How much tension must a rope withstand if it is used to accelerate a 1100 kg car vertically upward at 0.90 m/s²?

\[ \text{(Eq. 1)} \]

\[ T - mg = ma \]

\[ T = m(a + g) \]

\[ T = (1100 \text{ kg})(0.90 \text{ m/s}^2 + 9.8 \text{ m/s}^2) \]

\[ T = 11770 \text{ N} \]
A particular race car can cover a quarter mile track (402 m) in 6.00s, starting from a standstill. 

(a) Assuming the acceleration is constant, how many g's does the driver experience?

(b) And if the combined mass of the driver and race car is 495 kg, what horizontal force must the road exert on the tires?

\[ a_x = \frac{\frac{15}{9.8 \text{ m/s}^2}}{22.3 \text{ m/s}^2} \]

\[ a_x = 2.28 \text{ g} \]

\[ (F_{\text{net}})_x = m a_x \]

\[ (F_{\text{net}})_x = (495 \text{ kg})(22.3 \text{ m/s}^2) \]

\[ (F_{\text{net}})_x = 11,100 \text{ N} \]
An elevator (mass 4100 kg) is to be designed so that the maximum acceleration is 0.05g.

a) What is the maximum force the motor should exert on the supporting cable?

b) What is the minimum force the motor should exert on the supporting cable?

\[ T = m(a_y + g) \]

\[ T = 4100(0.49 + 9.8) \]

\[ T = 42,200 \text{ N} \]

For the minimum tension case, the elevator will be accelerating downwards at \[ a_y = -0.49 \text{ m/s}^2 \]

\[ T = m(a_y + g) \]

\[ T = 4100(-0.49 + 9.8) \]

\[ T = 38,200 \text{ N} \]
A person stands on a bathroom scale in a motionless elevator. When the elevator begins to move, the scale only reads 0.69 of the person's regular weight. Calculate the acceleration and direction of the elevator's acceleration.

1. Force Diagram for Person

\[
\text{\textbf{F}} \quad \text{\textbf{N}} \quad m \quad g
\]

2. \( F_{\text{net}} )_y = F_N - mg \)

3. \( F_{\text{net}} )_y = ma_y \)
\[
F_N - mg = ma_y
\]
\[
F_N = m(a_y + g)
\]
\[
0.69 \times g = m(a_y + g)
\]
\[
0.69g = a_y + g
\]
\[
0.69g - g = a_y
\]
\[
0.69(9.8\text{m/s}^2) - 1(9.8\text{m/s}^2) = a_y
\]
\[
|a_y| = 3.04\text{m/s}^2
\]
\[
\Rightarrow \text{ downwards (negative)}
\]

The reading on the bathroom scale is the normal force that the scale exerts on the person:

\[
F_N = 0.69mg
\]
a) What is the acceleration of two falling sky divers (m = 111.0 kg including parachute) when the upward force is equal to one fourth of their weight?

b) After popping open their parachute, the divers descend leisurely to the ground at constant speed. What now is the force of air resistance on the sky divers and their parachute?

\[ (F_{net})_y = F_{air} - mg \]
\[ (F_{net})_y = Xy(mg) - mg \]

\[ (F_{net})_y = ma_y \]
\[ Xy mg - mg = ma_y \]
\[ -3/4 mg = ma_y \]
\[ a_y = 3/4 (9.8 \text{ m/s}^2) \]
\[ a_y = 7.35 \text{ m/s}^2 \]

b) Constant velocity means no acceleration (a = 0)
Re-doing step 4 we have:

\[ F_{air} - mg = ma = 0 \]
\[ F_{air} - mg = 0 \]
\[ F_{air} = mg \]
\[ F_{air} = (111.0 \text{ kg})(9.8 \text{ m/s}^2) \]
\[ F_{air} = 1090 \text{ N} \]
A person jumps off the roof of a house 4.5m high. When he strikes the ground, he bends his knees so that his torso decelerates over an approximate distance of 0.70m. The mass of his torso (excluding legs) is 44kg.

a) Find his velocity just before he hits the ground.

\[ V_f = \sqrt{V_i^2 + 2a(x_f - x_i)} \]

\[ V_i = \sqrt{(0 \text{ m/s})^2 + 2(-9.8 \text{ m/s}^2)(0 - 4.5 \text{ m})} \]

\[ V_i = 9.39 \text{ m/s} \]

b) The person is no longer accelerating downwards at 9.8m/s\(^2\). His legs are pushing him upward while he decelerates his downward motion until finally \( V_f = 0 \text{ m/s} \).
\[ V_2^2 = V_1^2 + 2a(y_2 - y_1) \]
\[(0 m/s)^2 = (9.39 m/s)^2 + 2a(\frac{7 m - 0 m}{-50 s})\]

\[ a = 63.0 m/s^2 \]

2. \[ \begin{array}{c}
\text{Forces}\cr m_5
\end{array} \]

3. \[ \begin{array}{c}
(F_{net})_y = F_{legs} - mg.
\end{array} \]

4. \[ (F_{net})_y = ma_y \]

\[ F_{legs} - mg = ma_y \]

\[ F_{legs} = m(a_y + g) \]

\[ F_{legs} = (44 kg)(63.0 m/s^2 + 9.8 m/s^2) \]

\[ F_{legs} = 3200 N \]