Theme Music: Information Society

Pure Energy

Cartoon: Wiley Miller

Non Sequitur
Potential energy

\[ \Delta U^{\text{gravity}} = \Delta (mgh) \]
\[ \Delta U^{\text{spring}} = \Delta \left( \frac{1}{2} kx^2 \right) \]
\[ \Delta U^{\text{spring}} = \Delta \left( \frac{k_c qQ}{r} \right) \]
Foothold ideas:
Kinetic Energy and Work

- Newton’s laws tell us how velocity changes. The Work-Energy theorem tells us how speed (independent of direction) changes.
- Kinetic energy: \( \frac{1}{2} mv^2 \)
- Work done by a force: \( F_x \Delta x \) or \( F_{\parallel} \Delta r \) (part of force \( \parallel \) to displacement)
- Work-energy theorem: \( \Delta(\frac{1}{2} mv^2) = \vec{F}^{\text{net}} \cdot \Delta \vec{r} \)
Conservative forces

- Forces (like gravity or springs) are conservative if when the force takes KE away, you can get it back when you go back to where you started.

- If the kinetic energy that a force takes away can’t be restored by going back to where you started it is called non-conservative.

- Compare gravity and friction:

  
<table>
<thead>
<tr>
<th>Gravity: Conservative</th>
<th>Friction: Non-Conservative</th>
</tr>
</thead>
<tbody>
<tr>
<td>lose KE</td>
<td>lose KE</td>
</tr>
<tr>
<td>gain KE</td>
<td>both ways</td>
</tr>
</tbody>
</table>

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Foothold ideas: Potential Energy

For some forces work only depends on the change in position. Then the work done can be written

\[ \vec{F} \cdot \Delta \vec{r} = -\Delta U \]

\( U \) is called a potential energy.

For gravity,

\[ U_{\text{gravity}} = mgh \]

For a spring,

\[ U_{\text{spring}} = \frac{1}{2} kx^2 \]

For electric force,

\[ U_{\text{electric}} = k \frac{Q_1 Q_2}{r_{12}} \]
Foothold ideas:
Conservation of Mechanical Energy

■ Mechanical energy
  – The mechanical energy of a system of objects is conserved if resistive forces can be ignored.

\[
\Delta (KE + PE) = 0
\]

\[
KE_{\text{initial}} + PE_{\text{initial}} = KE_{\text{final}} + PE_{\text{final}}
\]

■ Thermal energy
  – Resistive forces transform coherent energy of motion (energy associated with a net momentum) into thermal energy (energy associated with internal chaotic motions and no net momentum).

This is why we define the PE with a negative sign.