Should have established an anchor...
The Physics of Climbing

The important physics concepts in climbing come from Newton's mechanics:

- Force of gravity
- Friction
- Equilibrium of forces
- Elastic forces
- Impact forces

\[
\text{Force} = \text{Mass} \times \text{Acceleration}
\]

\[
\text{Energy} = \text{Force} \times \text{Distance}
\]
Falling

\[ F_2 = \text{friction or upward force} \]

\[ W = \text{weight} \]

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**In equilibrium**

\[ W = F_1 + F_2 \]

\[ W - (F_1 + F_2) = 0 \]

**Net force = 0**

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**Not in equilibrium**

\[ \text{Net force} = W \neq 0 \]

\[ \text{(mass)}(\text{acceleration}) \]

\[ W = ma \]

\[ a = g = 9.8 \frac{m}{s^2} = 32 \frac{ft}{s^2} \]

Acceleration due to gravity
A multidirectional belay anchor withstand using upward and lateral forces.
Example 1

mass = \( m = 80 \) kg

Fall Factor = \( \frac{\text{length of fall}}{\text{length of rope out}} \)

= \( \frac{20}{10} = 2 \)

Energy of fall = \( mg \cdot h = (80)(10)(6) = 4,800 \) J

stopping distance = \( \text{length of rope} \times \text{elongation} \)

= \( (3)(0.20) = 0.6 \) m

Force = \( \frac{\text{Energy}}{\text{stopping distance}} = \frac{4,800}{0.6} = 8,000 \) N

= 8 kN = 11,800 lbf