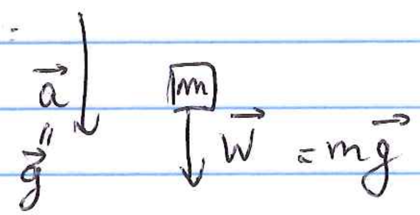
Newton's first law: $\vec{a} = 0$ unless $F_{net} \neq 0$
Newton's second law: $\vec{a} = \frac{\vec{F}_{net}}{m}$ or $\vec{F}_{net} = m\vec{a}$
Newton's Third law: $\vec{F}_{AB} = -\vec{F}_{BA}$

weight $\neq$ mass
weight = force due to gravity on an object of mass m
$\vec{W} = m\vec{g}$

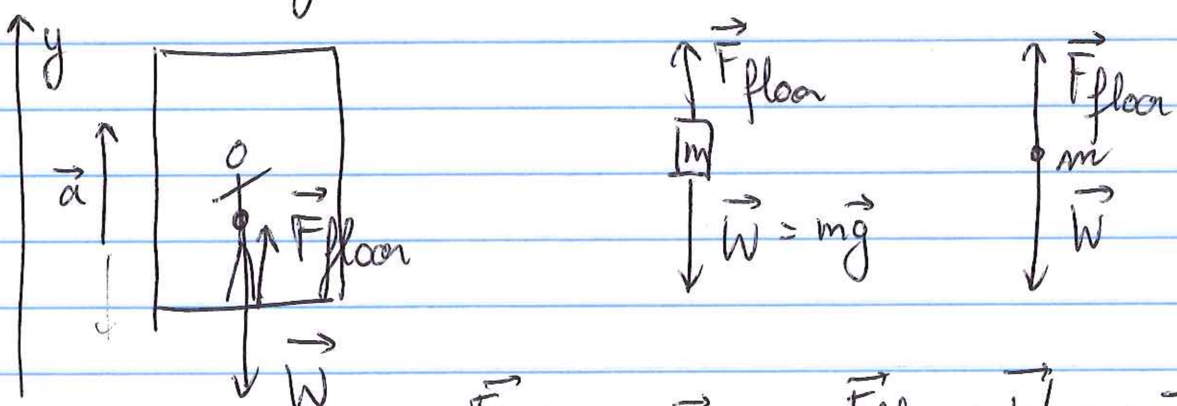
$\vec{g} = -9.80\ m/s^2$ down.

$g = |\vec{g}| = 9.80\ m/s^2$

free-body diagrams:



* Accelerating elevator:



$$\vec{F}_{net} = m\vec{a} = \vec{F}_{floor} + \vec{W} = m\vec{a}$$

$$y: \ F_{floor} - mg = ma$$

$F_{floor} = m(a+g)$

1) $\vec{a} = 0$, elevator at constant velocity $\rightarrow F_{floor} = mg$

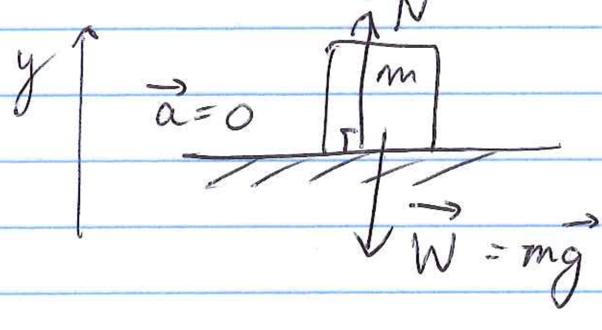
2) $a > 0$, accelerating up $\rightarrow F_{floor} = m(a+g) > mg$

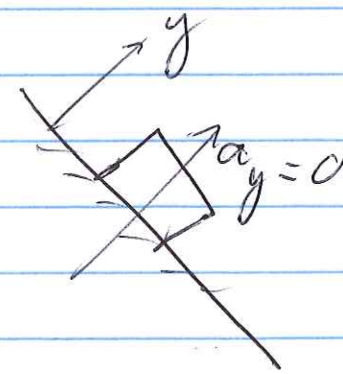
3) $a < 0$, accelerating down $\rightarrow F_{floor} = m(g - |a|) < mg$

↳ you feel lighter

* Contact forces : forces between macroscopic objects in contact with each other (electrical, chemical)

1) normal forces : perpendical force to the surface of the object

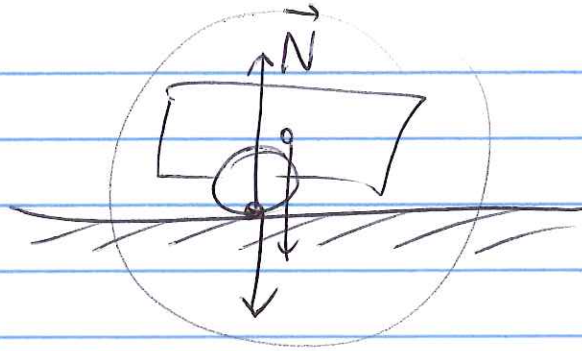




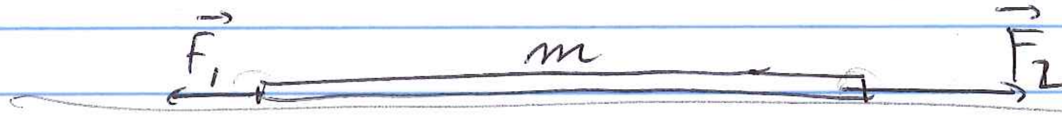
$0 = m\vec{a} = \vec{F}_{net} = N - mg$

↳ $\vec{N} = mg$

- "as large as it needs to be" to result in a zero acceleration perpendicular to the surface
- can only "push", can't "pull"



1) normal forces : can "push", can't "pull"
2) tension : can "pull", can't "push"



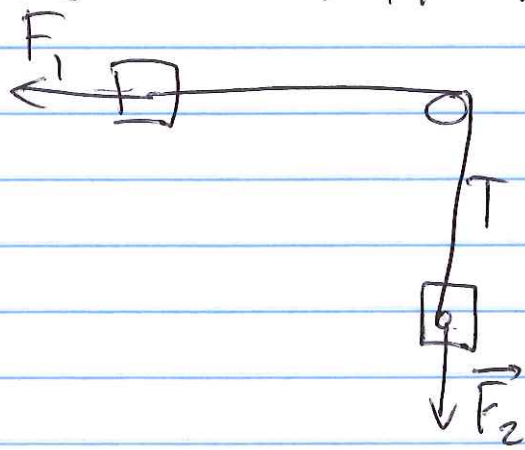
$$\vec{F}_{net} = \vec{F}_1 + \vec{F}_2 = m\vec{a} = 0$$

$$\hookrightarrow \vec{F}_1 = -\vec{F}_2 \Rightarrow T = |\vec{F}_1| = |\vec{F}_2|$$

$\vec{a} \neq 0$, m very small $\rightarrow m \approx 0$

$$\vec{F}_{net} = \vec{F}_1 + \vec{F}_2 = 0 = \cancel{m}^{0}\vec{a}$$

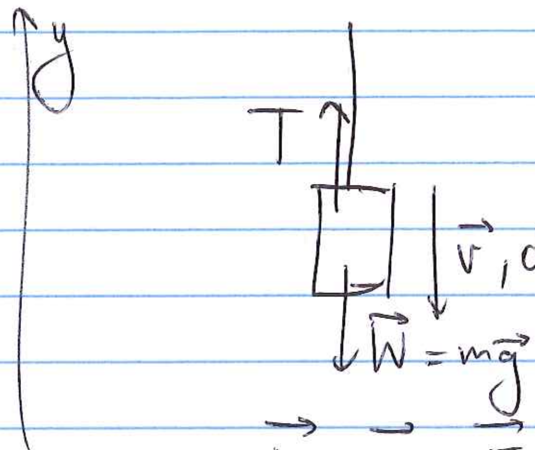
$$\hookrightarrow |\vec{F}_1| = |\vec{F}_2| = T$$



$$|\vec{F}_1| = |\vec{F}_2| = T$$

$\vec{v}$ constant

$\vec{a} = 0 \rightarrow \vec{F}_{net} = m\vec{a} = 0$



$\vec{v}$, decreasing speed

$\vec{a} \uparrow \quad \vec{a} > 0$

$$\vec{W} + \vec{T} = \vec{F}_{net} = m\vec{a} > 0$$

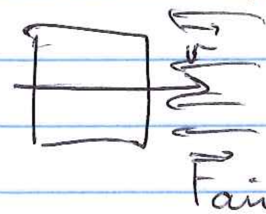
$$-mg + T > 0$$

$$T > mg$$

3) air resistance ; drag → how much does air affect the motion

$\vec{F}_{air} \sim - f(\vec{v})$

↑ opposite to $\vec{v}$

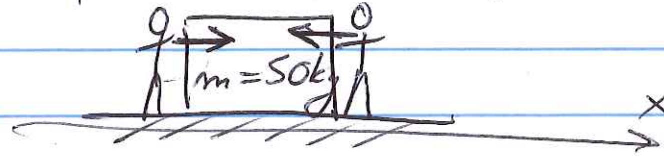


4) friction $\vec{f}$

$\vec{f} \sim \vec{N}$

* Examples:

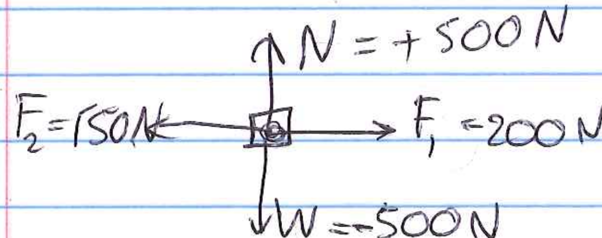
1) $\vec{F}_1 = 200N$ $150N = \vec{F}_2$



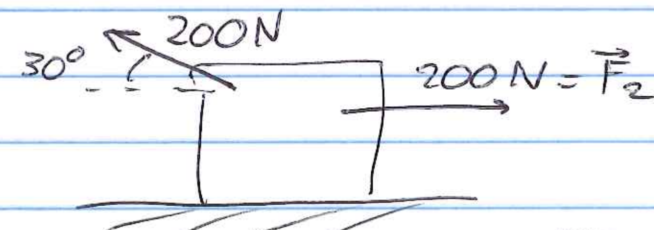
$$\vec{F}_{net} = \vec{F}_1 + \vec{F}_2 = m\vec{a}$$

$$+200N - 150N = \underline{50N} = m a_x$$

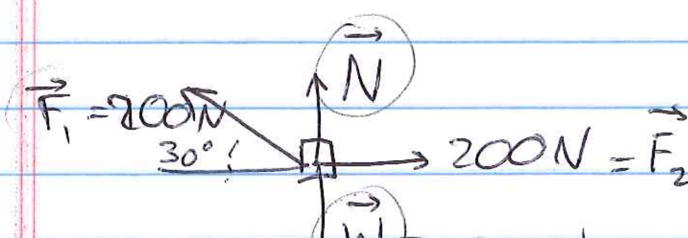
$$\hookrightarrow a_x = \frac{50N}{50kg} = +1 \, m/s^2$$



2)



$$\boxed{\vec{F}_{net} = m\vec{a}}$$



$$x \begin{cases} \overset{F_2}{\overset{\parallel}{200N}} - 200N\cos 30° = m a_x \\ -(500N) + \underline{N} + 200N \sin 30° = m a_y = 0 \end{cases} y$$

$$\begin{cases} a_y = 0 \rightarrow N = +390N \\ a_x = +0.54 \, m/s^2 \end{cases}$$