PHY 321, JANUARY 18, 2023

analyzing a physics problem

- inertial masses determined by measuring the acceleration for a given applied Force

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

- inertial masses are additive (and time independent, $\frac{dm}{dt} = 0$)

$$M = m_1 + m_2 + \cdots m_N = \sum_{i=1}^{N} m_i$$

$$\vec{F} = M \cdot \vec{a}$$

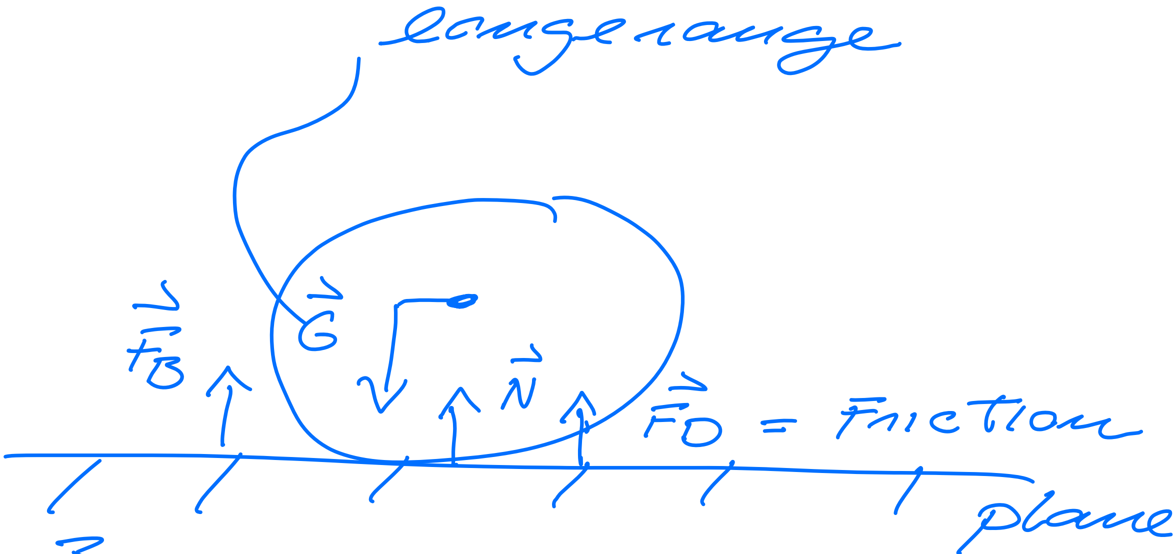
- only point particles

analyzing a problem:

1)
- Divide into system and environment
- all forces must have sources when they act on the system
- Forces are either long-range forces or contact forces

2)
- Draw a figure of the object and everything in contact with it
- Make a sketch
- Find contact points
- name all forces
- identify long-range and contact forces

- Decide upon choice of coordinate system



Buoyancy
different
air pressure

- Net external force

$$\vec{F}_{net} = m \cdot \vec{a} = \vec{G} + \vec{N} + \vec{F_D} + \vec{F_B}$$

Falling object
(1-dim)

$$\vec{F} = -G = -m \cdot g$$

$$= m \cdot \frac{d^2y}{dt^2}$$

$$v = \frac{dy}{dt} \qquad a = \frac{dv}{dt}$$

Define initial conditions

$$v(t_0) = v_0 \quad \wedge \quad y(t_0) = y_0$$

$$\int_{t_0}^{t} a \, dt' = \int_{t_0}^{t} \frac{dv}{dt'} \, dt'$$

$$= v(t) - v(t_0)$$

$$= \int_{t_0}^{t} (-g) \, dt'$$

$$= -g(t - t_0)$$

$$t_0 = 0 \quad \Rightarrow$$

$$v(t) = v_0 - g \cdot t$$

$$\int_{t_0}^{t} (v_0 - g t') \, dt' = y(t) - y_0$$

$$v_0 = 0$$

$$= -\frac{1}{2} g t^2 = y(t) - y_0$$

$$y(t) = y_0 - \frac{1}{2} g t^2$$

<u>approach 2</u> numerical approach

$$\frac{dv}{dt} = a \quad \wedge \quad \frac{dy}{dt} = v$$

Taylor expansion:

$$y(t + \Delta t) = y(t) + \Delta t \, y'(t) + \frac{(\Delta t)^2}{2!} y''(t) + O(\Delta t^3)$$

assume Δt small and truncate at Δt

$$y(t+\Delta t) \simeq y(t) + \Delta t\, y'(t)$$

$$t \Rightarrow t_i = t_0 + i\Delta t$$

$$y(t+\Delta t) = y_{i+1}$$

$$y(t) = y_i$$

$$y_{i+1} = y_i + \Delta t\, v_i$$

$$v(t+\Delta t) = v(t) + \Delta t\, v'(t)$$

$$\boxed{\begin{aligned} y_{i+1} &= y_i + \Delta t\, v_i \\ v_{i+1} &= v_i + \Delta t \cdot a_i \end{aligned}}$$

$$\Delta t = \frac{t_n - t_0}{n}$$

$y_0 \wedge v_0$ initial conditions