Theme Music: Tom Petty

Free Fallin’

Cartoon: Bob Thaves

Frank & Ernest
The Equation of the Day

Weight and mass

\[ \vec{F}_{A}^{\text{grav}} = \vec{W}_{A} = m_{A} \vec{g} \]
# Quiz 4

## Question #1

<p>| | | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>1=4&gt;2=3</td>
<td></td>
<td>51%</td>
</tr>
<tr>
<td>1&gt;2=3&gt;4</td>
<td></td>
<td>13%</td>
</tr>
<tr>
<td>1&gt;2=3&gt;4=0</td>
<td></td>
<td>3%</td>
</tr>
<tr>
<td>1&gt;4&gt;2=3</td>
<td></td>
<td>12%</td>
</tr>
<tr>
<td>1=2=3=4</td>
<td></td>
<td>6%</td>
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## 2.1

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<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>mv/F</td>
<td>66%</td>
<td></td>
</tr>
<tr>
<td>F/mv</td>
<td>6%</td>
<td></td>
</tr>
<tr>
<td>mΔv/F</td>
<td>10%</td>
<td></td>
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<tr>
<td>m/Fv</td>
<td>2%</td>
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## 2.2

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<table>
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<tbody>
<tr>
<td>mv/f</td>
<td>47%</td>
<td></td>
</tr>
<tr>
<td>-mv/f</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>mΔv/f</td>
<td>9%</td>
<td></td>
</tr>
<tr>
<td>f/mv</td>
<td>3%</td>
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</tbody>
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## 2.3

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<tbody>
<tr>
<td>mv^2/2f</td>
<td>7%</td>
<td></td>
</tr>
<tr>
<td>mv^2/f</td>
<td>22%</td>
<td></td>
</tr>
<tr>
<td>fv/m</td>
<td>6%</td>
<td></td>
</tr>
<tr>
<td>mv/f</td>
<td>8%</td>
<td></td>
</tr>
<tr>
<td>f/mv^2</td>
<td>1%</td>
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</tbody>
</table>

Average score: 6.2
Foothold Principles
Newton’s Laws

- **Newton 0:**
  - An object responds to the forces it feels when it feels them.

- **Newton 1:**
  - An object that feels a net force of 0 keeps moving with the same velocity (which may = 0).

- **Newton 2:**
  - An object that is acted upon by other objects changes its velocity according to the rule

\[
\vec{a}_A = \frac{\vec{F}_{A}^{\text{net}}}{m_A}
\]

- **Newton 3:**
  - When two objects interact the forces they exert on each other are equal and opposite.

\[
\vec{F}_{A\rightarrow B}^\text{type} = -\vec{F}_{B\rightarrow A}^\text{type}
\]
Kinds of Forces

- Forces are what objects do to each other when they interact.

- Types of Force
  - Normal: $N$
  - Tension: $T$
  - Friction: $f$
  - Weight: $W$
  - Electric: $F^E$

\[
T = k \Delta L
\]

\[
f \leq \mu N
\]

\[
\vec{W} = m \vec{g}
\]
Foothold Ideas: Gravity

- Every object (near the surface of the earth) feels a downward pull proportional to its mass:
  \[ \vec{W}_{E \rightarrow m} = m \vec{g} \]
  where \( \vec{g} \) is referred to as the gravitational field.
- This is a Force even though nothing touching the object is responsible for it.
- The gravitational field has the same magnitude for all objects irrespective of their motion and at all points.
- The gravitational field always points down.
- It is measured to be \( g \approx 9.8 \) N/kg

What object causes \( W \)?

Why N/kg instead of m/s\(^2\)?
Response to Gravity: Free Fall

- After an object has been released,
  - if it is dense enough so the forces from the air can be ignored
  - if nothing else is touching it
the only force acting on it is gravity.

- The force of gravity is proportional to the mass.

\[
\vec{a} = \frac{\vec{F}^{\text{net}}}{m} = \frac{\vec{W}_{E\rightarrow m}}{m} = \frac{mg}{m} = \vec{g}
\]