Newton's Laws

• **Newton's 1st Law (Same as Galileo's law of inertia): No force => no acceleration.**

"An object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction unless acted upon by a force."

$$\vec{F} = 0 \quad \Rightarrow \quad \vec{v} = const$$

• **Newton's 2nd Law:**

"Force equals mass times acceleration"

$$\vec{F} = m\vec{a}$$

• **Newton's 3rd Law:**

"Any Force of action has an equal and opposite Force of reaction "

$$\vec{F}_{B\to A} = -\vec{F}_{A\to B}$$

Unit of force is called Newton (N)

$$1N = 1\frac{kg \cdot m}{s^2}$$

Homework 10

When solving the problem below follow these steps:

- **Draw a picture with all the forces acting on the rocket shown.**
- **Use Newton's 2nd Law to find its acceleration. DO NOT SUBSTITUTE NUMBERS! Try to get a general formula for acceleration *a* in terms of *F, M,* and *g*.**
- **Now substitute appropriate numbers in your formula and get result for both (a) and (b)**

Problem

The Apollo mission to Moon was lunched by a very powerful rocket called Saturn V. The total mass of the rocket right before launch was $M=2.8\times10^6$ ***kg***. Total thrust (propulsion force) of 5 engines of the first stage is $F=34\times10^6$ ***N*** (Newtons). The rockets is launched vertically upward.

a) Find the ***total force*** acting on the rocket and acceleration of the rocket right after the launch. Neglect air resistance.

b) Similarly to part (a), find acceleration right before the fuel of the first stage is fully burned. The mass of the fuel is $m=2.1\times10^6$ ***kg.*** The force will remain constant at this point.