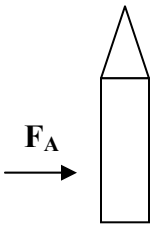
An example using Newton's Second Law

Ex. The Strongman Empire State Building (ESB) Push



To win the ESB Push competition, a contestant has to produce a constant acceleration of $.01\frac{m}{s^2}$ for 1 *s*.

In order to accelerate the mass of the ESB, a contestant would have to exert a constant force ***F*** *equal to m****a***.

Assume that the ESB is free to move on a frictionless surface and has a mass of $3.31*10^8$ *kg* (365,000 *tons*). What is the net force required to produce this size of an acceleration?

$$F = ma$$

$$F = (3.31*10^8 kg)\left(.01\frac{m}{s^2}\right)$$

$$F = 3{,}310{,}000 \text{ N}$$

Ex.

After the competition is over, an unknown vehicle quickly latches on to the ESB and proceeds to make a get-a-way. After dragging the ESB a few feet, he sees the police coming and quickly unhooks his 2150 *kg* truck and speeds away.

a) What is the acceleration of the truck if the truck engine can generate a force equal to that from the previous example?

$$F = ma$$

$$a = \frac{3310000N}{2150kg}$$

$$a = 1540\frac{m}{s^2}$$

b) After 10 *s*, what would be the thief's speed (assuming $v_i = 0$)?

$$v_f = v_i + at$$

$$v_f = 0\frac{m}{s} + \left(1540\frac{m}{s^2}\right)(10s)$$

$$v_f = 15400\frac{m}{s} \qquad or \qquad \sim 34{,}400\ mph$$

To put this number in perspective, the space shuttle at maximum thrust only reaches a velocity of ~ 17,300 mph.