**Today’s Topics:**
- Power
- Conservative Forces
- Gravitational Potential Energy

Power: \[ P = \frac{W}{\Delta t} = \frac{F \Delta x}{\Delta t} = \]

Calculus form

Vector form

\[ P = \]

Units of Power:
- SI: 1 J/s = 1 watt (W)
- USC: 550 ft-lb/s = 1 horsepower (hp)
- Conversion: 1 hp = 746 W

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**Example Problem – Horsepower**

Determine the engine size (in hp) required for a 3000 pound car to climb a 10° hill at a steady speed of 50 mph (73.3 ft/s). Assume a retarding force of 150 lb from internal friction and wind resistance, and that the engine is 70% efficient.

\[ \text{1 hp} = 550 \text{ ft-lb/sec} \]

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**Conservative Forces**

- If the work done by a force on an object is _______________ of the path taken by the object from initial to final position then the force is _______________.

- If a conservative force acts on an object and the object follows a path that brings it back to its _______________ _______________ then the force will have done no net work on the object.

- Only need to know ___________ and ___________ positions.

- Which is a conservative force:

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**Conservative and Non-conservative Forces**

- Conservative forces
  - ________
  - ________

- Non-conservative (path dependent) forces
  - ________
  - ________

- Where does energy go with non-conservative forces?
  - ________
  - ________
  - ________
**Gravitational Potential Energy**

- Account for work from gravitational force based on initial and final position.
- Work that ________________ by gravity on the object if the object went from its current height to some reference position, \( h_{\text{datum}} \).
- Coordinate system is defined so that \( h_{\text{datum}} \) is __________.

\[
U_{\text{grav}} = 
\]

What sign do we use for \( g \)? __________

Suggestions on datum:
- Set at or below ______ elevation of problem.
- Gravitational potential energy will always be ________.

**Conservation of Mechanical Energy**

\[
K_0 + W_{\text{net}} = K_f
\]

Account for gravitational potential energy separately.

Sometimes convenient to separate \( W_{\text{other}} \) into work coming into the system, \( W_{\text{in}} \), and energy losses, \( E_{\text{loss}} \).

**Example Problem**

Roller coaster velocity
- \( F = ma \) approach
- Energy method

\[
K_0 + U_{\text{grav}0} + W_{\text{in}} = K_f + U_{\text{grav}f} + E_{\text{loss}}
\]

Which coaster has the greater speed at the bottom?

Which coaster reaches the bottom first?

A. Coaster 1
B. Coaster 2
C. Both the same
D. Cannot determine

**0.25-kg Cart Rolling Down Track**

\[
h_0 = 0.2 \text{ m} \quad h_f = 0.0 \text{ m}
\]

Car travels 1.6 m

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<th>Case</th>
<th>Initial Velocity</th>
<th>Friction</th>
<th>Work</th>
<th>( V_f ) (m/s)</th>
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<td>0.0 m/s</td>
<td>0</td>
<td>0</td>
<td>0.0 m/s</td>
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<td>0.8 m/s down</td>
<td>0</td>
<td>0</td>
<td>0.8 m/s</td>
</tr>
<tr>
<td>C</td>
<td>0.8 m/s up</td>
<td>0</td>
<td>0</td>
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<tr>
<td>D</td>
<td>0.8 m/s down</td>
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<table>
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<tr>
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<th>( KE_0 )</th>
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<th>( W_{\text{in}} )</th>
<th>( KE_f )</th>
<th>( PE_f )</th>
<th>( E_{\text{loss}} )</th>
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<tbody>
<tr>
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<td>=</td>
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