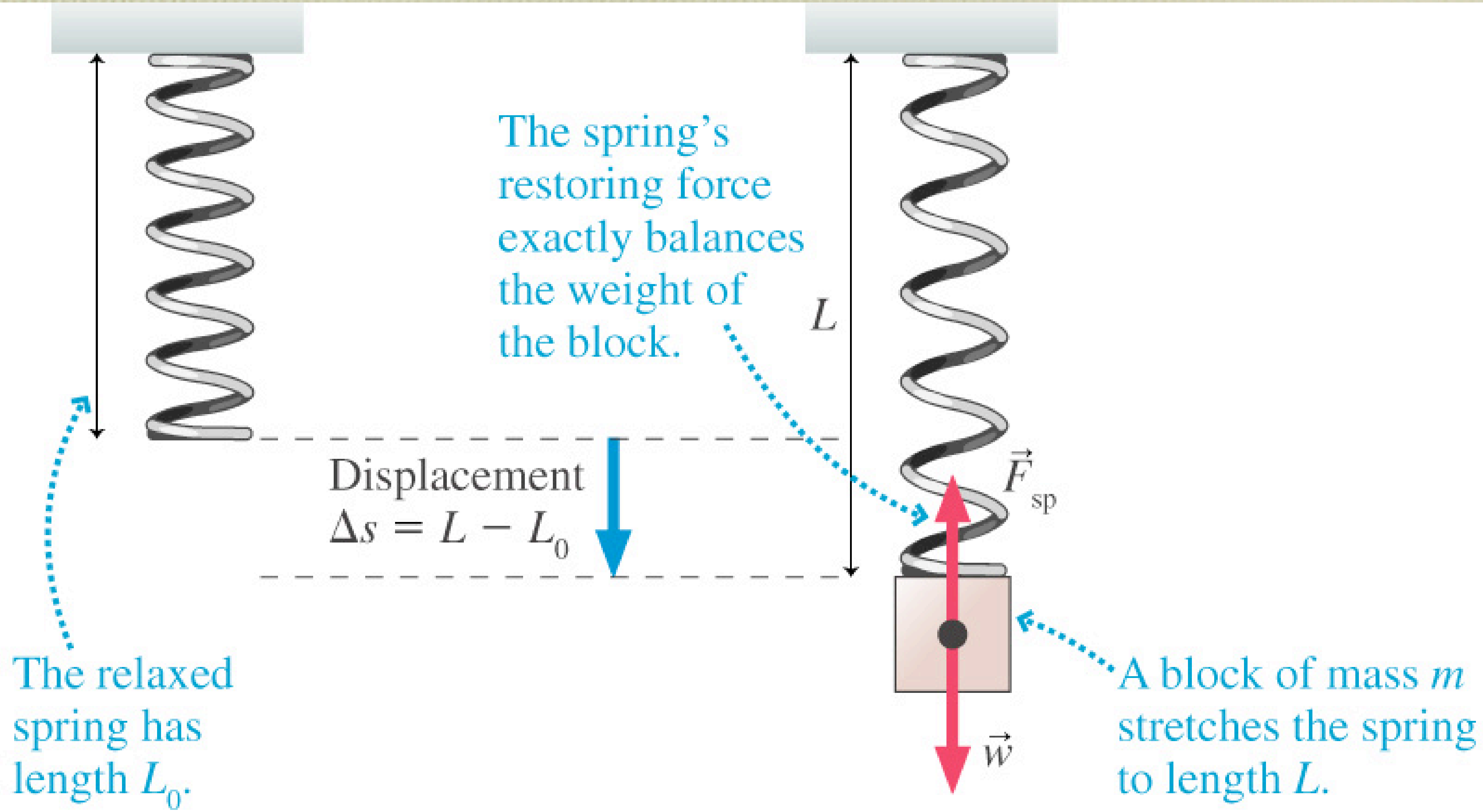
# Spring Energy

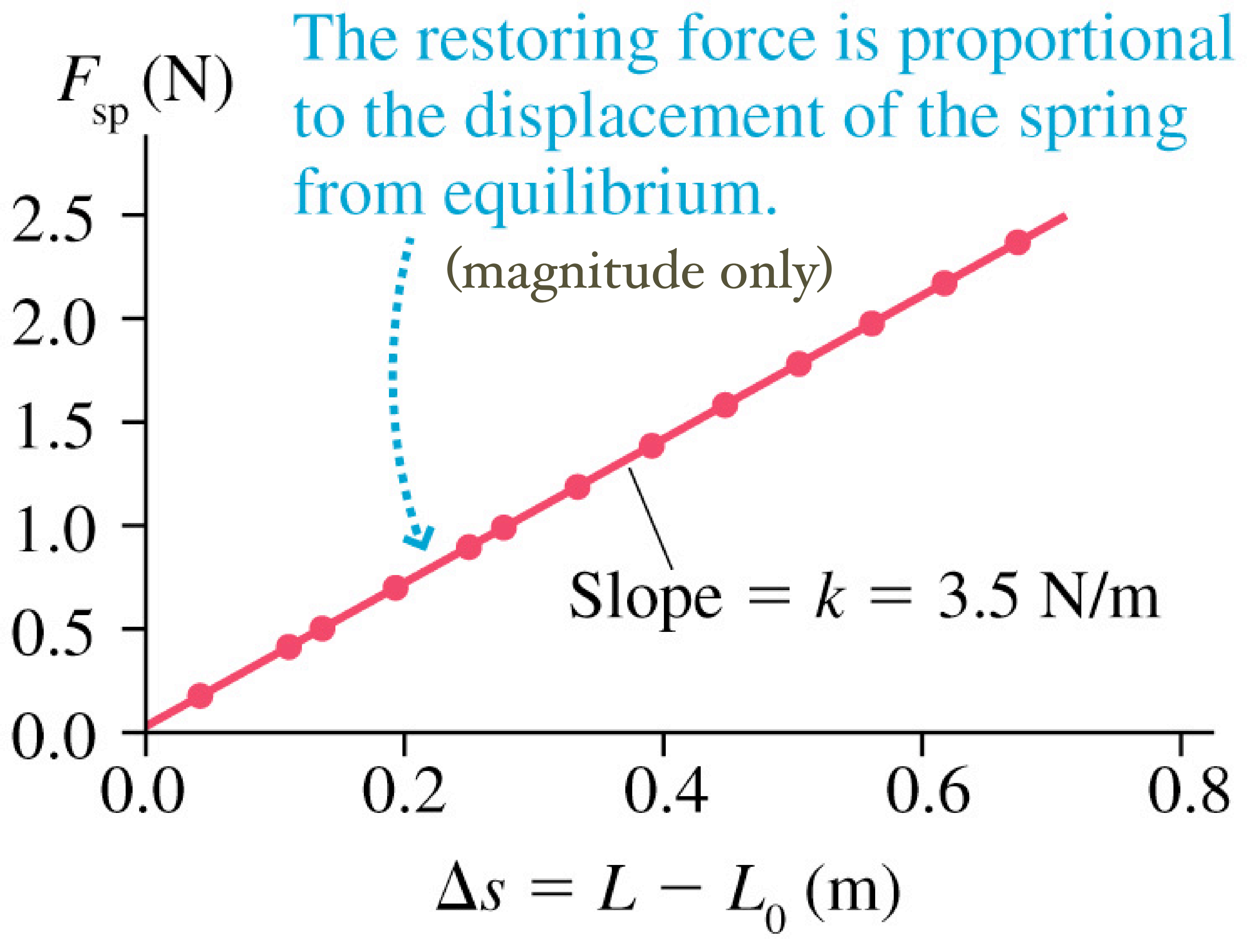
## Elastic Potential Energy

# Force vs. Stretch




Assume spring's mass is negligible.

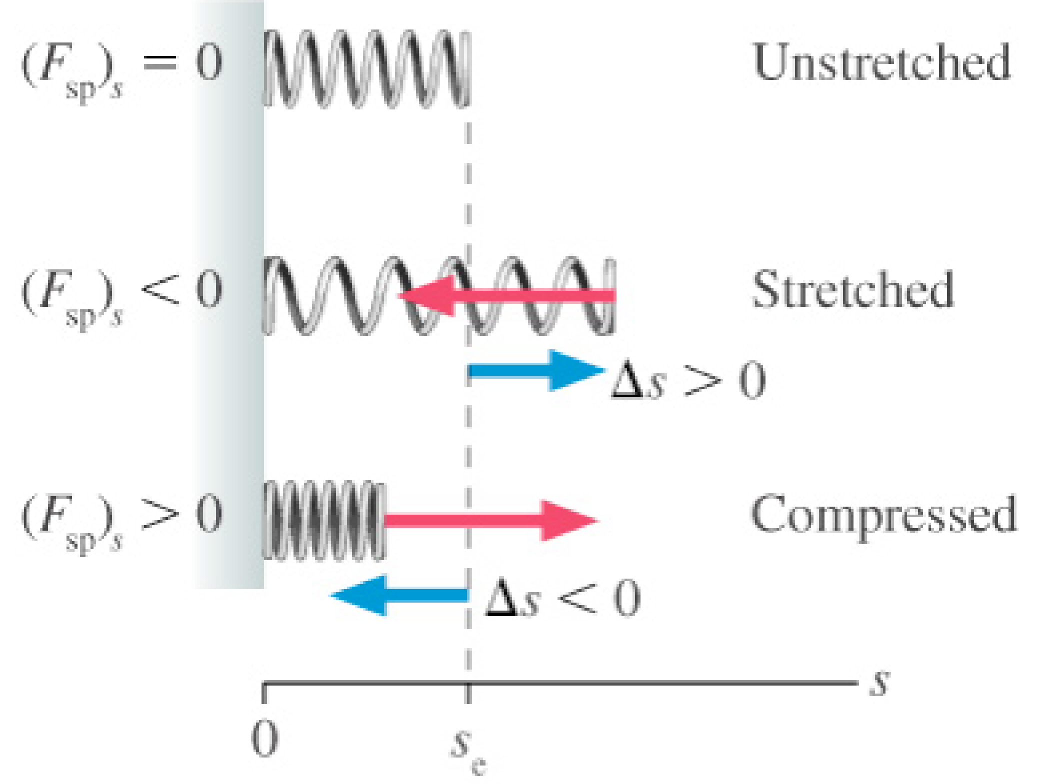
# Hooke's Law

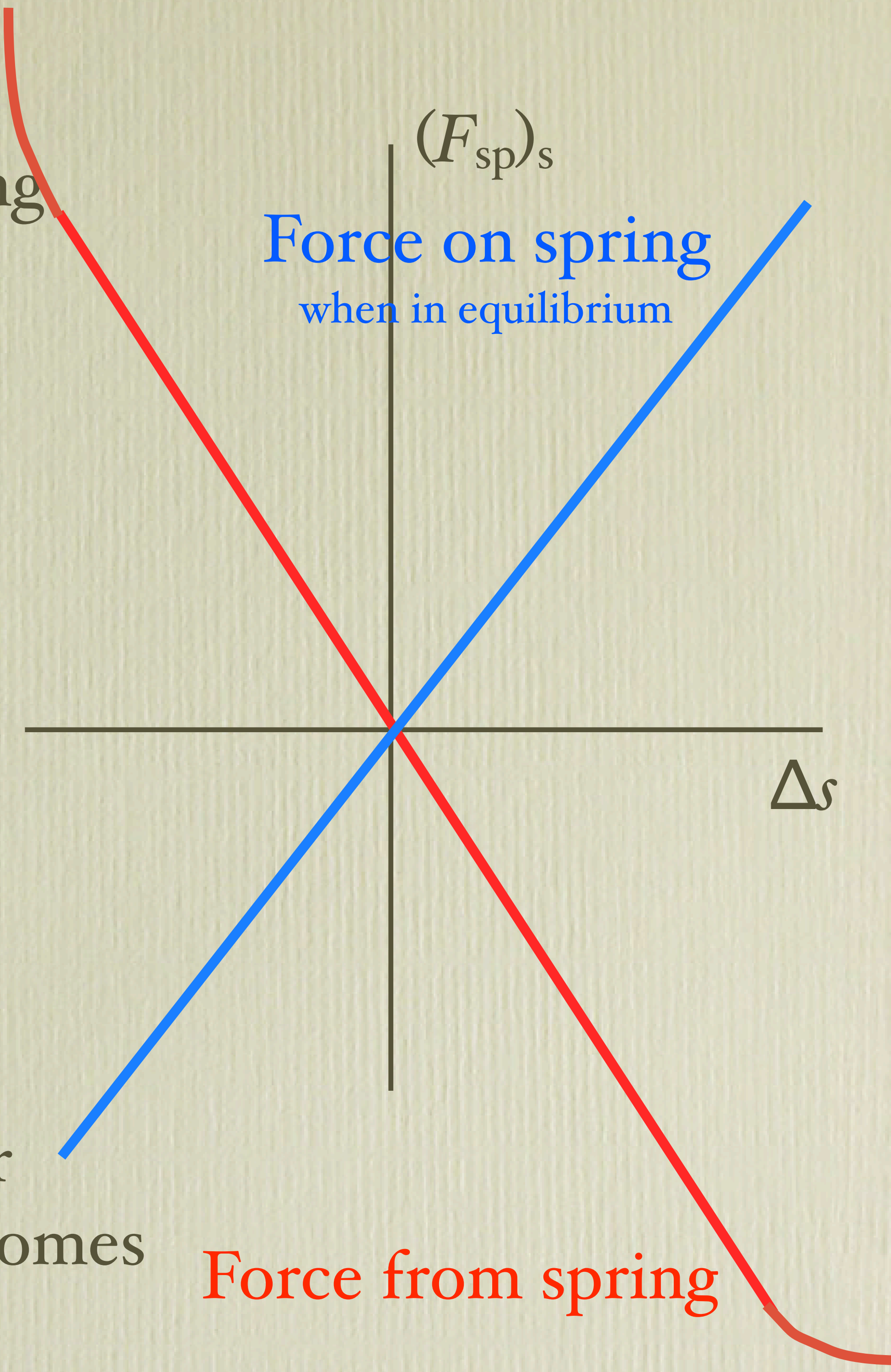


The restoring force is proportional to the displacement of the spring from equilibrium.
(magnitude only)
$F_{sp}$ (N)
2.5
2.0
1.5
1.0
0.5
0.0
Slope = $k$ = 3.5 N/m
0.0
0.2
0.4
0.6
0.8
$\Delta s = L - L_0$ (m)

# Hooke's Law

$(F_{sp})_s$ is the component of the spring force in the stretch direction.

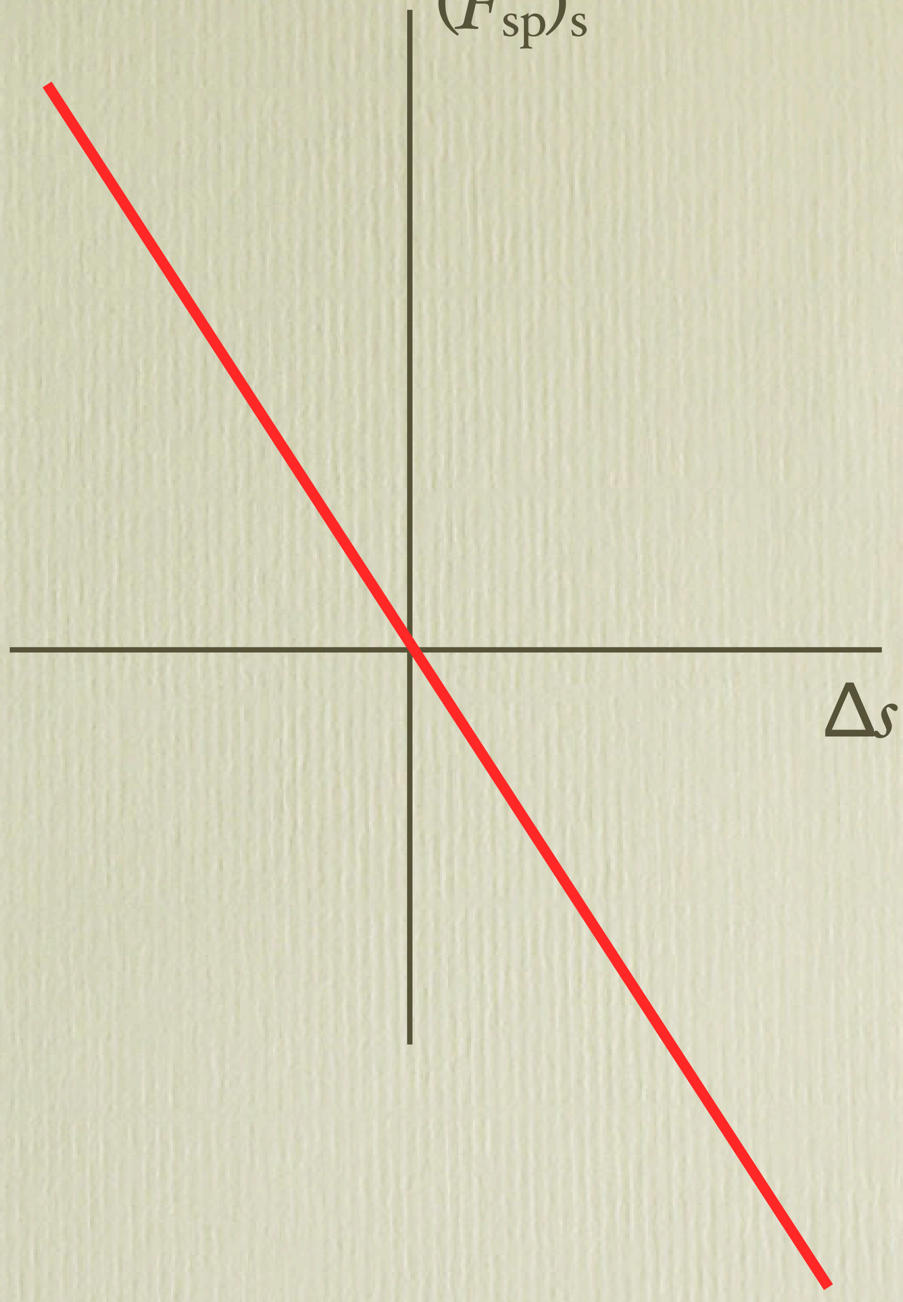



As the spring is compressed or expanded further, it eventually becomes non-linear.

# Hooke's Law

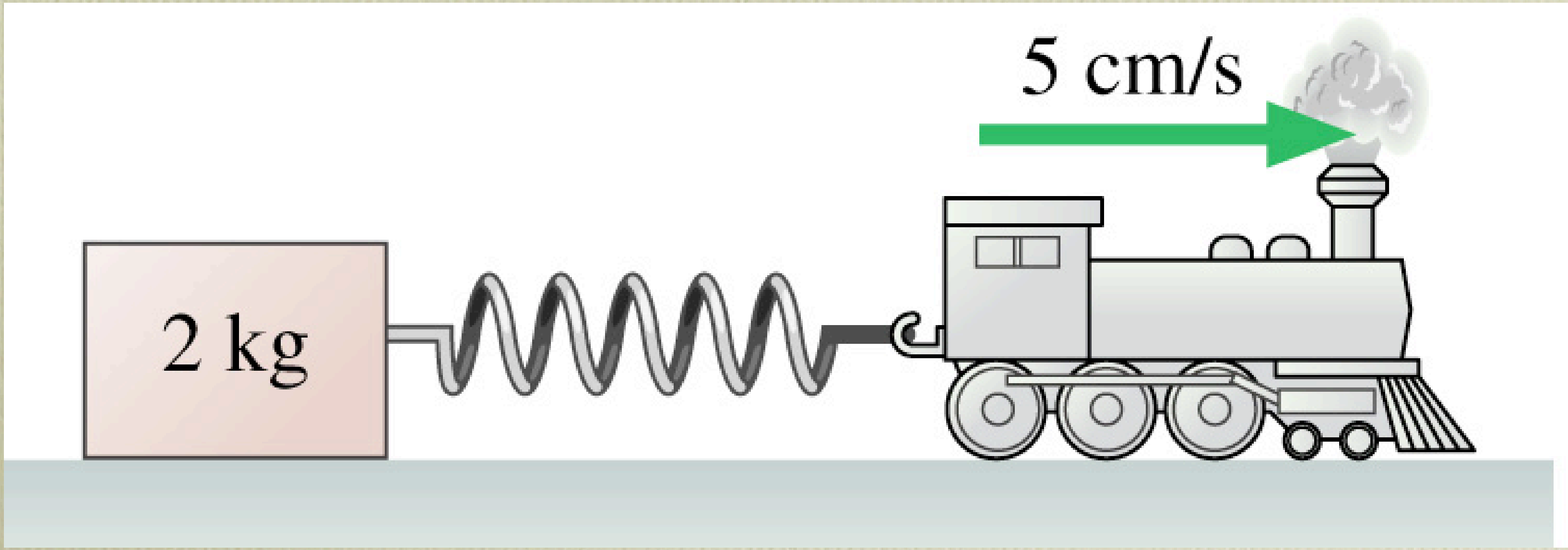
$$(F_{\text{sp}})_s = -k\Delta s$$



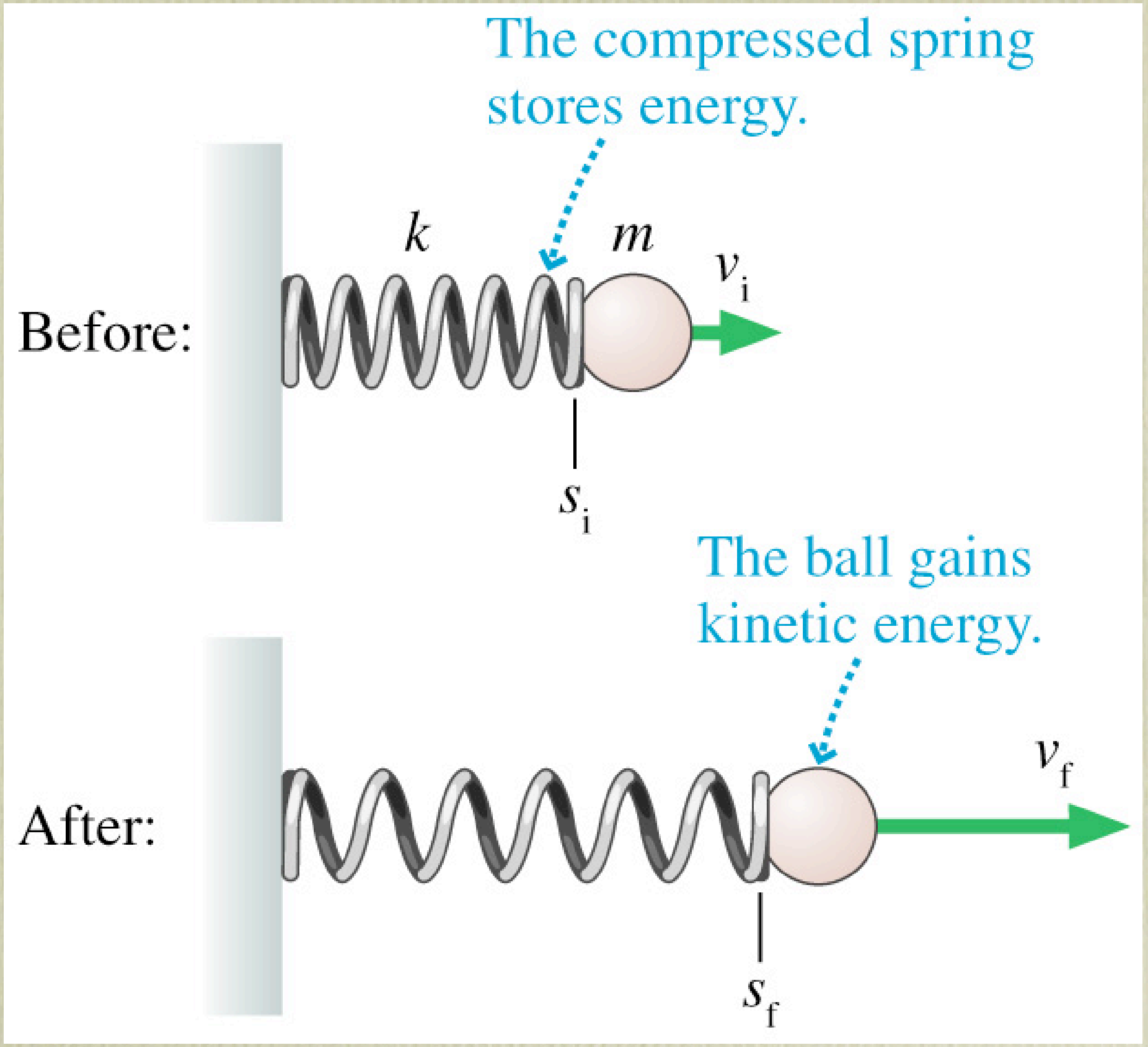

Let's measure it!

# Slip-Stick

- Model of an Earthquake
- Not as simple as the book implies



# Energy in a Spring




$$\int_{s_i}^{s_f} F ds = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

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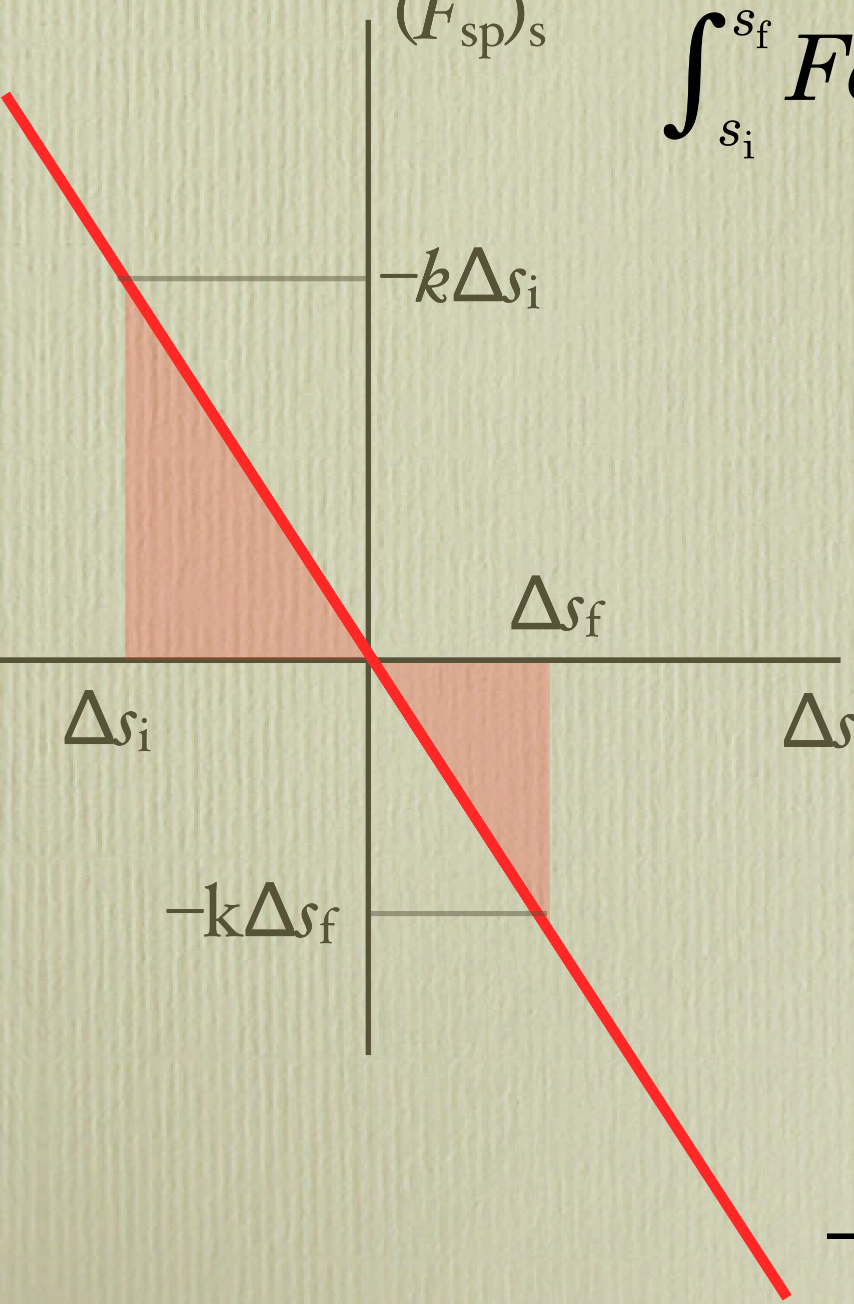
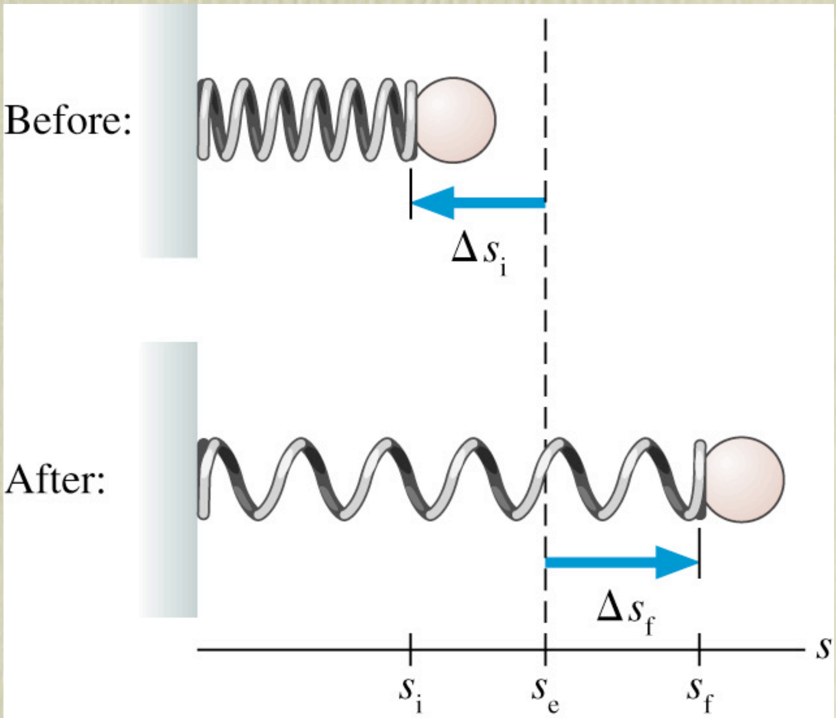
$$\int_{s_i}^{s_f} F ds = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

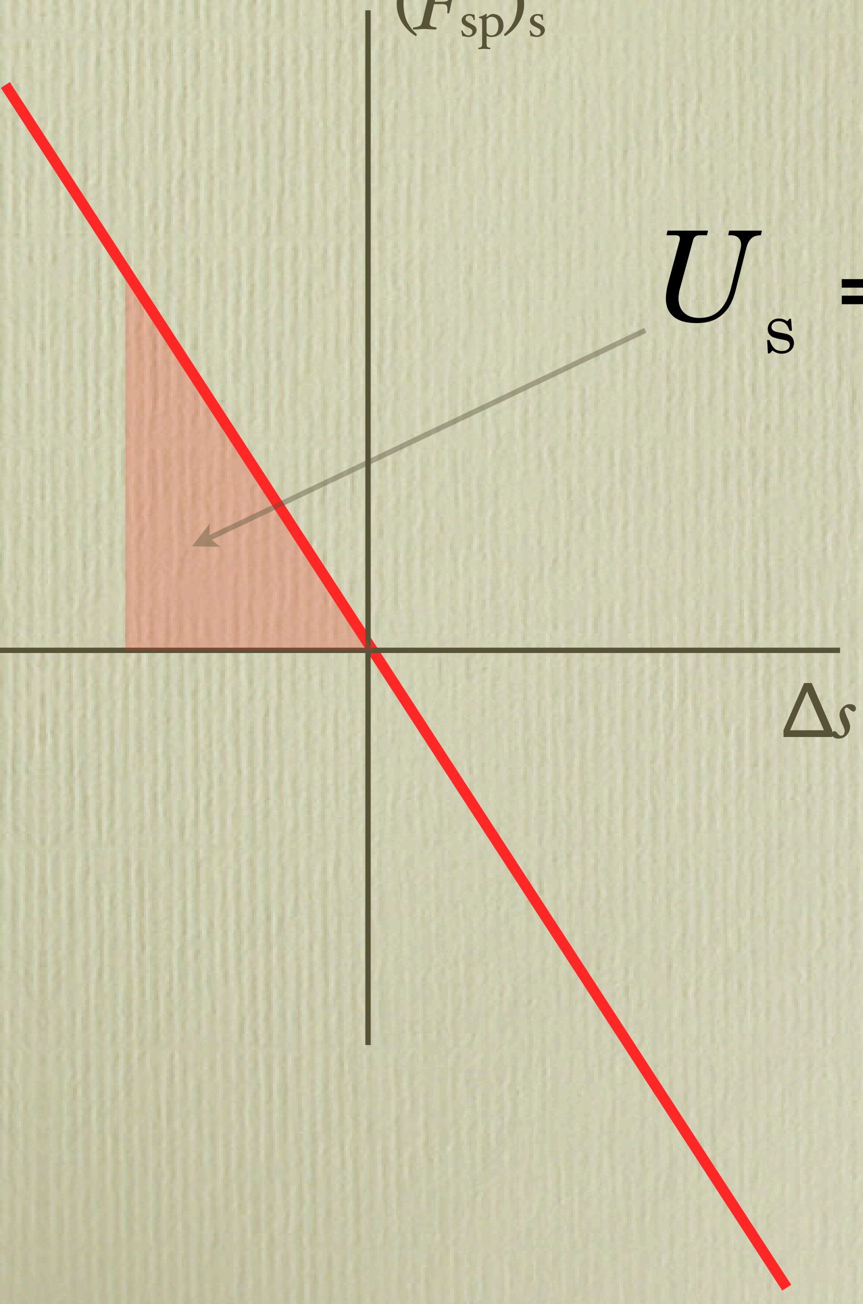



$$\int_{s_i}^{s_f} \left(-k\Delta s\right) ds = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

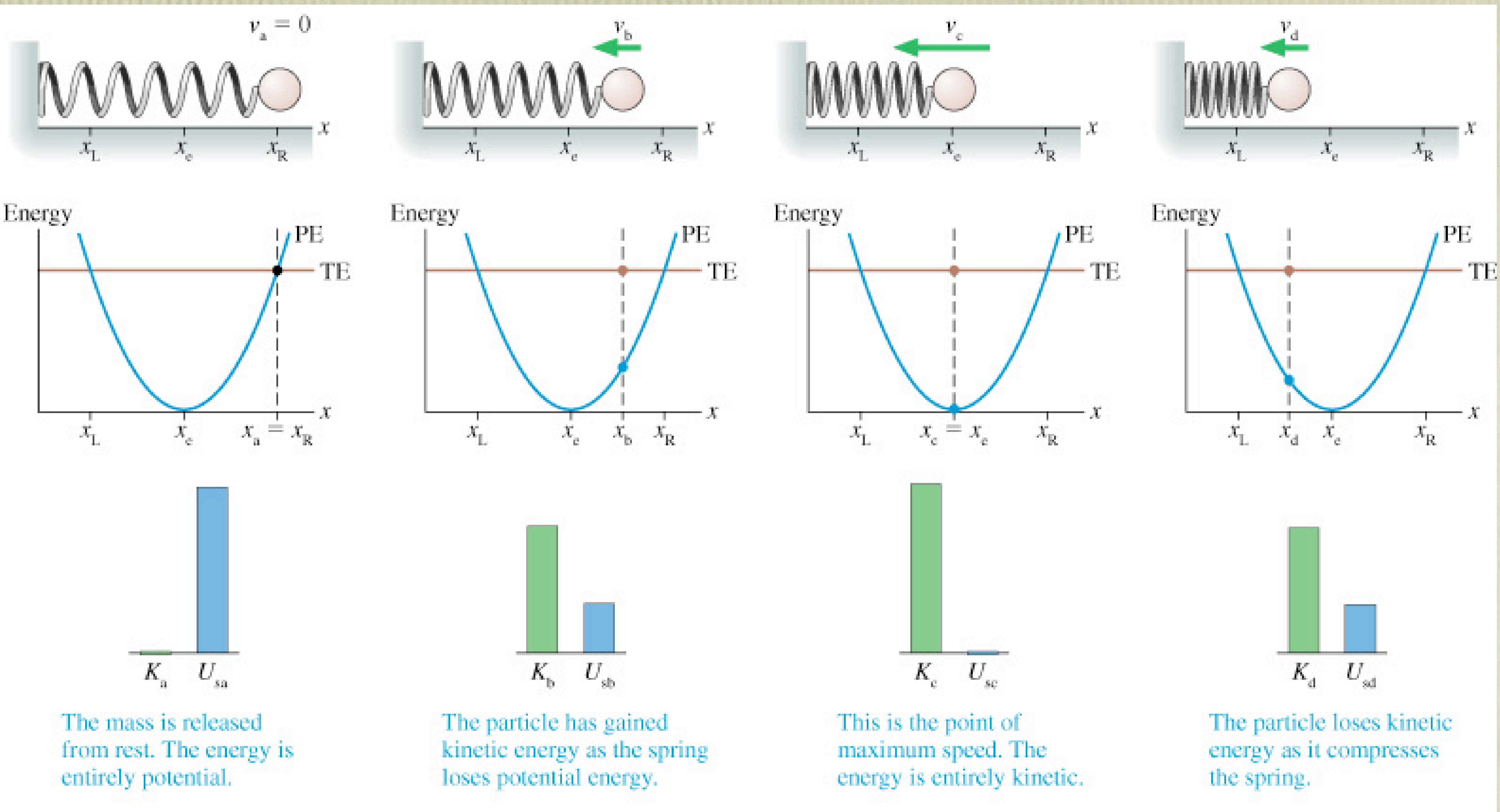
$$-\frac{1}{2}k\left(\Delta s_f\right)^2 + \frac{1}{2}k\left(\Delta s_i\right)^2 = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

# Elastic Potential Energy




$$U_s = \frac{1}{2}k\left(\Delta s\right)^2$$

# Energy Diagrams



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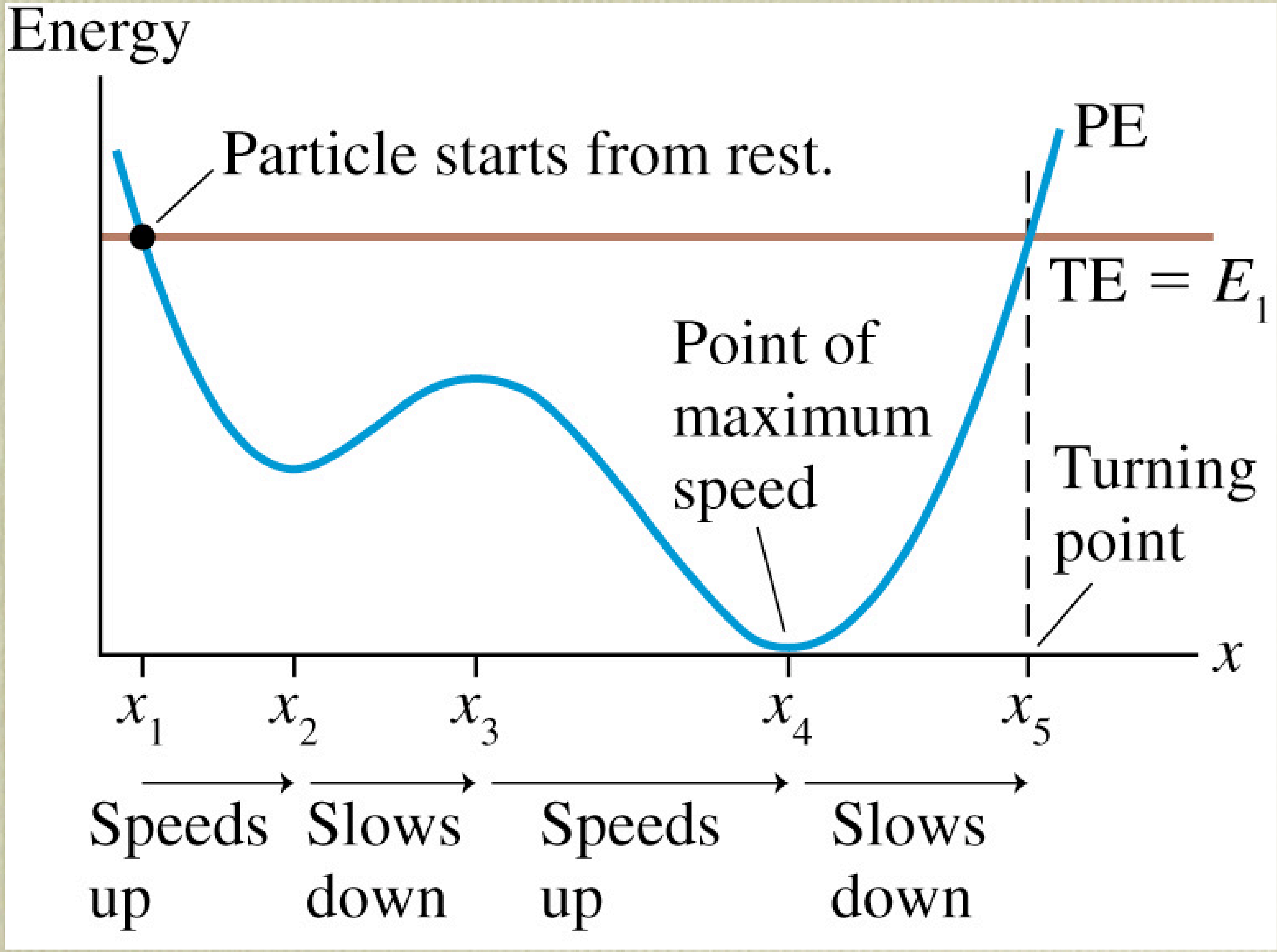

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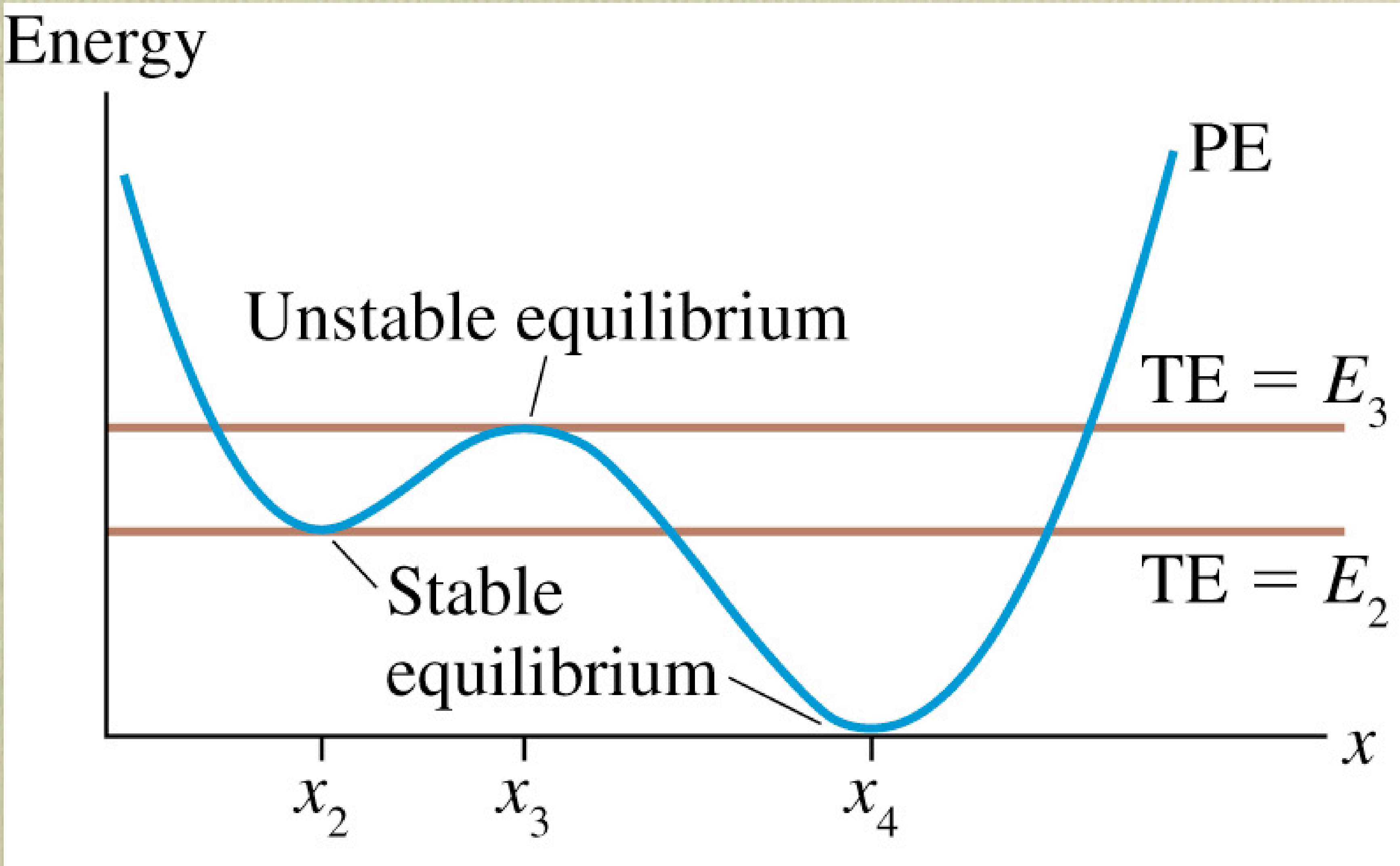

# Molecular Bonds