Definition of potential energy, \( U \): \[ W_c = U_i - U_f = -(U_f - U_i) = -\Delta U \]

- Falling object – gravity does + work, potential energy decreases
- Lifted object – gravity does – work, potential energy increases

Gravity

- \( W_c = Fd = mgh = U_i - U_f \)
- \( U_i = mgh + U_f \)
- If the final position has no potential energy due to height, then \( U = mgh \) (gravitational PE)

**Example 1**: Find the gravitational potential energy of an 80.0-kg person standing atop Mt. Everest, at an altitude of 8848 m. Use sea level as the location for \( h = 0 \).

**Example 2**: As a cliff diver drops to the water from a height of 40.0 m, her gravitational potential energy decreases by 25,000 J. How much does the diver weigh?

Springs

- \( W_c = \frac{1}{2} kx^2 = U_i - U_f \)
- If the final position of the spring has zero potential energy, \( U = \frac{1}{2} kx^2 \) (spring PE)

**Example 1**: Find the potential energy of a spring with spring constant \( k = 680 \text{ N/m} \) if it is (a) stretched by 5.00 cm or (b) compressed by 7.00 cm.

**Example 2**: When a force of 120.0 \( \text{N} \) is applied to a certain spring, it causes a stretch of 2.25 cm. What is the potential energy of this spring when it is compressed by 3.50 cm?
- Mechanical energy, \( E = U + K \)
- Mechanical energy is conserved in systems involving only conservative forces (\( E = \text{constant} \))
- Mechanical energy can change in systems with nonconservative forces, like friction — conversion of mechanical energy to thermal energy (heat)
- To show that \( E \) is conserved for conservative forces:
  \[
  W_{\text{total}} = \Delta K = K_f - K_i
  \]
  If the system only has 1 force acting on it and it is a conservative force:
  \[
  W_{\text{total}} = W_c
  \]
  If \( W_c = -\Delta U = U_i - U_f \), then
  \[
  K_f - K_i = U_i - U_f \quad \text{or} \quad K_f + U_f = K_i + U_i \quad \text{For cons. forces,} \quad E_f = E_i
  \]

**Example 1:** At the end of a graduation ceremony, graduates fling their caps into the air. Suppose a .120-kg cap is thrown straight upward with an initial speed of 7.85 m/s, and that frictional forces can be ignored.

(a) Use kinematics to find the speed of the cap when it is 1.18 m above the release point.

(b) Show that the mechanical energy at the release point is the same as the mechanical energy 1.18 m above the release point.

**Example 2:** In the bottom of the ninth inning a player hits a .15-kg baseball over the outfield fence. The ball leaves the bat with a speed of 36 m/s, and a fan in the bleachers catches if 7.2 m above the point where it was hit. Assume frictional forces can be ignored.

(a) Find the kinetic energy of the ball when it is caught.

(c) Find the speed of the ball when it’s caught.
Definition of potential energy, $U$:

- Falling object –
- Lifted object –

Gravity

- 
- 
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• Mechanical energy

•

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• To show that $E$ is conserved for conservative forces:

\[ W_{\text{total}} = \Delta K = K_f - K_i \]

If the system only has 1 force acting on it and it is a conservative force:

\[ W_{c} = -\Delta U = U_i - U_f, \]

then
\[ K_f - K_i = U_i - U_f \]

or
\[ K_f + U_f = K_i + U_i \]

For cons. forces, $E_f = E_i$

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