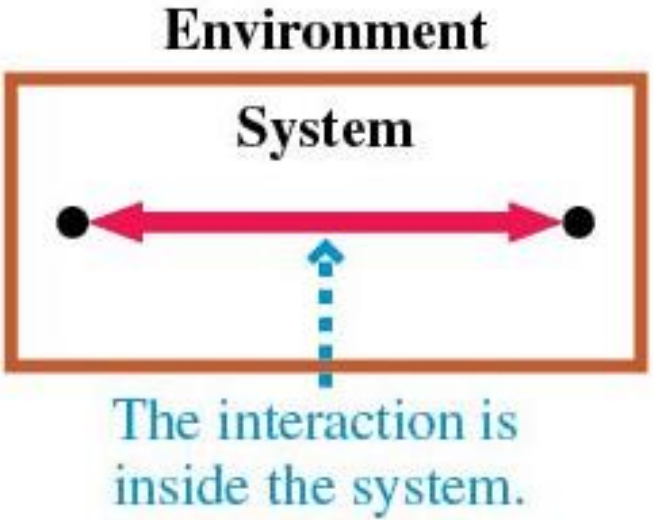
Chapter 10 – Interactions and Potential Energy

- Potential energy and conservation of energy
- Energy bar charts and energy diagrams
- Relationship between force and potential energy
- Conservative and nonconservative forces

How do interactions affect energy?

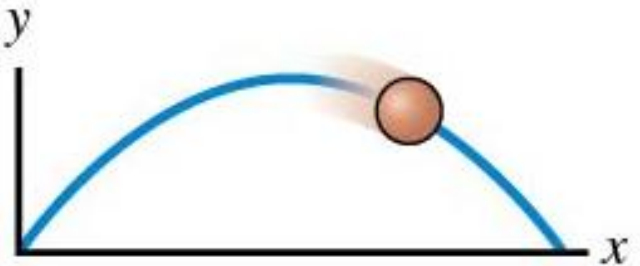
We continue our investigation of energy by allowing **interactions** to be part of the system, rather than external forces. You will learn that interactions can **store energy** within the system. Further, this **interaction energy** can be transformed—via the interaction forces—into kinetic energy.



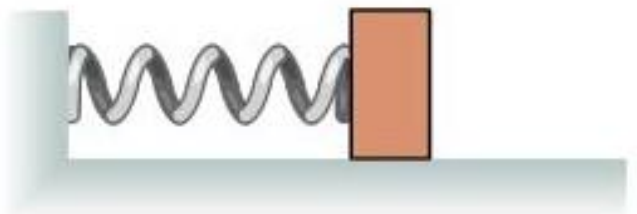
عندما $W_g > 0 \rightarrow \Delta U_g < 0$

What is potential energy?

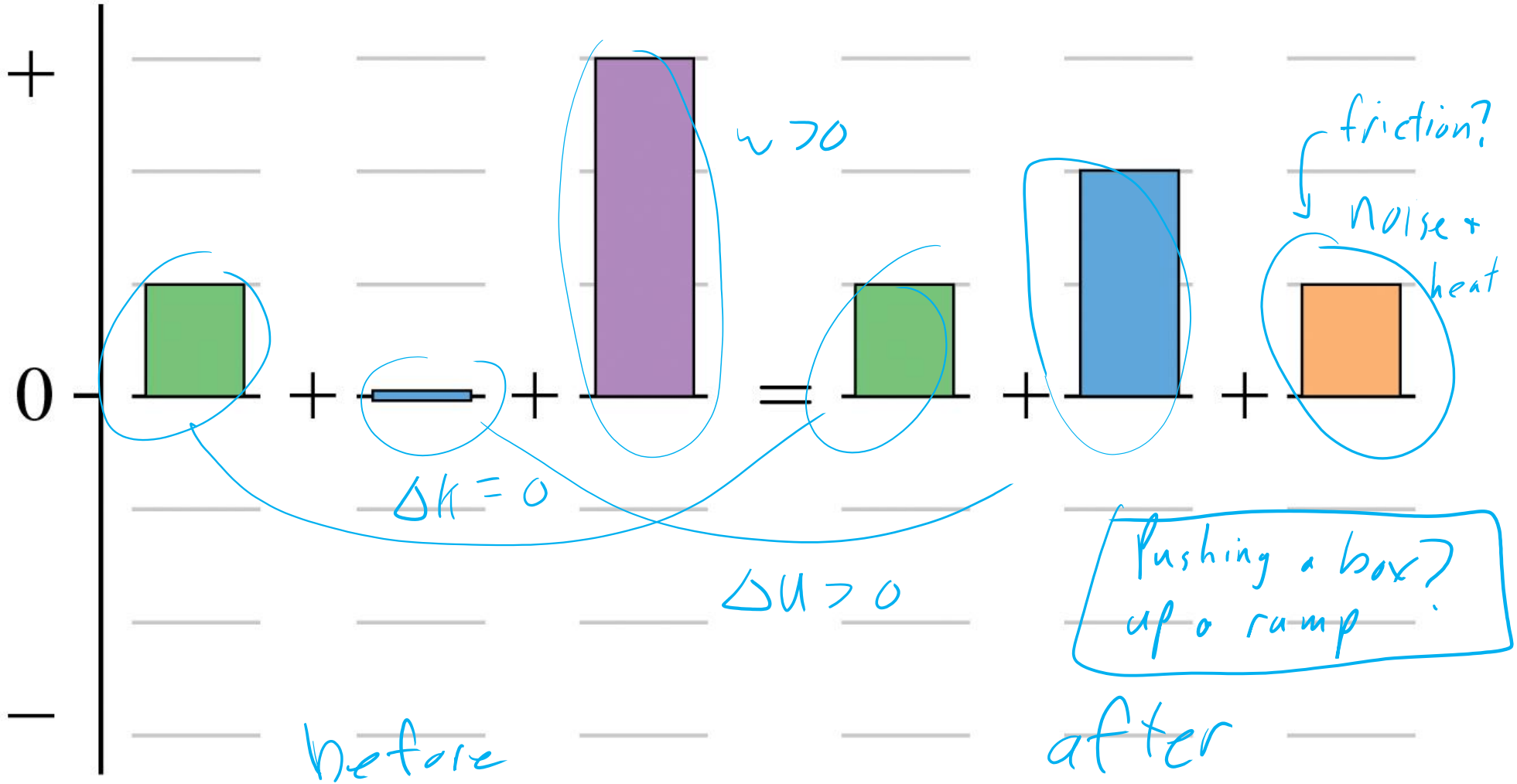
Interaction energy is usually called **potential energy**. There are many kinds of potential energy, each associated with *position*.



- **Gravitational potential energy** changes with height.
- **Elastic potential energy** changes with stretching.



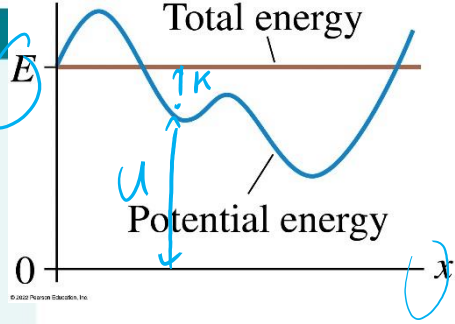
« **LOOKING BACK** Section 9.1 Energy overview



$$K_i + U_i + W_{ext} = K_f + U_f + \Delta E_{th}$$

TACTICS BOX 10.1

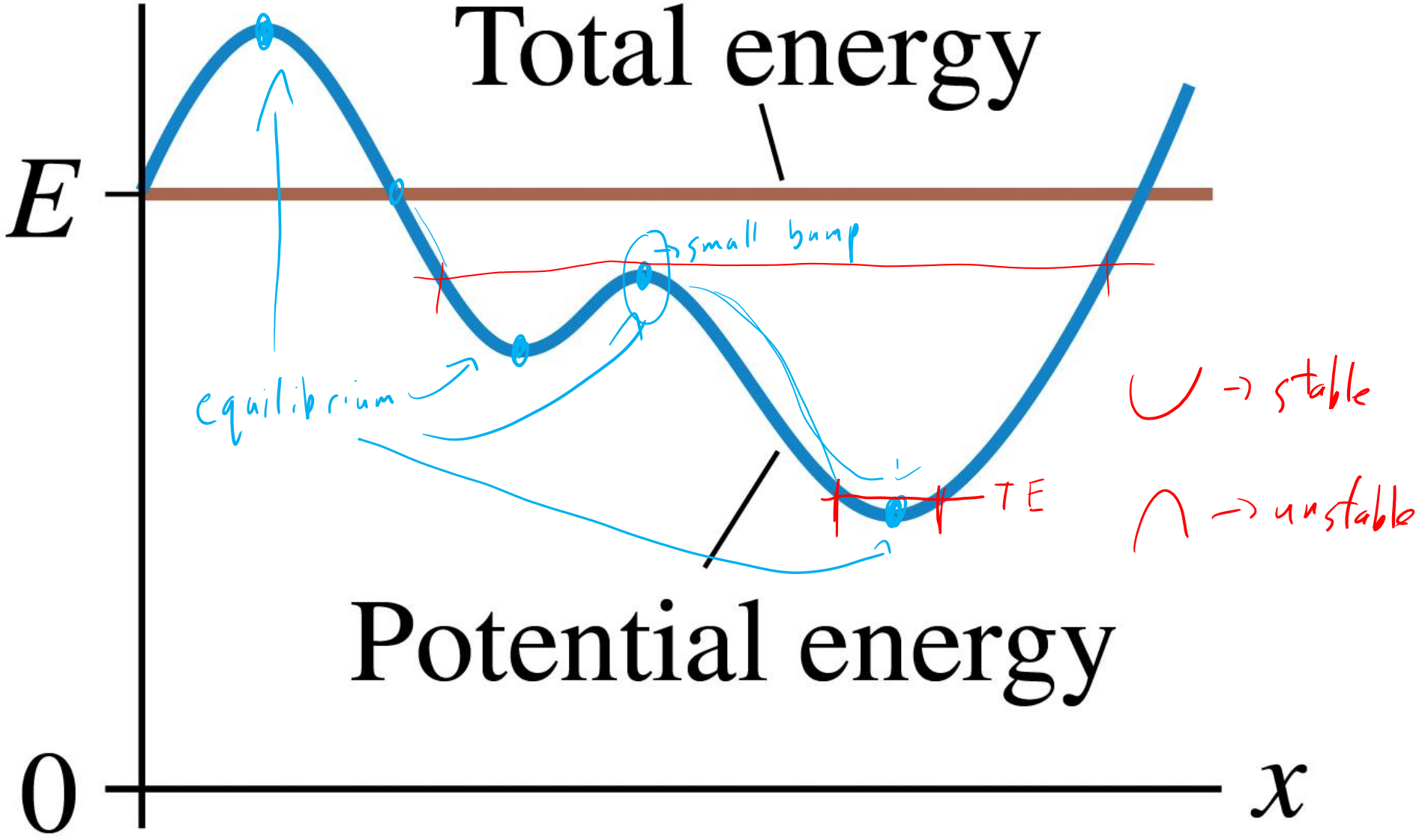
Interpreting an energy diagram



E(x) graph

1. The distance from the axis to the PE curve is the system's potential energy. The distance from the PE curve to the TE line is its kinetic energy. These are transformed as the position changes, causing the particle to speed up or slow down, but the sum $K + U$ doesn't change. $K+U=E$
2. A point where the TE line crosses the PE curve is a turning point. The particle reverses direction. $U=E \rightarrow K=0 \rightarrow v=0 \rightarrow$ stopped
3. The particle cannot be at a point where the PE curve is above the TE line. $\rightarrow K<0$ $\frac{1}{2}mv^2<0$ $v^2<0$?
4. The PE curve is determined by the properties of the system—mass, spring constant, and the like. You cannot change the PE curve. However, you can raise or lower the TE line simply by changing the initial conditions to give the system more or less total energy.
5. A minimum in the PE curve is a point of stable equilibrium. A maximum in the PE curve is a point of unstable equilibrium.

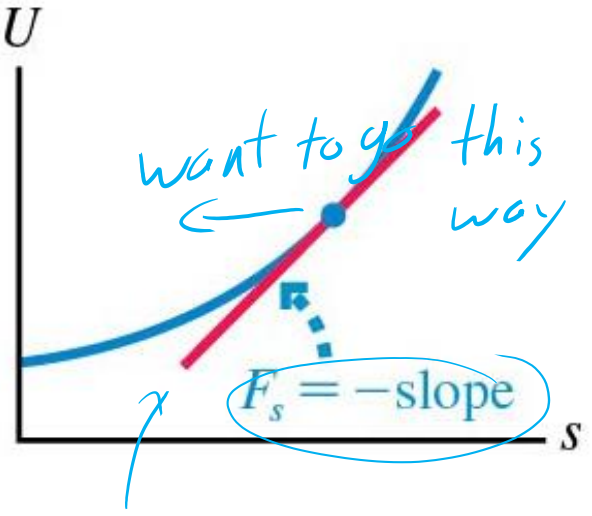
Exercises 15–17



How is force related to potential energy?

Only certain types of forces, called **conservative forces**, are associated with a potential energy. For these forces,

- The work done changes the potential energy by $\Delta U = -W$.
- Force is the negative of the slope of the potential-energy curve.

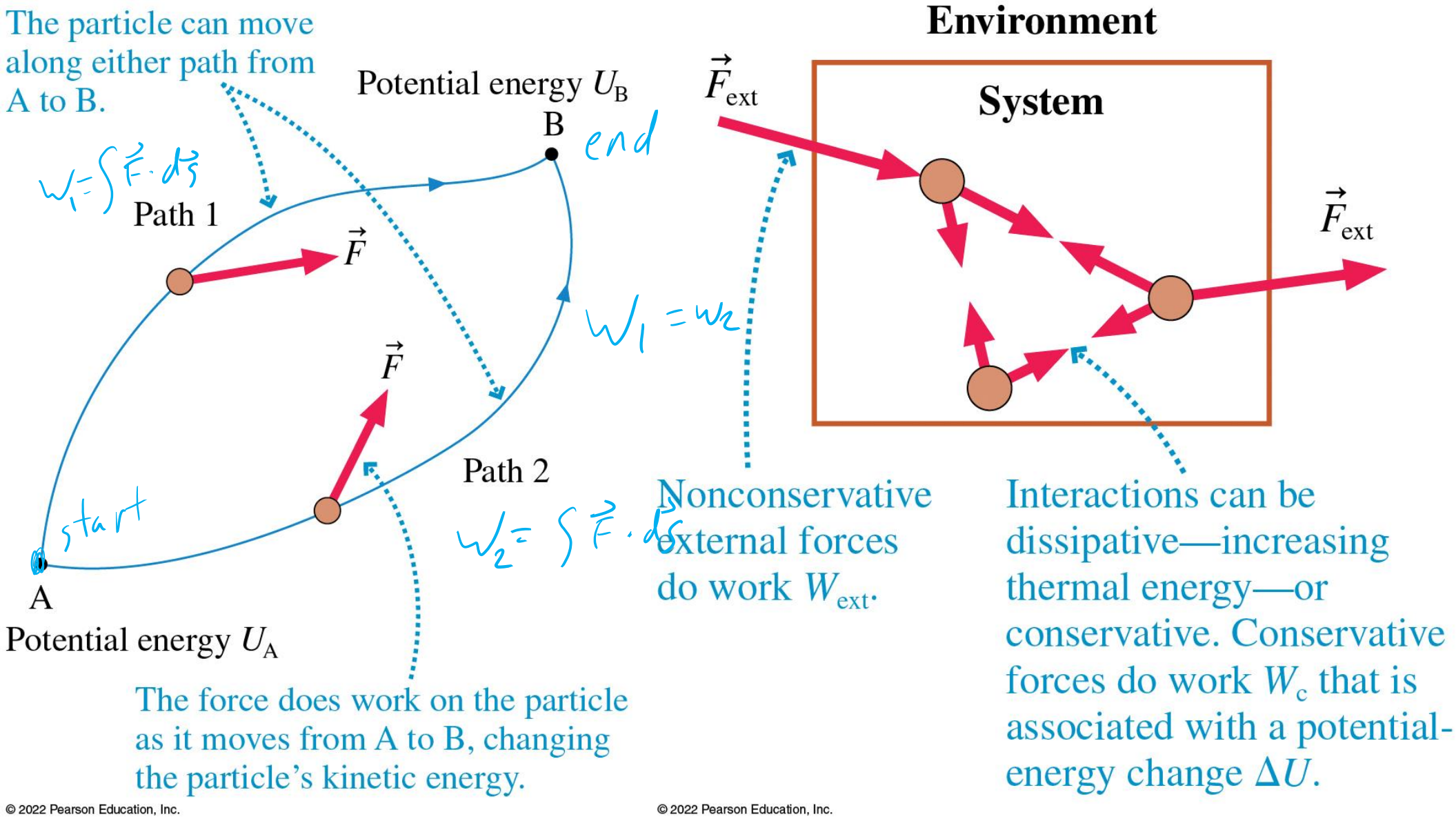


slope > 0

F < 0 → left

$-W = \Delta U = -\int \vec{F} \cdot d\vec{s}$

$\frac{dU}{ds} = -\vec{F}$



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