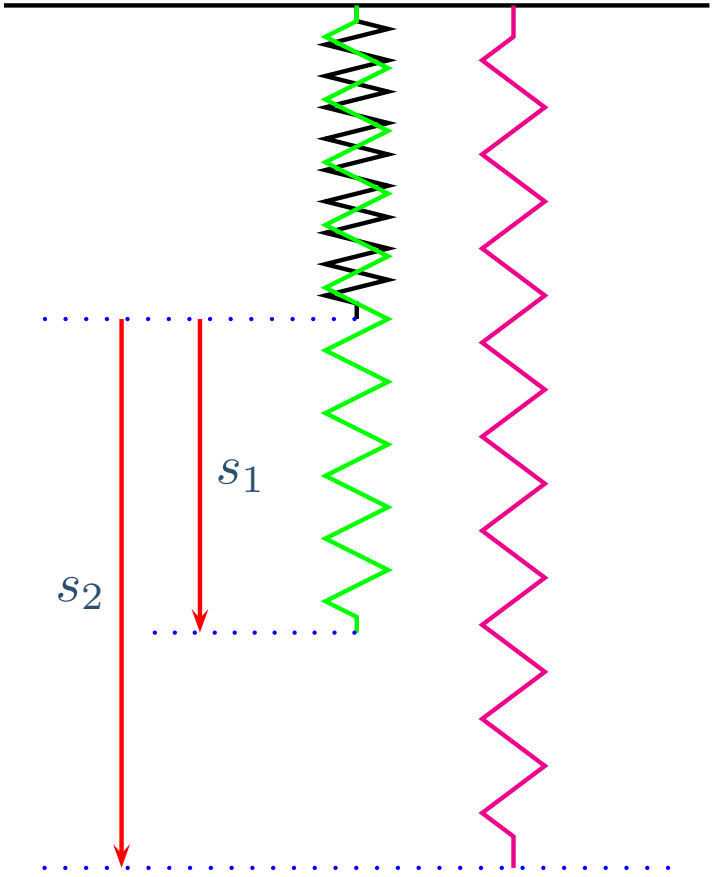

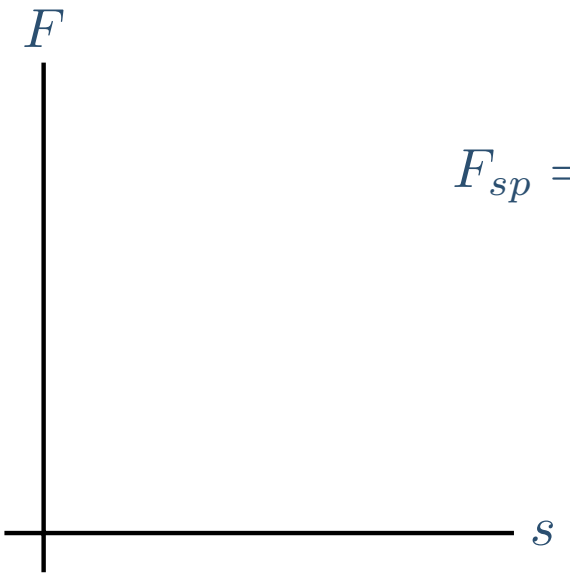

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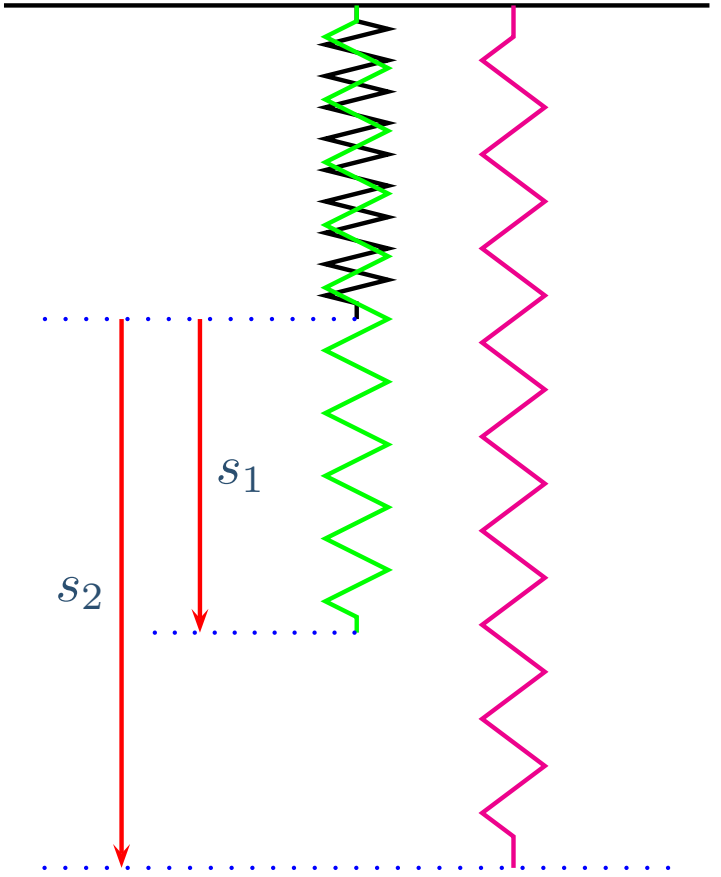

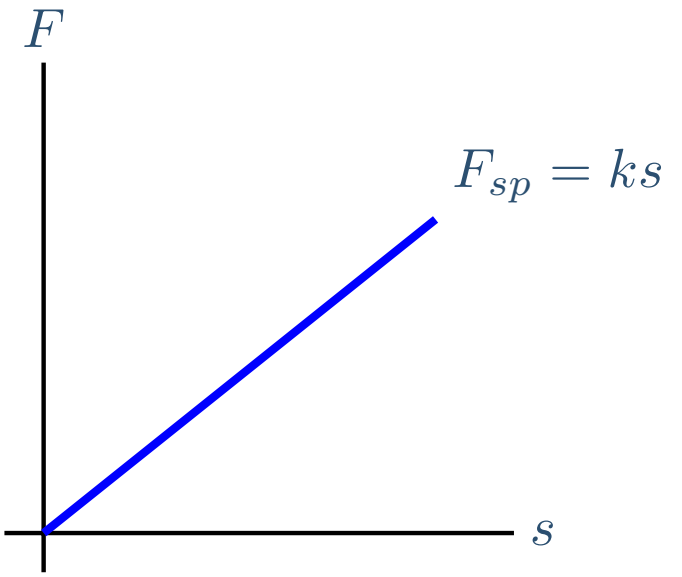

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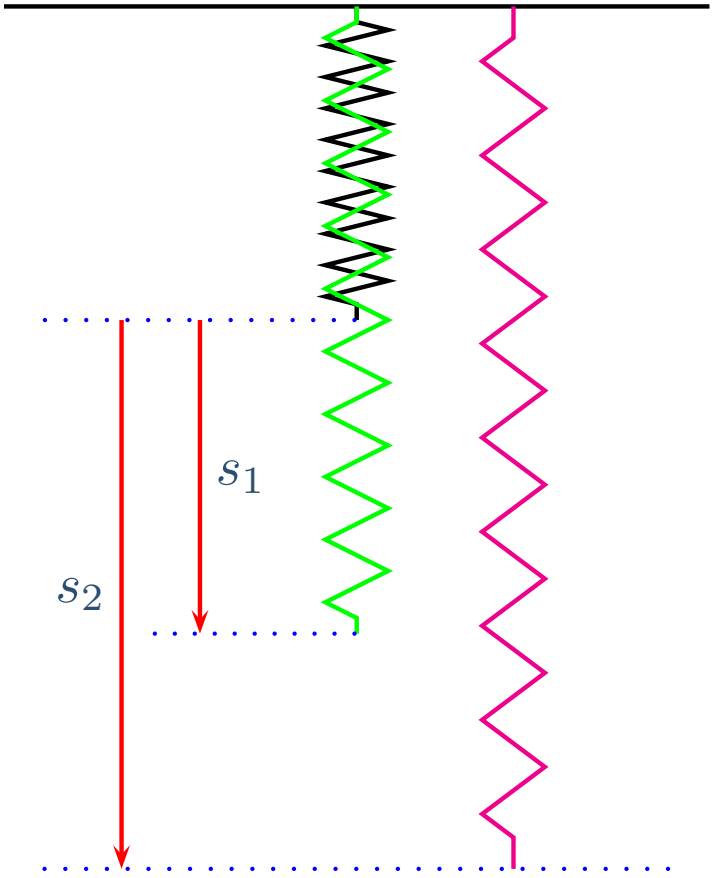

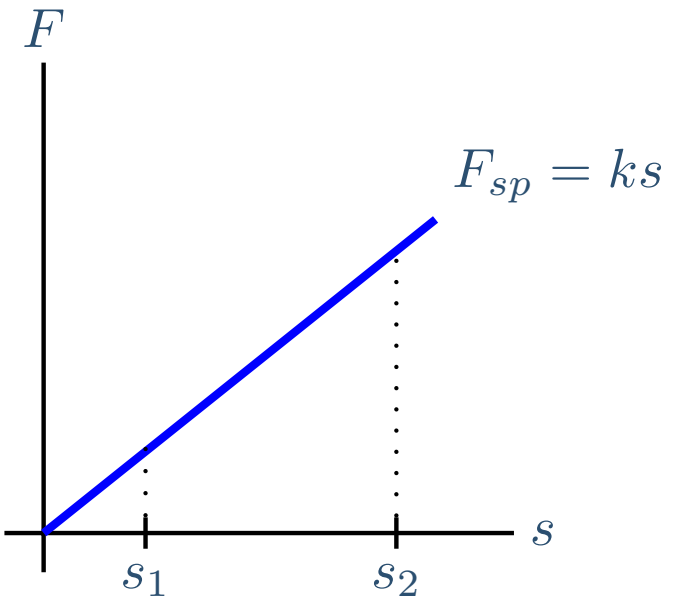

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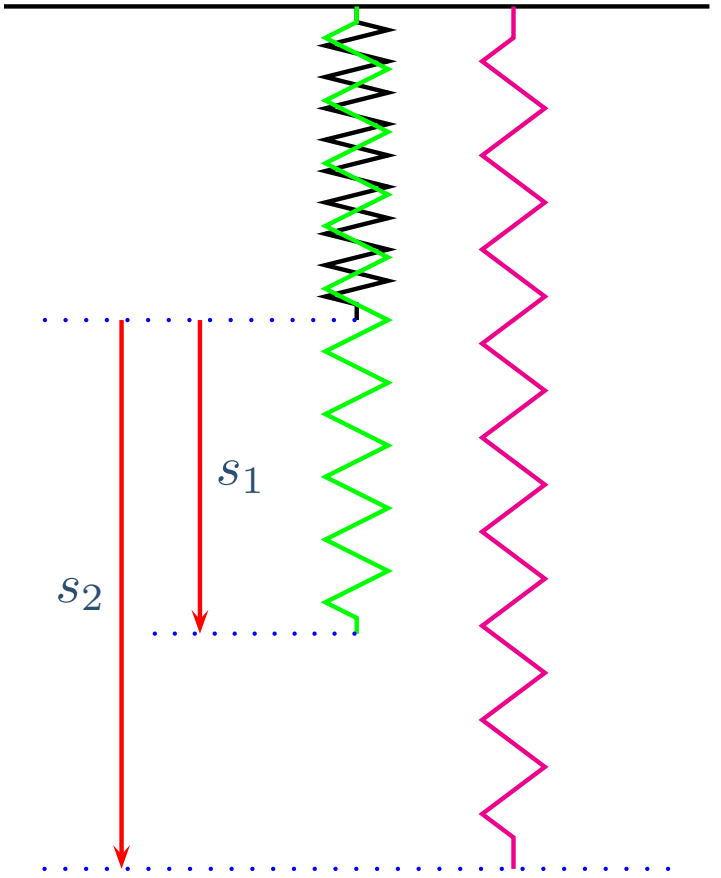

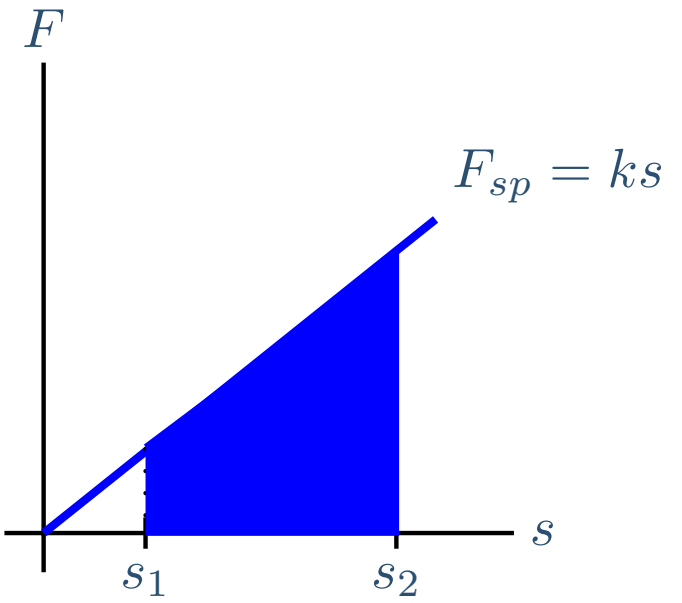

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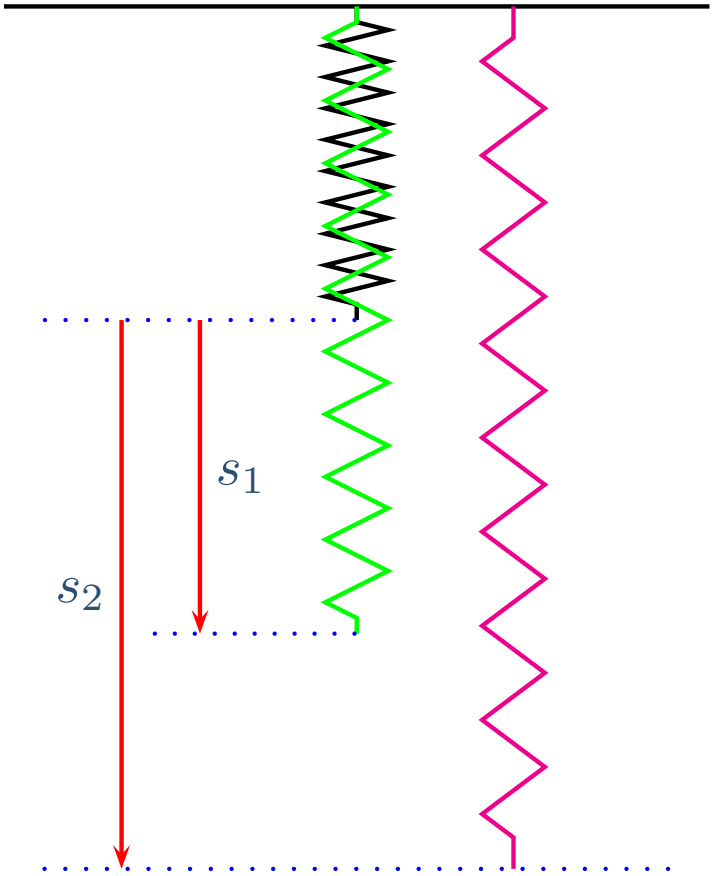
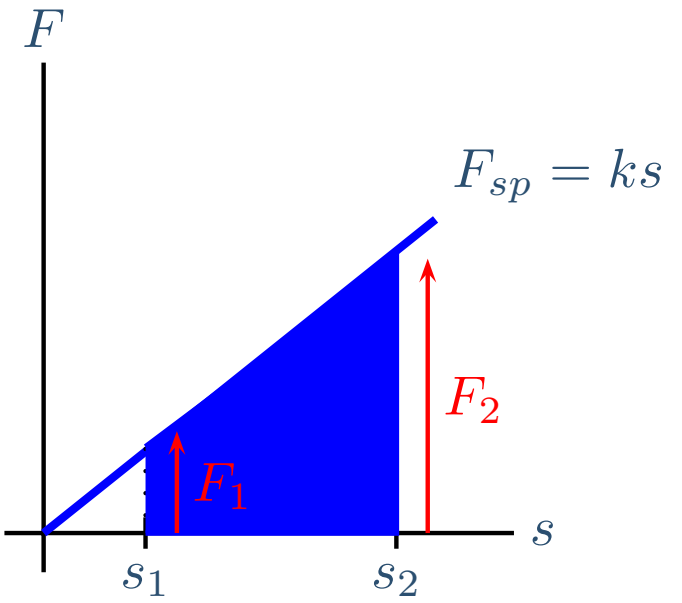
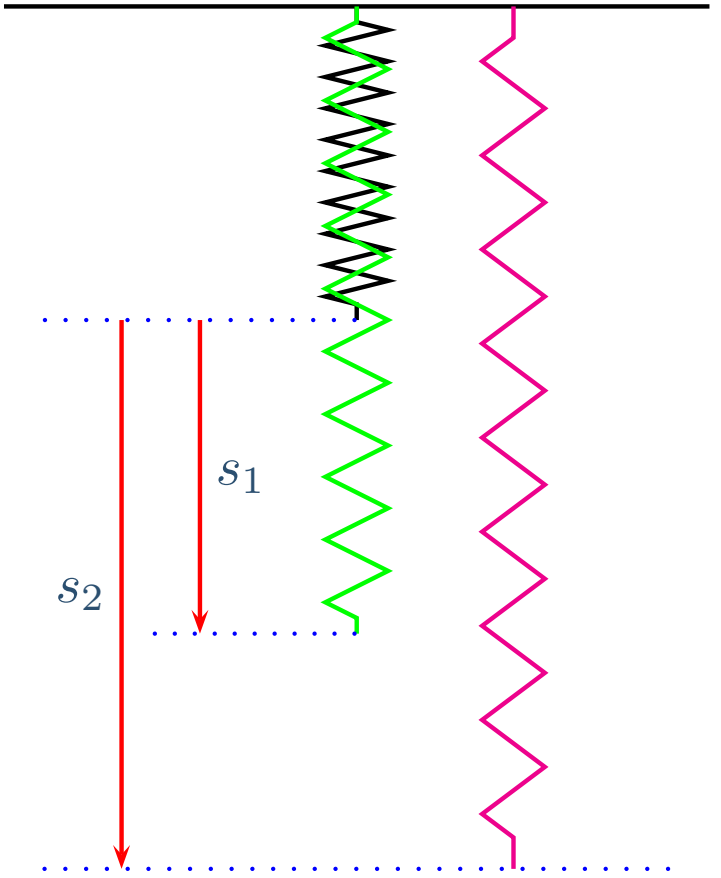
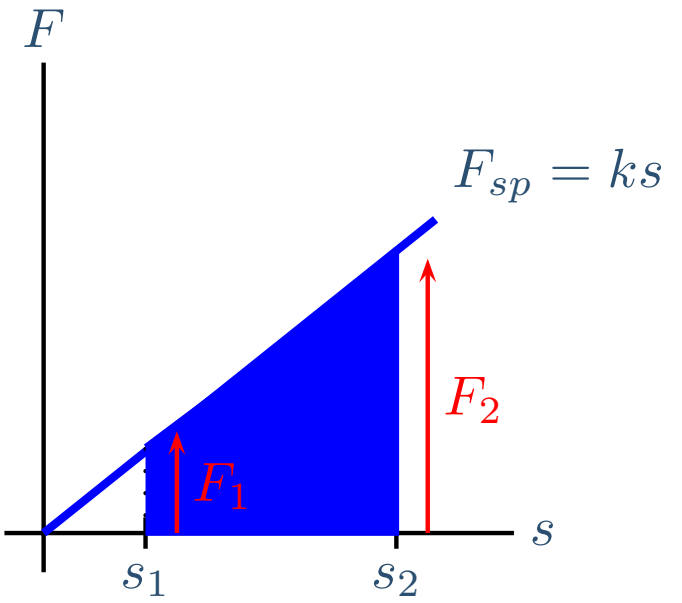




$$W = \tfrac{1}{2}(s_2)(F_2) - \tfrac{1}{2}(s_1)(F_1)$$

Work to Stretch a Spring





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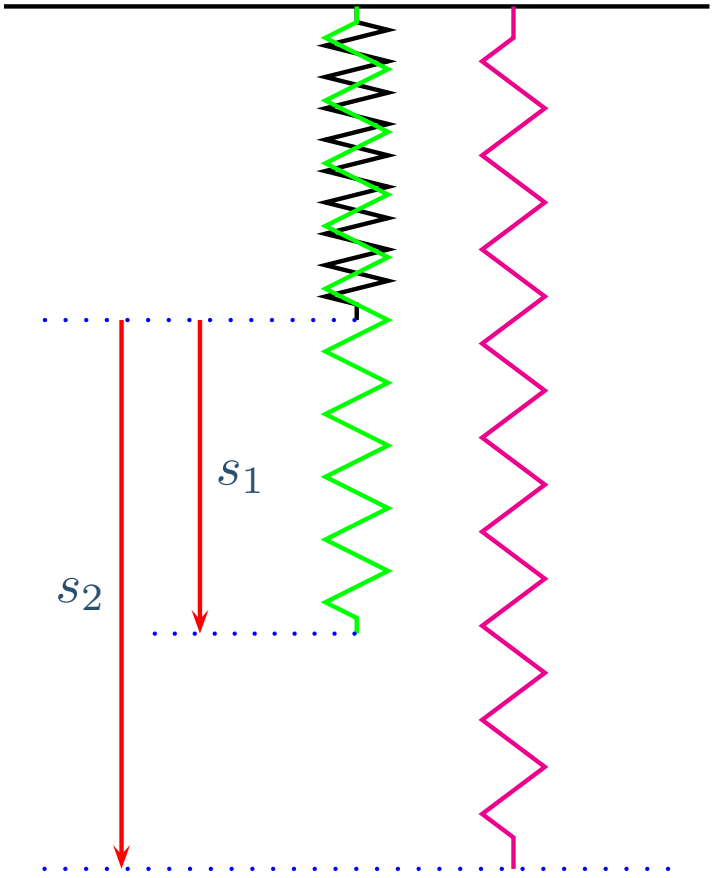
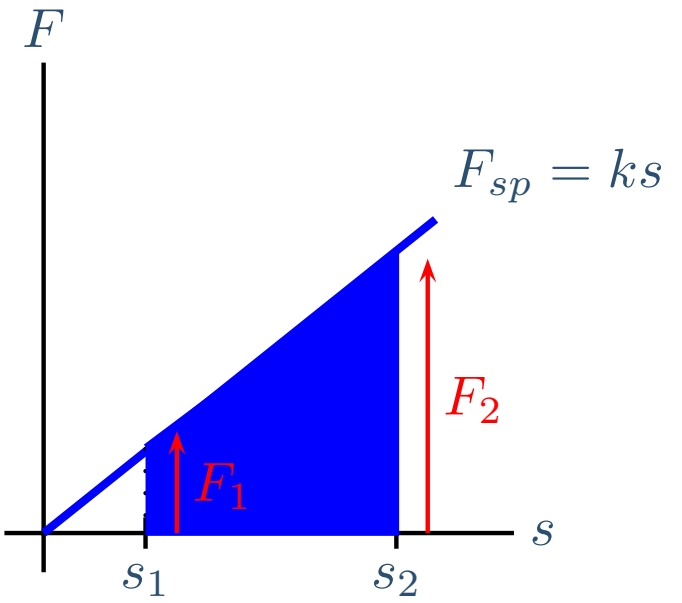
Work to Stretch a Spring





$$W = \tfrac{1}{2}(s_2)(F_2) - \tfrac{1}{2}(s_1)(F_1)$$

$$W = \tfrac{1}{2}(s_2)(ks_2) - \tfrac{1}{2}(s_1)(ks_1)$$

$$W = \tfrac{1}{2}ks_2^2 - \tfrac{1}{2}ks_1^2$$

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Elastic Potential energy - Potential energy due to a spring.

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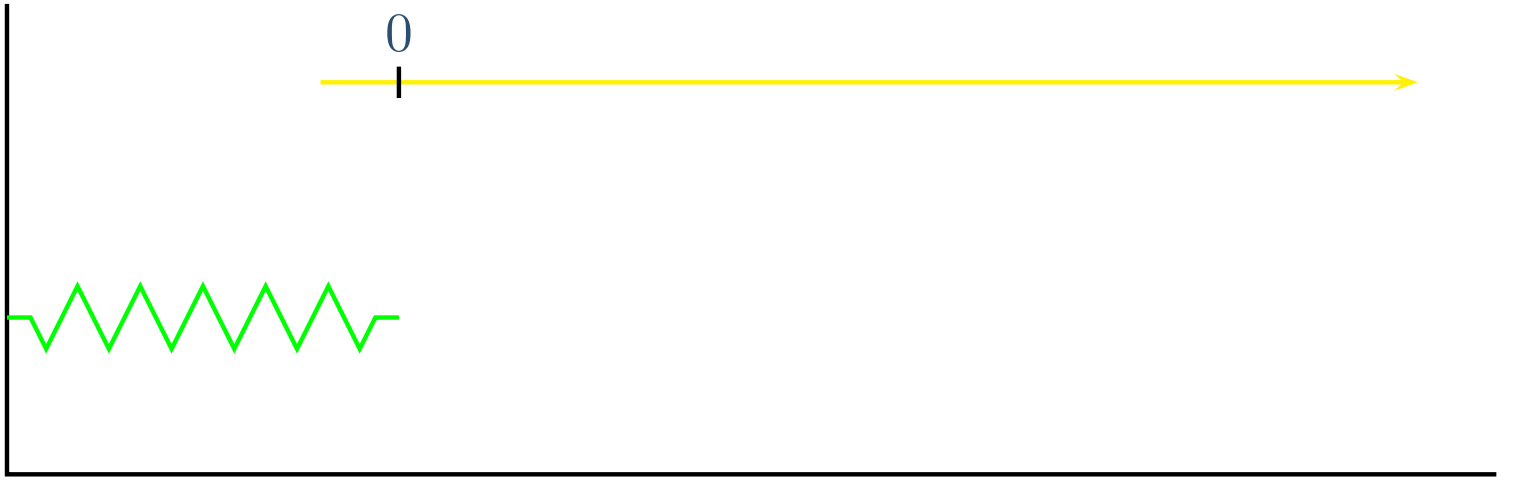

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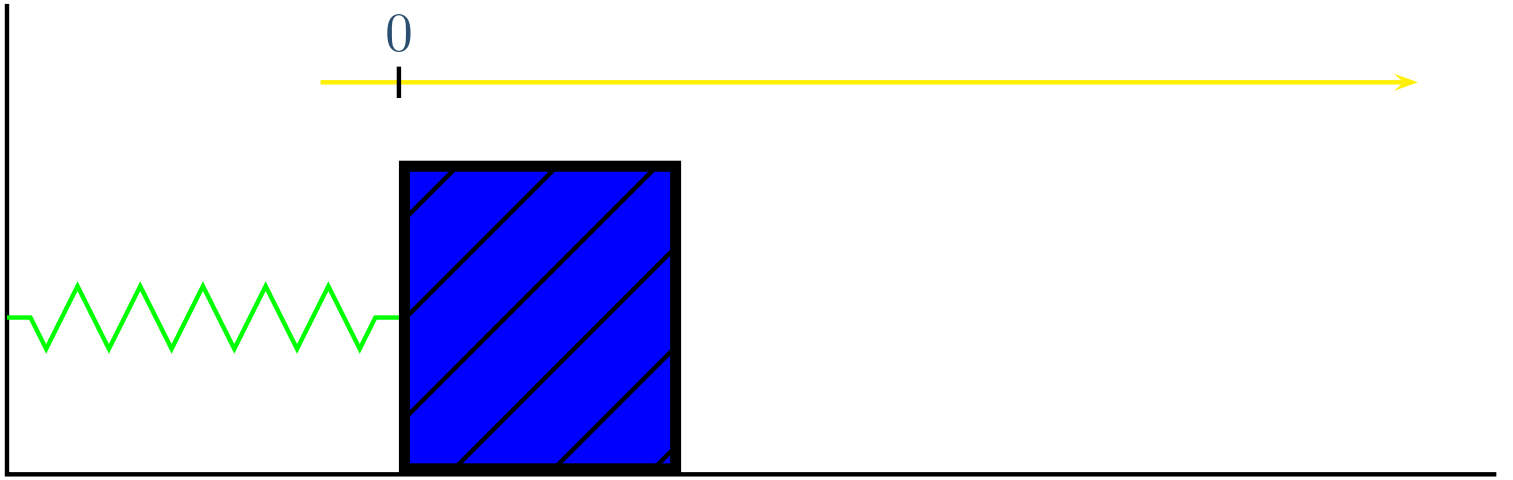

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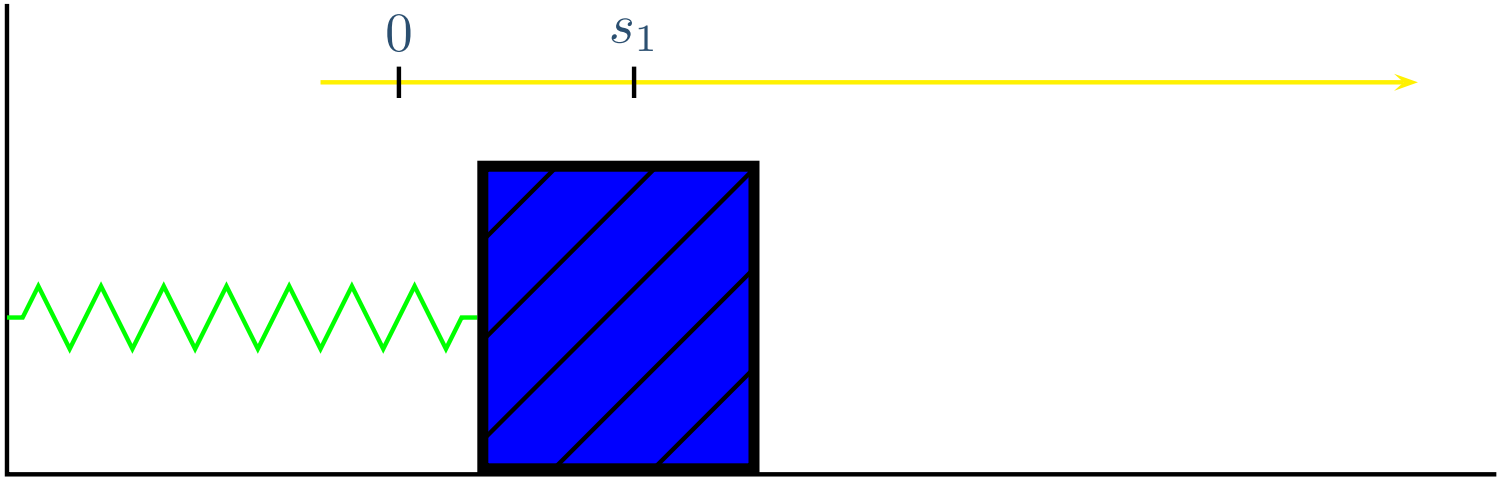

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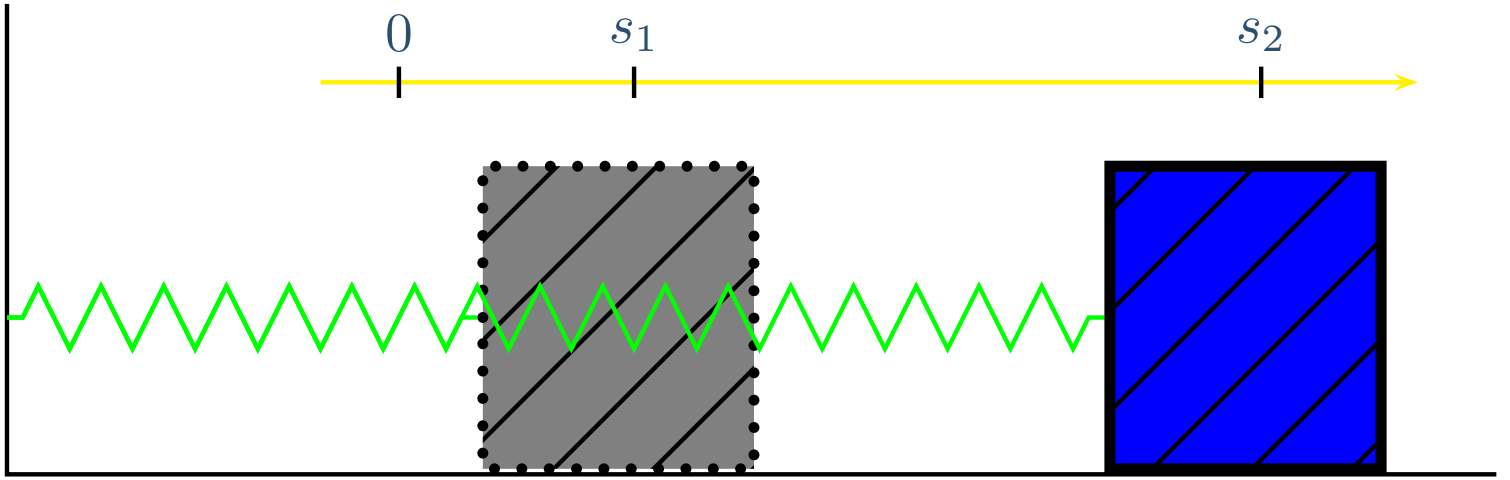

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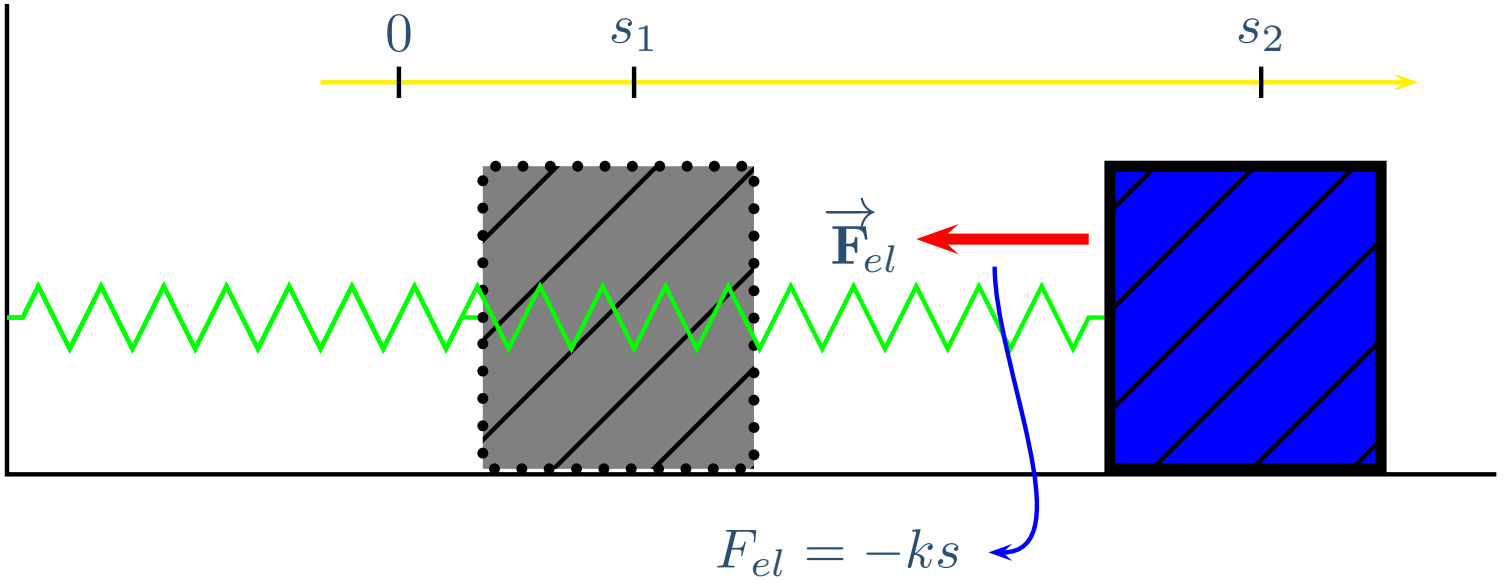

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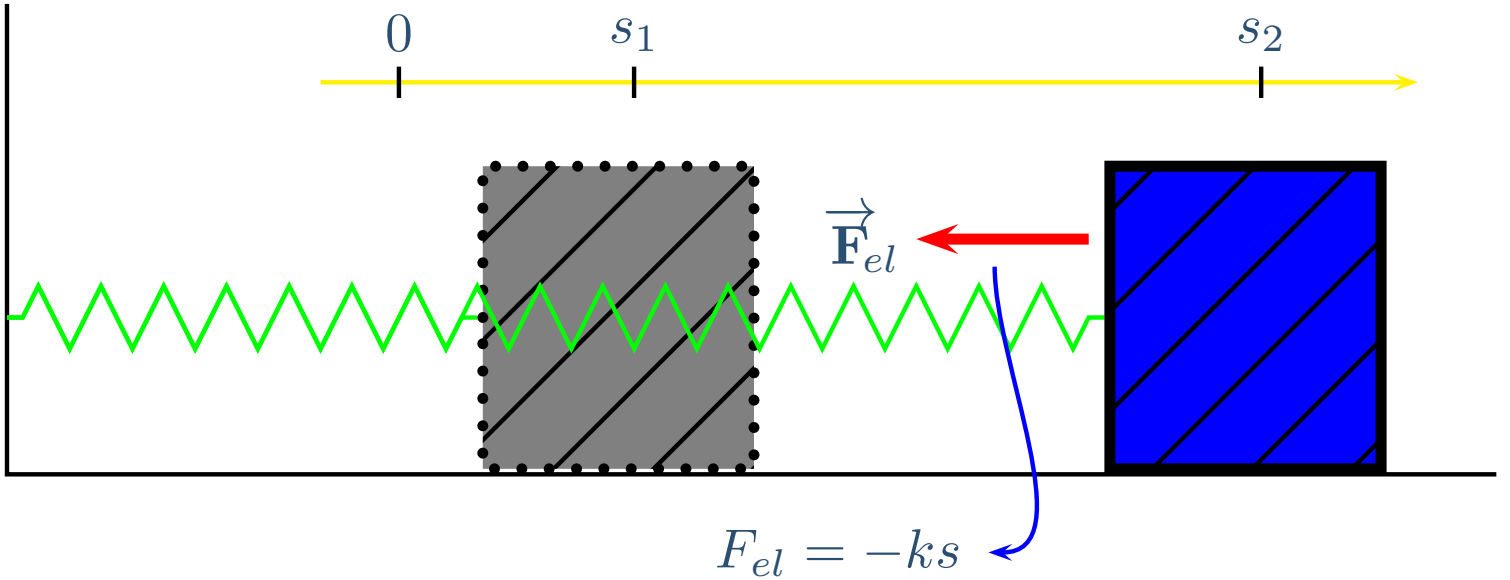
$W_{el} = -\left(\frac{1}{2}ks_2^2 - \frac{1}{2}ks_1^2\right)$ - Elastic work converted to potential energy



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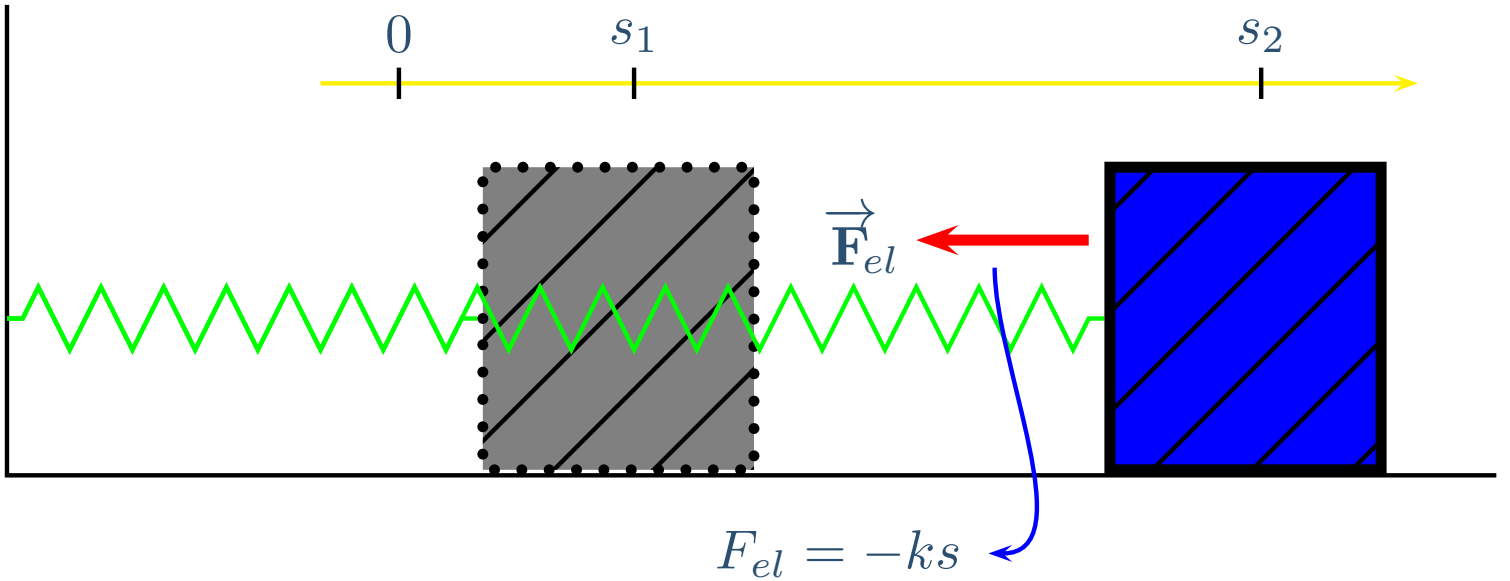

$$W_{el} = -\Delta U_{el} \Rightarrow \boxed{U_{el} = \frac{1}{2}ks^2}$$

Conservation of Elastic Energy

If a spring is the only force doing work on something,

$$E_1 = E_2$$

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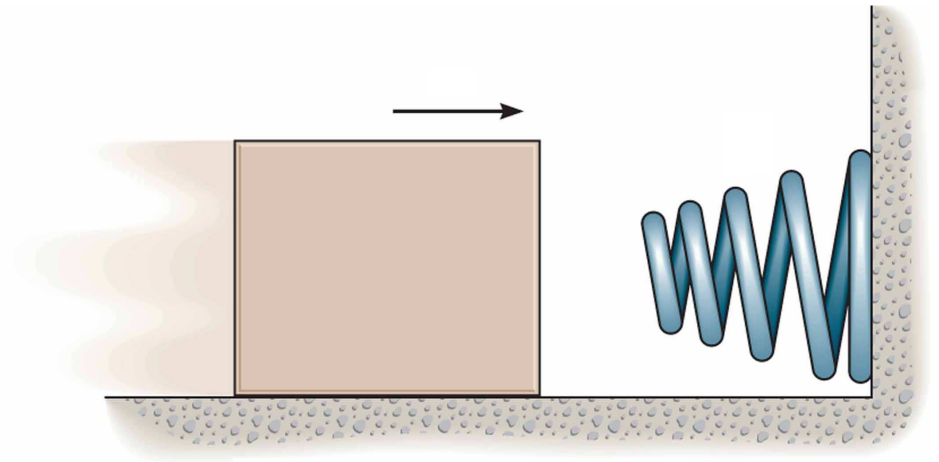
Elastic Potential Energy Exercise

A $10\,kg$ mass slides across a frictionless, horizontal floor going $5\,m/s$ (and therefore has $125\,J$ of kinetic energy) when it collides with the $k = 500\,N/m$ spring shown. What is the maximum compression of the spring?



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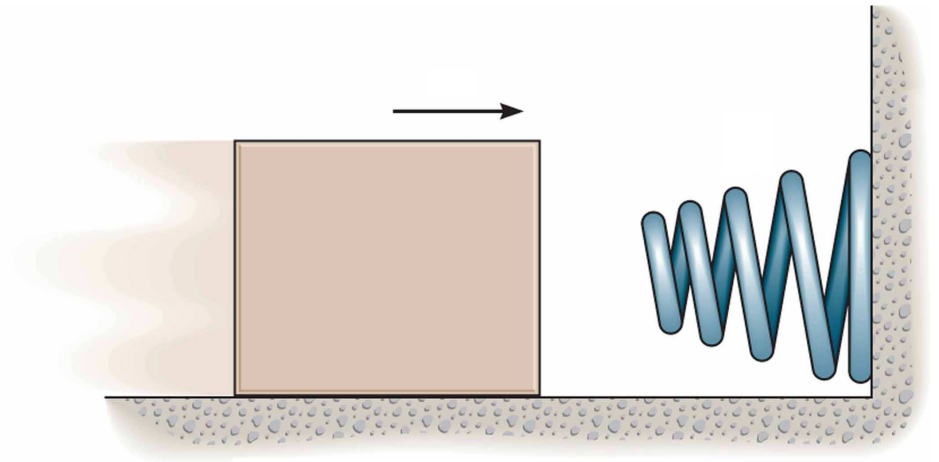

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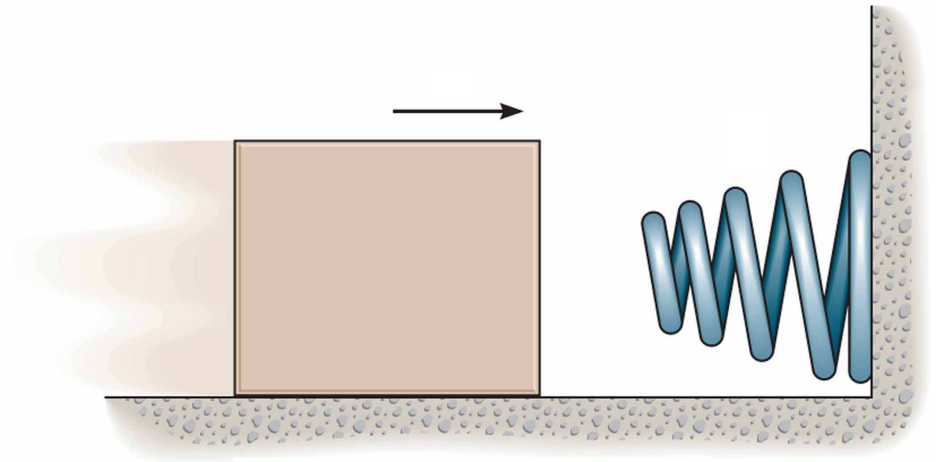

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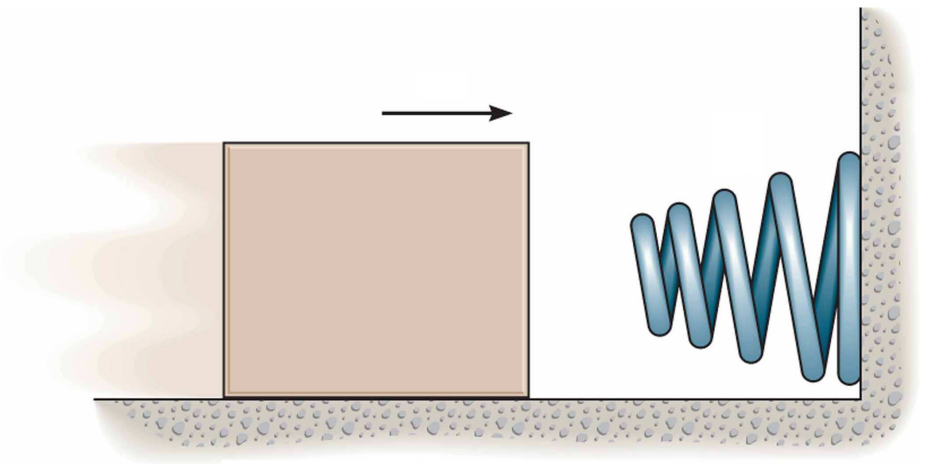

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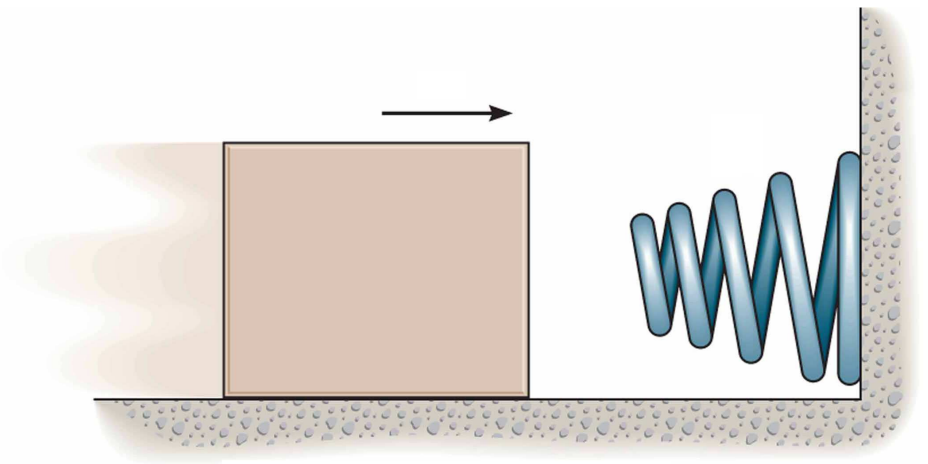

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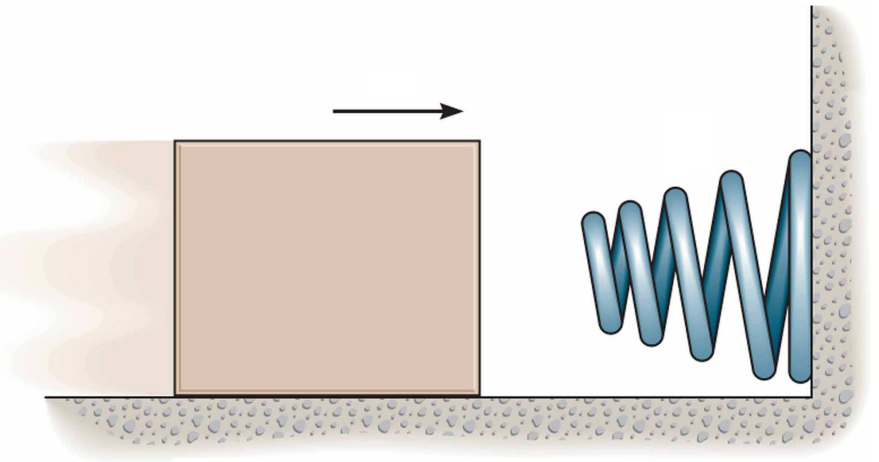

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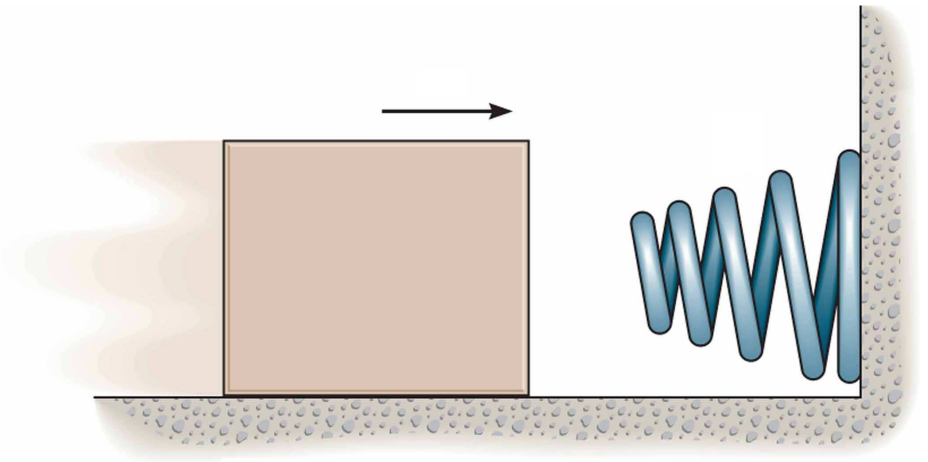

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General Energy Problems

The most general problems (this term) involve gravity, springs, and other forces all doing work.

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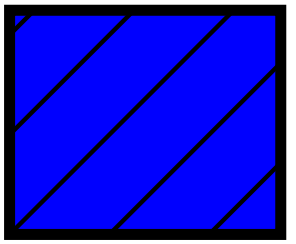

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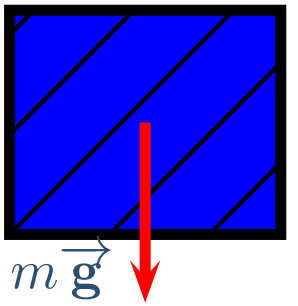

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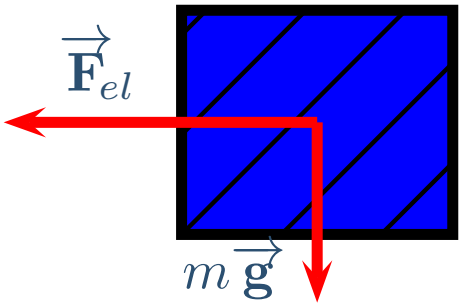

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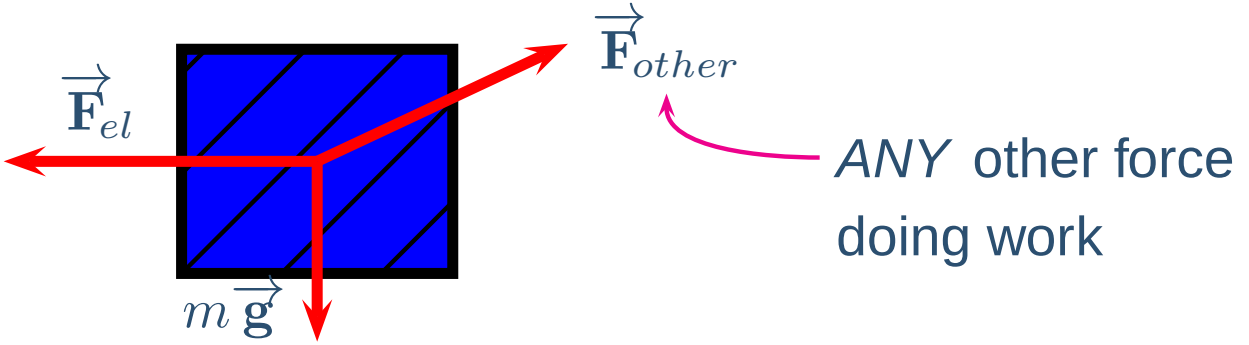

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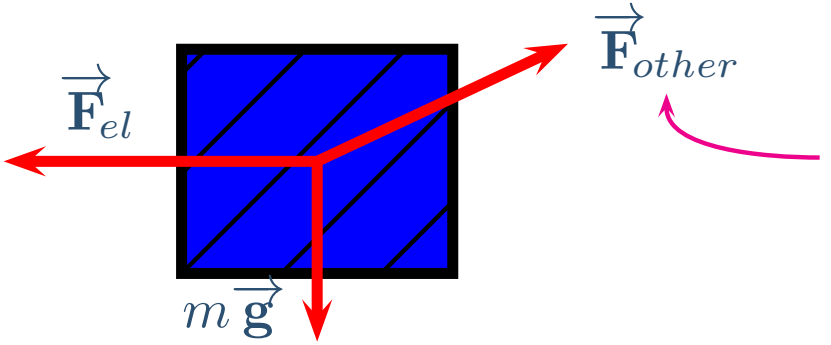

$$W_{total} = W_g + W_{el} + W_{other}$$

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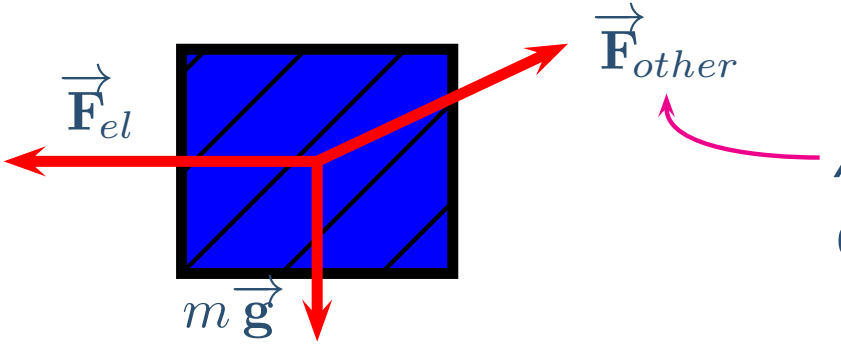

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ΔK

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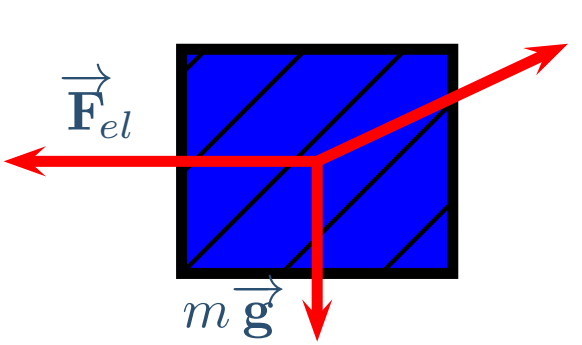

ANY other force doing work

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ΔK

$-\Delta U_g$

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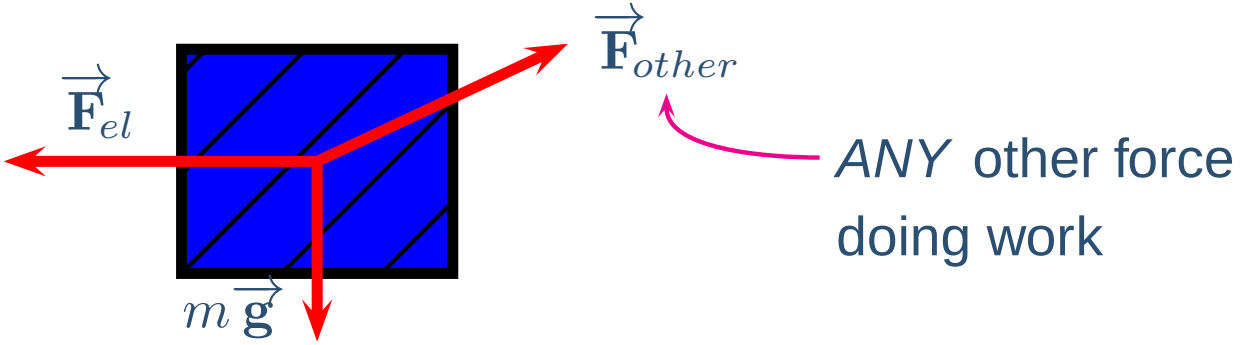

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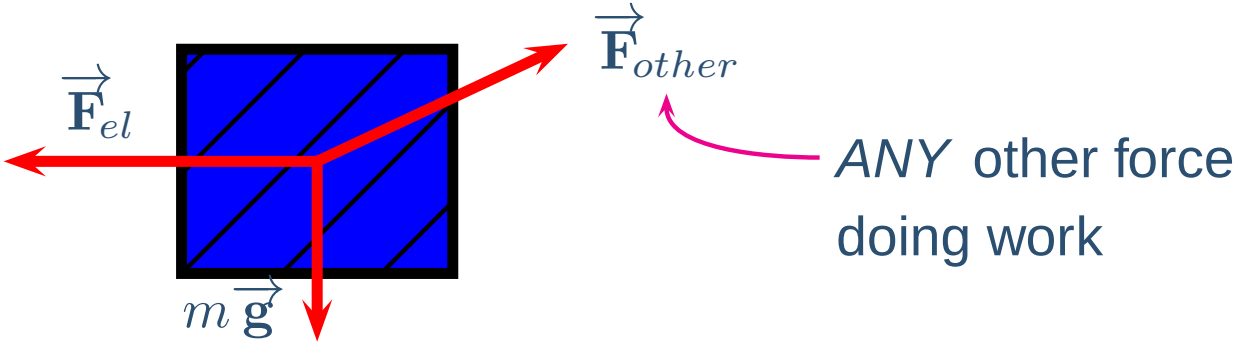

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$$\frac{1}{2}mv_i^2 + mgy_i + \frac{1}{2}ks_i^2 + W_{other} = \frac{1}{2}mv_f^2 + mgy_f + \frac{1}{2}ks_f^2$$