## 7.1 Force and Quantity of Matter

Newton, def of force acting on object: an impressed force is an action exerted upon a body, in order to change its state, either of rest, or of uniform motion in a right line.

inertial mass: "quantity of matter", constant of proportionality introduced to define magnitude of force.

→ Take standard mass, aka standard body.

Apply a force, inducing accel. $|\vec{a}|$

$|\vec{F}|$ is defined $|\vec{F}| \equiv m_s |\vec{a}|$, and the direction of $\vec{F}$ is defined as the direction of $\vec{a}$.

$\Rightarrow \quad \vec{F} \equiv m_s \vec{a}$

mass calibration

→ above, we applied different forces to the standard body, obtained different $\vec{a}$, and defined forces.

→ we could apply the same force to different bodies and calibrate the masses in terms of the mass of the standard body

mass thus measured is called inertial mass

$$F = m_{in} a_{in} = m_s a_s \Rightarrow m_{in} = m_s \frac{a_s}{a_{in}} \quad \text{or} \quad \frac{m_{in}}{m_s} = \frac{a_s}{a_{in}}$$

# 7.3 Momentum, Newton's Second and Third Laws

**Def** (Quantity of Motion, Momentum): $\vec{p} = m\vec{v}$

$m$: inertial mass

## Newton's Second Law

- "change of motion is proportional to the motive force impressed, and is made in the direction of the right line in which that force is impressed"

- suppose force applied to a body for interval $\Delta t$

impressed force or impulse produces change in momentum of the body

$$\vec{I} = \vec{F}\Delta t = \Delta\vec{p}$$

instantaneous action of the total force at time $t$

$$\vec{F} = \lim_{\Delta t \to 0} \frac{\Delta\vec{p}}{\Delta t} = \frac{d\vec{p}}{dt}$$

if mass is constant in time, $\vec{F} = m\dfrac{d\vec{v}}{dt} = m\vec{a}$

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

equation of motion