- Work

\[ \mathbf{E} = \mathbf{F} \cdot \mathbf{d} \] (vectors)

\[ \mathbf{E} = \int \mathbf{F} \cdot d\mathbf{s} \] (path)

\text{never going to do anything complicated}

- Transfer of energy

work has a \textit{sign}

- Potential energy

- Kinetic energy \(- \frac{1}{2}mv^2\)

"by virtue of position"

"by virtue of velocity"
<table>
<thead>
<tr>
<th></th>
<th>Potential (mgh)</th>
<th>Kinetic ($\frac{1}{2}mv^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>mgh</td>
<td>0</td>
</tr>
<tr>
<td>Q</td>
<td>0</td>
<td>$\frac{1}{2}mv_Q^2$</td>
</tr>
<tr>
<td>R</td>
<td>mghR</td>
<td>$\frac{1}{2}mv_R^2 = \frac{1}{2}m v_Q^2 \cos^2 \beta$</td>
</tr>
</tbody>
</table>

We used physics.

- Zero gravity
- Frictionless

Diagram notes:
- Points A, B, C, D
- Forces and energies indicated
- Calculations and equations noted
Total energy: \[ E_{T} = mgh + \frac{1}{2}mv_{O}^{2} \]

Conservation of energy: \[ E_{P} = E_{Q} \]

\[ E_{P} = \frac{1}{2}mv_{Q}^{2} \]

\[ E_{Q} = mgh + \frac{1}{2}mv_{O}^{2} \]

\[ \sqrt{\frac{1}{2}gh} = \frac{1}{\sqrt{2}}v_{O} \]

\[ \frac{\sqrt{1}}{\sqrt{2}} = \cos \theta \]

\[ \theta = \frac{\pi}{4} \]